Perspectives

A Framework to Guide Thinking and Analysis Regarding Climate Change Policies

Ralph L. Keeney1 and Timothy L. McDaniels2*

The potential impacts from climate change, and climate change policies, are massive. Careful thinking about what we want climate change policies to achieve is a crucial first step for analysts to help governments make wise policy choices to address these concerns. This article presents an adaptive framework to help guide comparative analysis of climate change policies. The framework recognizes the inability to forecast long-term impacts (due in part to path dependence) as a constraint on the use of standard policy analysis, and stresses learning over time as a fundamental concern. The framework focuses on the objectives relevant for climate change policy in North America over the near term (e.g., the next 20 years). For planning and evaluating current climate policy alternatives, a combination of fundamental objectives for the near term and proxy objectives for characterizing the state of the climate problem and the ability to address it at the end of that term is suggested. Broad uses of the framework are discussed, along with some concrete examples. The framework is intended to provide a basis for policy analysis that explicitly considers the benefits of learning over time to improve climate change policies.

KEY WORDS: Values; learning; climate change; policy analysis

INTRODUCTION

Climate change induced by global warming is a profound concern for governments, organizations, scientists, and citizens throughout the world. Many large research efforts are under way to improve understanding of climate change, estimate its possible consequences, and reduce its potential severity. The consequences of climate change could be enormous in terms of the potential loss of ecological systems and biodiversity; loss of life; loss of cultures; and other adverse economic, social, and institutional impacts (Pearce et al., 1996). Many billions of dollars could be spent annually to reduce the possible extent of climate change, and to mitigate its consequences (Nordhaus, 1994).

Given the scale of these concerns, it is imperative that governments (particularly national governments in developed countries) make wise choices regarding major policy decisions about climate change and its potential impacts. An important question for analysts is how to help governments make those choices. As a first step, governments need to understand what they want to achieve with climate change policy choices.

This study used value-focused thinking (Keeney, 1992) to develop a set of objectives for climate change policy decisions by North American governments over the near term (e.g., to 2020). In brief, value-focused thinking argues that all decisions would benefit from early attention to values. Clarity about values is crucial for identifying information needs, creating more attractive alternatives, and serving as the basis for

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Policy decisions regarding climate change are profoundly complex, involving many conflicting objectives, enormous uncertainties, a vast array of alternatives, and a fragmented institutional structure. One normative framework for addressing such complexities is subjective expected utility theory (von Neumann & Morgenstern, 1947). Applying this analytical approach in public sector contexts requires some distinct steps. First, interested parties identify a set of fundamental objectives that are important to achieve by the set of alternatives implemented over time. Then policy analysts try to create a rich set of alternatives to achieve those objectives. After that, scientists use modeling tools to estimate the degree to which the various alternatives perform in terms of the objectives, given current understanding of the uncertainties. Finally, analysts identify the alternatives that best balance achievement of the multiple objectives, given a range of views on appropriate trade-offs among these objectives. A version of this normative framework, cast in terms of applied welfare economics, has served as the basis for much of the most widely cited policy analysis conducted for climate change policy choices (e.g., Nordhaus, 1994; Pearce et al., 1996).

Several authors have observed that standard tools of policy analysis are often not well suited to climate change policy choices (Morgan, Kandlikar, Risbey, & Dowlatabadi, 1999; Rayner & Malone, 1998). Others have questioned how well the standard tools have been applied in analyses to date (Demeritt & Rothman, 1999). Here we consider changes in the standard analytical approach, based on recognition that consequences of climate change will occur over hundreds of years, and that we cannot begin to accurately estimate the consequences of current decisions. The framework proposed below is intended to account for this reality.

At present, it is possible to specify a reasonable set of fundamental objectives of concern for climate change policy issues by drawing on interviews with knowledgeable people and previous writing. As an initial step in this study, these sources were used to develop a first-cut list of fundamental objectives (Table I) to represent “what matters” with regard to climate change policy decisions in North America. We used approaches in Keeney (1992) as a basis for developing a list of concerns and structuring it into a preliminary set of objectives. When considering the objectives in Table I, it is important to recognize that policy makers and societies are concerned about achieving these objectives in each year over a long period of time. The consequences of current climate change decisions will certainly be felt over several hundred years.

Analysts can also specify the policy alternatives that might be pursued at present. However, alternatives that might be pursued in the future will depend greatly on what has been learned from the current al-

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3 The focus on North America in this article is because that was the context in which the interviews that formed one basis for the work were conducted. Similar objectives would likely be relevant for policy decisions by all developed countries.

4 The period of 20 years was arbitrarily selected to represent a finite time period, in which it is possible to develop, implement, and begin to learn from policy decisions. If we happen to learn something significant in, say, 15 years, then major policy decisions should be revisited at that time, accounting for the new information.
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alternatives and the consequences of those alternatives. Hence, it soon becomes nearly impossible to think of reasonable sets of alternatives for time periods more than about 20 years into the future. It is also unreasonable to forecast the consequences of current policies over time horizons of hundreds of years, based on our current understanding of these impacts. Clearly the impacts of future alternatives will depend, to some extent—perhaps to a large extent—on what other actions are taken over time. That is, the future impacts depend greatly on the policy development path that is fostered by existing and future policies.

For over 30 years, economists and systems analysts have recognized the significance of “learning by doing,” or, as more recently termed, “path dependence,” as a major influence on the attractiveness of alternatives for long-term or repeated decisions (Arrow, 1962; Arthur, 1987). The significance of learning by doing has been specifically addressed in environmental policy contexts such as pest management and agriculture (Cowan & Gunby, 1996; Ruttan, 1996). One important example drawn from climate change policy choices is the future costs and efficiencies of new energy technologies. These costs will depend greatly on current and future efforts by governments and corporations to develop and implement new energy technologies, as well as the scale at which they are implemented. Hence, it is imperative to recognize path dependence in frameworks to analyze climate change policies (Dowlatabadi, 1998, H. Dowlatabadi, personal communication, October 21–22, 1998).

Several features make path dependence a fundamental concern in the analysis of climate change policy choices over the long term. These features include the repeated decisions that must be made annually over hundreds of years, the vast array of alternatives that could be considered in any year, the significant uncertainties over the efficacy of these alternatives (given the lack of institutional or applied experience with their implementation on a large scale), and the degree to which investing in learning about any of the alternatives may shape their future impacts. Hence, it is impractical and misleading to use the fundamental objectives, such as those in Table I, as the only basis to guide current policy decisions about climate change. It is impractical because of the uncertainties and path dependencies, and misleading because of the inattention to learning over time.

Figure 1A illustrates this point. For simplicity, suppose that decisions about climate change policies are made every 20 years and that some of their consequences are resolved over the next 20 years. Thus, for choices made in the year 2000, we subsequently learn their initial consequences, and other information through 2020. Then in 2020, additional decisions are made based on choices in 2000, their consequences, what was learned, and other new information. The 2020 decisions lead to additional near-term

Table I. Preliminary List of Fundamental Objectives for Climate Change Policy Decisions Over the Long Term

<table>
<thead>
<tr>
<th>Objective</th>
<th>North America</th>
<th>Outside North America</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. On human health and safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mortality</td>
<td>In North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>• Morbidity</td>
<td>In North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>2. On ecological systems and species</td>
<td>In North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>3. On human comfort</td>
<td>In North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>4. On economic productivity</td>
<td>In North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>5. On buildings and infrastructures</td>
<td>In North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>6. On ancient cultures</td>
<td>In North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>Minimize net direct costs of climate change policies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Financial costs</td>
<td>Inside North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>8. Other costs</td>
<td>Inside North America</td>
<td>Outside North America</td>
</tr>
<tr>
<td>Maximize equity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Among countries</td>
<td>Developed</td>
<td>Less developed</td>
</tr>
<tr>
<td>10. Among affected groups</td>
<td>Beneficiaries</td>
<td>Cost bearers</td>
</tr>
<tr>
<td>11. Among generations</td>
<td>Current</td>
<td>Future</td>
</tr>
<tr>
<td>12. Among species</td>
<td>Humans</td>
<td>Others</td>
</tr>
<tr>
<td>13. Among cultures</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Net” refers to the notions that efforts to address climate change may have indirect impacts that could be positive. This is the “no regrets” argument for climate change policy. Hence, the positive and negative indirect impacts of alternatives need to be considered in appraising the impacts of alternatives.
consequences and new information that should be used in making decisions in 2040. This sequence of deciding, revealing near-term consequences described in terms of the fundamental objectives, and learning repeats at 20-year intervals.

Given the pervasive and overwhelming uncertainties about climate change impacts, it is unworkable to evaluate alternatives for decisions made in 2000 in terms of the consequences over hundreds of years, defined only by the fundamental objectives in Table I. Yet this approach (or much more limited versions) is adopted in many of the previous efforts involving economic evaluation of climate change policy alternatives (Cline, 1992; Nordhaus, 1994; Pearce et al., 1996).

**A PRACTICAL FRAMEWORK**

**Shorter Time Frame**

It is clearly necessary to focus on a shorter time frame to lend useful insights about current climate change policies. The framework illustrated in Figs. 1B and 2 provides this focus. This framework is based on the set of objectives that decision-makers (and other interested and informed parties) hope to achieve over the next 20 years (or some other suitable near-term period for the climate change problem). These objectives should be useful for (1) characterizing how much progress has been made on the climate change problem in that 20-year period, and (2) indicating our ability to address the problem from that time forward.

Rather than attempt to model the long-term consequences of current decisions, analysts should use near-term proxy measures to describe the government’s ability to deal effectively with future decisions when they are made. Current policies that place governments in a better position to address the climate change problem in 2020 and beyond, and also minimize any detrimental consequences between now and 2020, would be preferred.

Hence, the framework outlined here emphasizes the sequential decisions faced by all governments in choosing and implementing climate change polices. It argues for an adaptive approach that focuses on selecting policies based on near-term consequences, and the learning they will provide to place governments in better positions to address climate change decisions in the future.

**Analogous Decisions**

The general approach described above is analogous to reasonable approaches for business and personal decisions that involve significant uncertainties and consequences that occur over relatively long time horizons. We briefly outline two examples, to indicate the intent for the more complex climate change problem.

Consider business decisions that influence both profits in the near term and the alternatives available in 2 years, in 4 years, and at later time periods. If one could model the consequences of sequences of decisions under various circumstances, the decisions today might be described in terms of their contributions to profits in each of the next 100 years. Realistically, management will likely not foresee all the important decisions they could face in the next 5 years, particularly in
some dynamic fields. A practical way to deal with this problem is to evaluate current alternatives in terms of their contributions to profits of the business in the short term (say, the next 3 years), as well as effects on its market share at the end of that 3-year period. The objective to maximize the market share of the business at the end of 3 years is a proxy for long-term profitability. It captures the ability of the business to make the necessary decisions 3 years from now to continue to survive and maximize profits in the future.

A class of personal decisions with similar characteristics has to do with an individual's investment for retirement. The way people allocate their money today between current consumption and savings influences the consequences they experience between now and the time of their retirement (e.g., consumption now versus funds available for retirement). The amount of funds people have at retirement is of concern because it is assumed that the more funds they have, the better able they will be to make decisions that will allow them to enjoy a quality life during retirement. Funds available for retirement are used to evaluate current decisions because people cannot now anticipate all the decisions they will face in retirement.

Both of these examples employ a combination of different types of objectives for evaluation. These include: (1) fundamental objectives for which performance of alternatives can be predicted in the short term (e.g., profits), and (2) other objectives that are proxies for achieving better long-term performance on the same fundamental objectives (e.g., market share as a proxy for long-term profits). The two kinds of objectives provide a practical basis for making current decisions that have both short-term and long-term implications.

**NEAR-TERM POLICY OBJECTIVES FOR CLIMATE CHANGE**

To specify a useful set of short-term policy objectives for climate change, discussions were held with four members of the Center for Integrated Study of the Human Dimensions of Global Change at Carnegie-Mellon University: Hadi Dowlatabadi, Baruch Fischhoff, Lester Lave, and Granger Morgan. After dis-

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**Fig. 2.** Schematic of a practical model for climate change policy choices. CC = climate change.
cussing the ideas mentioned above, each participant was asked to individually list all points they thought would be appropriate to strive to achieve by 2020 regarding climate change. These lists were then combined to create the set of policy objectives indicated in Table II.

The objectives presented in Table II capture three basic concerns:

- Progress regarding the ability to address long-term climate change problems,
- Progress in limiting the magnitude of the climate change problem by 2020, and
- Contributions (over the next 20 years) toward achieving the fundamental climate change objectives.

Figure 2 links these concerns with current policy decisions, policy objectives for decisions to 2020, and achievement of the long-term fundamental objectives. It shows that current climate change policies influence these three concerns of climate change policy objectives through 2020, represented by three arrows coming out of the box on the left of the figure. The column of boxes in the center of the figure, headed “Policy Objectives for 2020,” contains three boxes that represent the three kinds of objectives outlined in Table II. The top box of the middle column in turn influences our ability to make better decisions over time. All these boxes ultimately contribute to achieving the fundamental objectives for climate change policies over time.

Table III elaborates on the objectives introduced in Table II by providing some examples to illustrate what the objectives mean. The examples are not intended to be an exhaustive list, but rather to spur thinking. The objectives regarding learning (1–5) are necessary to better understand the problem. This understanding contributes to being able to make more informed decisions about climate change in the year 2020, as well as at any future time. Thus, learning objectives are both the means to better decisions in 2020 and an end in 2020 representing a proxy for decisions in future time periods. Learning is also a means that provides information to help better educate the public and officials about the extent and all other aspects of the climate change problem (6). Better education is a means objective to making better decisions in 2020, but also an end in 2020 that is a proxy for the will and ability to better deal with the problem past 2020.

Three specific objectives (7–9) are characterized for the ability to make more informed decisions regarding the 2020 alternatives. These include creating better alternatives in terms of both quality and quantity, being able to more clearly describe how well each of these alternatives meets longer term climate change objectives, and having the ability to implement the attractive alternatives.

The policy objective concerning severity (10) is of a different nature. By 2020, North American governments would like to reduce the severity of the climate change problem, or at least limit the increase in the severity of the problem. One might characterize severity in terms of the accumulation of greenhouse gases in the

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**Table II. Preliminary Policy Objectives for Climate Change Decisions by Governments in North America Over the Next 20 Years**

<table>
<thead>
<tr>
<th>Objectives regarding learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learn about science relevant to climate change</td>
</tr>
<tr>
<td>• Geophysical sciences (e.g., weather phenomena)</td>
</tr>
<tr>
<td>• Biosciences (e.g., species reaction to climate changes)</td>
</tr>
<tr>
<td>• Social sciences (e.g., social group response to climate change)</td>
</tr>
<tr>
<td>2. Learn about relevant engineering and application of science (e.g., creating energy generation technologies with much less pollution)</td>
</tr>
<tr>
<td>3. Learn about institutions and incentives (e.g., about strategies to enhance the success of international negotiations)</td>
</tr>
<tr>
<td>4. Learn about relative values of possible climate change consequences</td>
</tr>
<tr>
<td>5. Learn about the consequences of current climate change policies</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Objectives regarding education</th>
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</thead>
<tbody>
<tr>
<td>6. Better educate the public and policy makers about climate change</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objectives regarding alternatives in 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Create better alternatives in quantity and quality</td>
</tr>
<tr>
<td>8. Be better able to assess the consequences of the 2020 alternatives</td>
</tr>
<tr>
<td>9. Be better able to implement attractive alternatives</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Objectives regarding the problem severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Limit the severity of the climate change problem in 2020 (i.e., reduce or limit greenhouse gas concentrations and the rate of emissions by 2020)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objectives regarding fundamental consequences of the current alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Limit adverse consequences to humans and the environment</td>
</tr>
<tr>
<td>• Minimize health and safety consequences</td>
</tr>
<tr>
<td>• Minimize environmental consequences to species other than humans</td>
</tr>
<tr>
<td>• Reduce social disruption</td>
</tr>
<tr>
<td>• Maximize equity</td>
</tr>
<tr>
<td>12. Limit direct costs of current alternatives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objectives regarding accountability</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Be able to monitor and assess the value of current alternatives over the next 20 years</td>
</tr>
</tbody>
</table>
Table III. Preliminary Policy Objectives for Climate Change Decisions by Governments in North America Over the Next 20 Years with Examples in Areas Addressed

Objectives regarding learning
1. Learn about science relevant to climate change
   • Geophysical sciences (e.g., weather phenomena)
     —Better knowledge about climate change
     —Understand implications of climate change on extreme events
     —Biosciences (e.g., species reaction to climate changes)
     —Ecological impacts of climate change
     —Avoid irreversible losses of biodiversity
     —Social sciences (e.g., social group response to climate change)
     —Learn about how climate change introduces disparities among groups
     —Understand how climate change might induce conflicts among groups
2. Learn about relevant engineering and application of science (e.g., creating energy generation technologies with much less pollution)
   • Reduce carbon dioxide from generating electricity
   • Create new agriculture products
3. Learn about institutions and incentives (e.g., about strategies to enhance the excess of international negotiations)
   • Understand how local and regional institutions interact
   • Learn about modifying cultural demands for certain foods
   • Understand the role of international organizations
   • Learn institutional and regulatory effects on the evolution of energy systems
4. Learn about relative values of possible climate change consequences
5. Learn about the consequences of current climate change policies

Objectives regarding education
6. Better educate the public and policy makers about climate change
   • Educate about basic science and the problem
   • Educate about individual and business action to address problem

Objectives regarding alternatives in 2020
7. Create better alternatives in quantity and quality
   • Energy generation
   • Energy consumption
   • Market mechanisms
   • Regulatory mechanisms
8. Be better able to assess the consequences of the 2020 alternatives
   • Assess consequences in terms of fundamental objectives
   • Identify potential irreversible consequences
9. Be better able to create and implement attractive alternatives
   • Create alternatives to achieve each climate change objective
   • Develop public support for action
   • Build will to have higher level responses
   • Develop institutions to facilitate implementation of climate change policies
   • Foster cooperative actions to address climate change
     —Among nations
     —Among organizations
     —Among groups

Objectives regarding the problem severity
10. Limit the severity of the climate change problem in 2020 (i.e., reduce or limit greenhouse gas concentrations and the rate of emissions by 2020)
    • Mitigate emissions

Objectives regarding fundamental consequences of the current alternatives
11. Limit adverse consequences to humans and the environment
    • Minimize health and safety consequences
    • Minimize environmental consequences to species other than humans
    • Reduce social disruption
    • Maximize equity
    • Identify potential irreversible consequences
12. Limit direct costs of current alternatives

Objectives regarding accountability
13. Be able to monitor and assess the value of current alternatives over the next 20 years
atmosphere (or change in radiative forcing), as well as the rate of change in those parameters at that time.

The next two policy objectives (11, 12) address the contributions toward achieving the fundamental climate change objectives over the next 20 years. One might expect that there would be limited direct adverse consequences to humans and the environment over that time period, but the economic cost of the alternatives could be significant.

The last policy objective (13) concerns accountability and the ability to monitor progress on meeting the objectives. Governments and societies want to be able to assess and demonstrate the value (or lack of value) of the alternatives chosen and implemented, and want to be informed to adapt decisions as appropriate.

BROAD USES OF THIS FRAMEWORK

Most analyses of climate change policies start with a few generic alternatives as we understand them today, and then evaluate possible consequences of this limited set of alternatives over hundreds of years. The framework outlined in this article breaks analysis into smaller pieces. It starts with values articulated by a combination of fundamental objectives and means objectives that are proxies for long-term performance on the fundamental objectives. These objectives can be used both to create and evaluate alternatives. It is a practical approach that attempts to address the long-term complexities, uncertainties, and path dependencies of climate change alternatives.

One important use of the framework is to provide a basis for creating attractive alternatives at the current time. Simply put, analysts should ask what types of alternatives might best achieve each of the objectives, considering them one at a time. The responses could be assembled into richer sets of alternative strategies that extend beyond the current alternatives (Keeney, 1992). Another major purpose of the policy objectives is to provide guidance for discussing and evaluating current alternatives regarding climate change. The objectives indicate the type of information that is useful for appraising current policy alternatives. Such information would be helpful regardless of whether any formal evaluation of the alternatives occurred.

The objectives also provide a basis for a comparison of different kinds of alternatives. These may include such diverse strategies as investments in learning that improve our ability to deal with the climate change problem in 20 years, and investments that try to reduce the problem today. Comparisons of this nature may rely on formal analyses that identify measures (i.e., attributes) to specify the degree to which each of the policy objectives is achieved, state possible ranges of impacts for consideration, and then assess utility or value functions (Keeney & Raiffa, 1993). To have the most value, such analyses should be conducted from multiple perspectives, that indicate how different individuals or groups view these trade-offs, and explore the implications of the differences. A less mathematical approach could also provide useful insights about the relative significance of the different policy objectives at this time, assuming measures and ranges are clarified.

When considering priorities among objectives, it is useful to recognize that the significance of the different objectives will likely change over time. At present, analysts might expect that greater importance is placed on objectives involving learning about the problem, as opposed to reducing the problem and minimizing fundamental consequences. Over time, the relative significance of these kinds of objectives could switch, because governments may have learned how better to deal with the problem, or because the fundamental consequences may become more serious over time, or both.

CONCRETE EXAMPLES USING THIS FRAMEWORK

Use of this framework should provide some important insights that are different from those suggested by using other frameworks (e.g., Brunner, 1996; Nordhaus, 1994; Pearce et al., 1996; Rayner & Malone, 1998). Specifically, use of this framework should (1) help identify alternatives to learn more about how to make appropriate choices in the future, (2) provide a basis for comparing the value of gaining more information now versus trying to limit the consequences of climate change directly by actions now, and (3) promote relevant research on aspects of global climate change other than scientific and technological issues—particularly values. Current approaches were not designed to create or evaluate alternatives in terms of such considerations.

Evaluating Consequences of Current Policies

One obvious application of this framework is to provide the basis for evaluating the consequences of current policies. As indicated in Fig. 2, these evaluations would include consequences that address (1) limiting the severity of the climate change problem during the period to 2020, (2) achieving the fundamental objectives during the period to 2020, and (3)
preparing to more effectively address climate change problems in 2020 and beyond. The learning and creation of alternatives included in the third set of concerns are not explicitly addressed in current policy analysis approaches. Such analyses could include detailed modeling and integrated assessment studies at one extreme, or educated judgments by technical experts at the other extreme. The evaluations could be conducted ex ante or ex post. To indicate the utility of employing the proposed framework in this manner, we briefly outline the viewpoints of our colleague, Hadi Dowlatabadi, on how well the Kyoto Accord is likely to address these three fundamental concerns. We also draw on the views of another colleague, Anand Patwardan, to briefly discuss how the Kyoto Accord could address the ability to foster cooperative policy approaches. These views illustrate how discourse on this important policy can be structured informatively through the use of the proposed framework.

Limiting the Severity of the Climate Change Problem to 2020

The main thrust of the Kyoto Accord is to limit the greenhouse gas emissions of the industrialized countries to within a few percent of 1990 levels for the period 2008 to 2012. If the Accord is ultimately successful in achieving this target, then one could say that it has limited the growth (more accurately, slowed the growth rate) of the climate change problem during the period to 2020. However, there are major concerns about how successfully the Accord will achieve this stated target. First, it seems clear that most or all of the signatories to the Accord will find it difficult or impossible to meet their commitment, given current trends. Second, one can readily show that a target based on annual emission quotas is far more difficult to achieve and maintain than another target less sensitive to economic cycles, such as greenhouse gas levels in the atmosphere. Fluctuations in annual emissions due to economic cycles could lead to confusing economic signals about the cost of controls, and weaken the long-term signals for innovations to address climate change precursors. Third, in an attempt to allow flexibility in approaches to greenhouse gas controls, emissions trading was permitted. This approach opened up the possibility that greenhouse gas emissions may not be controlled in the industrialized nations, but by their hapless partners, desperate for capital to develop their domestic economies. Fourth, by allowing flexibility mechanisms involving sinks and other greenhouse gases, the problems of monitoring and enforcement were made so complicated that they diverted the attention of parties to the protocol more toward how to close loopholes in the treaty rather than how to meet its intent. Finally, in a few nations in which emissions are lower than 1990, the underlying reasons are invariably significant changes in level or patterns of the domestic economy and energy markets (e.g., the dissolution of the Soviet Union, the reunion of Germany, and the collapse of the National Union of Coal Miners in the United Kingdom). Hence, the treaty is unlikely to lead to emission reductions in the intended regions (H. Dowlatabadi, personal communication, October 21–22, 1998 and October 30, 2000).

Achieving the Fundamental Objectives of Climate Change Policies to 2020

Table I showed that, as a first cut, the fundamental objectives fall into three categories: (1) minimizing the adverse (net) impacts of climate change on a wide range of subobjectives; (2) minimizing the costs of climate change policies; and (3) maximizing equity among various groups, including nations. Regarding the first of these, integrated assessment modeling shows that if the 1990 limits for emissions are successfully re-established in industrialized nations, the reduction in the growth rate of atmospheric greenhouse gases would have a near negligible influence on the global climate change trajectory. In other words, the Kyoto Accord does little to minimize the adverse impacts of climate change, in the period to 2020, other than by possibly reducing the rate of growth of greenhouse gas concentrations, which was addressed above. Regarding the costs of climate change policies, the emphasis on emissions trading in the Kyoto Accord may serve to reduce the costs of achieving a given level of emissions reduction, if the experience with emissions trading in other contexts transfers to this one. However, emissions trading has never occurred between countries at very different levels of economic and social development. This difference among buyers and sellers has, in other contexts, often led to inequitable outcomes for poorer nations. This experience suggests that there is a significant chance that trades between the industrial and less industrial countries will lead to the latter forgoing development paths that would serve their needs better. More broadly, the fundamental inequity arising from the Kyoto Accord is that climate change is far from being the most important challenge facing less industrialized countries. By focusing attention on climate change, the Kyoto Accord effectively limits the opportunities available to
address more pressing problems in less industrialized countries (H. Dowlatabadi, personal communication, October 21–22, 1998 and October 30, 2000).

Preparing to More Effectively Address Climate Change Problems Beyond 2020

Objectives concerned with preparing to more effectively address climate change problems beyond 2020 are those for which the Kyoto Accord is perhaps the least effective. Given the recognition that the emissions limits in the Kyoto Accord are not large enough to avoid the adverse impacts of climate change, then the rationale for the Accord has to lie elsewhere. One obvious place would be in providing a basis for learning more about climate change, its impacts, and means to control them both. Yet there are many ways in which the terms of the Kyoto Accord could do better in fostering learning.

The emphasis on emissions trading is one way in which the Accord provides flexibility, and possibly more opportunities for certain kinds of learning, compared with the alternative of more command and control-oriented regulation. Yet there are reasons to be concerned that emissions trading may lead to rejection of other approaches to controls in the future. The self-interest of emission traders could motivate further insistence on using similar mechanisms. On the other hand, taxation-based regulatory mechanisms may lead to governments growing used to the revenue streams. In either case, a fixed commitment to a given policy regime (which is seen as desirable from the view of those who are being regulated) would likely mean little flexibility in exploring other regimes, a result that is highly constraining when the consequences of different regimes are largely unknown (H. Dowlatabadi, personal communication, October 21–22, 1998 and October 30, 2000).

Other aspects of the contributions of the Kyoto Accord to learning about climate change are also cause for concern. Some argue that the scale and scope of the Kyoto Accord as an explicit policy experiment is not sufficient to teach us much about many aspects of the problems in which learning is much needed. Other more basic concerns are that the Kyoto Accord is not explicitly set up and viewed as an experiment. With a more modest program, targeted at willing (or appropriately motivated) industrial partners, societies could have gained experience with the methods and costs of controls in a more limited arena. Such a program would have had far fewer degrees of freedom, and could have already run its course, informing the next steps. However, the Kyoto Accord has been successful in providing opportunities for learning about diplomacy and some kinds of science, particularly monitoring and enforcement. It has certainly identified some of the challenges in reaching a practicable global accord (H. Dowlatabadi, personal communication, October 21–22, 1998 and October 30, 2000).

There is one important dimension of the objectives in Tables II and III for which the Kyoto Accord could potentially perform well in terms of preparing to more effectively address climate change problems in the future. This objective is the ability to create and implement better alternatives, through efforts to foster cooperative actions to address climate change among nations and organizations. Clearly, cooperation and substantial commitments by many nations and organizations will be needed if we are to address climate change in a meaningful manner. How to foster cooperation in common property dilemmas has been a topic of increasing study in the last 2 decades (e.g., Axelrod, 1984). Some of the key lessons are that credible, unilateral commitments are important to build trust among the parties. The Kyoto Accord does provide a framework that outlines credible, unilateral commitments of the developed nations. If these nations are able to meet these commitments, they set the stage for future cooperative steps through commitments by others (Patwardan, 2001). It seems likely that controversy over whether the United States and other developed nations should meet their commitments under the Kyoto Accord stems, in part, from the desire to foster further commitments by others, as opposed to the direct benefits of the Kyoto Accord actions.

Future Research Efforts

Social Science Research

At present, research programs regarding climate change are largely oriented toward acquiring additional knowledge in both the physical and biological sciences. Yet the underlying motivation is largely to reduce potential negative impacts on humans and societies. The first policy objective in Table III identifies the importance of understanding the potential impacts on humans and groups that could occur because of climate change. If individuals and societies can anticipate what changes might occur, they may have more opportunities to prepare and lessen potential negative impacts and conflicts. In other words, use of this framework could potentially help strengthen the
adaptive capacities of societies to cope with adverse impacts (Kane & Yohe, in press; Smit, Burton, Klein, & Street, in press).

Institutional Research

Suppose sufficient learning has occurred so that scientists, policy makers, and affected parties all agree on what needs to be done to address climate change. At such a point, will what needs to be done actually happen, in a timely manner? The factors limiting the implementation of appropriate action will likely include institutional practices as stumbling blocks (Gunderson, Holling, & Light, 1995; O’Riordan et al., 1998). Better understanding is needed of the practices, advantages, and shortcomings of current institutions, both international and national, in order to make and implement appropriate decisions. The third policy objective in Table III focuses on this need.

Identifying Potential Irreversible Consequences

Concern over irreversible consequences is one of the major drawbacks of a policy that emphasizes waiting before undertaking strong actions to address climate change. As suggested by the seventh policy objective in Table III, creating a comprehensive list of potential irreversible consequences (that could subsequently be agreed upon by relevant institutions) is an important step to clarify thinking about these irreversible consequences. The list should include the consequence, a current assessment of chance of occurring, judgments about if and when it might occur under various global change scenarios, and its importance if it occurs. Such a list should lead to alternatives that would reduce the likelihood of some irreversible consequences, and also provide a clearer rationale for some stronger actions sooner.

Specifying Relative Values of Global Warming Consequences

The proposed framework calls for balancing learning versus limiting the future severity of the climate change problem versus avoiding current consequences of climate change. Governments should consider a major project which would involve assessing relative priorities for achieving different amounts on each of the 12 policy objectives in Table III. For example, would it be more desirable to limit energy consumption to the current level for 20 years or to reduce greenhouse gas emissions from existing fossil energy facilities by 20%? How much is it worth, in terms of other objectives, to reduce worldwide greenhouse gas emissions by 5%? With involvement from many knowledgeable people, it would be possible to assess utility functions over the ranges of possible consequences corresponding to the 12 policy objectives. This step should indicate areas of agreement and disagreement and the reasons why.

The values in Tables I and II indicate the reasons that we (Western societies) care about climate change. Hence, these objectives should be fundamental for thinking and dialogue, and provide guidance for all that we do to address climate change. Simply stated, what we should do is to achieve our values as best we can. It is extremely complex to forecast the consequences of any action, but it is easier—although still very difficult—to assign relative values to these possible consequences. Hence, assessing these values is an important area for productive work on climate change policy.

DISCUSSION

Given the attention devoted to climate change, there has been remarkably little effort focused on articulating the range of multiple objectives that should guide climate change policies. This limitation is serious, as has contributed to the discord over current policy choices. The proposed framework provides a reasonable basis for (1) fostering more thoughtful and well-structured debate about policies, (2) creating more attractive alternatives, (3) identifying information requirements, and (4) evaluating policies. We also hope it will encourage a reorientation of thinking about what good policies, and good policy analysis, should entail for climate change.

We propose an adaptive approach that explicitly calls for viewing near-term climate change policies as initial steps, or experiments, within a long sequence of repeated decisions (Holling, 1976, 1995). Questions of how learning occurs in such contexts, the conditions that favor or impede it, and how it is synthesized have been explored by others, but much remains to be done on such issues (O’Riordan et al., 1998; Parson & Clark, 1995). To our knowledge, this is the first attempt to characterize concerns for learning in terms of objectives for creating and evaluating policies; that is, as an explicit aspect of policy analysis for climate change. Given where we are on the learning curve for policies to address climate change, learning seems to be an important component for any well-designed policy.

The proposed framework should lead to consid-
eration of a much wider range of policies than under consideration at present. It should also lead to broader evaluations of existing policies. For example, minimizing costs and reducing greenhouse gas emissions appear to be the predominant objectives driving current policies in North America regarding climate change. This framework should lead to creation and evaluation of alternatives based on a wider array of fundamental objectives (as in Table I), as well as on the basis of proxy objectives that characterize how well governments will be able to address climate change in the future (Tables II and III). Current policy analyses do not lend insight into the pros and cons of such alternatives.

Whether new alternatives that could be fostered through this framework are superior to existing policies remains to be seen. Yet the reality is that we do not understand many factors that will influence the consequences of current climate change policies. It then seems that policies that are based on a broader set of objectives and are oriented explicitly toward preparing societies to make more informed choices over the longer term will be crucial for achieving the fundamental objectives that are the reasons why we are concerned about climate change.

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