

Beyond the Kyoto/Marrakech Protocol: Options and Strategies

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Abstract

This essay argues that the Kyoto Protocol was flawed not because it went too far in its objectives relative to mitigating the global warming problem, but because it did not go far enough. The rejection of the protocol by the United States is welcomed because it creates an opportunity for reappraisal of the problem and consideration of what suite of policies might make better sense in the circumstances. Given the long time scales over which trace gases are resident in the atmosphere, the author argues that a “buying time” strategy makes the most sense.

This perspective is justified by a combination of defining the policy problem comprehensively and showing, through a close reading of the history of the negotiations leading up to the Kyoto Protocol and the Marrakech implementation agreement, that such negotiations can lead only to “solutions” that fall far short of the mark. The objective of a “buying time” strategy is to push out the time horizon of irreversible impacts while the international community struggles to mount an effective response to the problem. This “buying time” strategy combines increasing efficiency via a carbon tax, emissions trading, revenue recycling, shifting out of coal to an emphasis on natural gas and nuclear power, and a serious evaluation of all options to sequester carbon.

Introduction

Prior to the resumption of international negotiations on the Kyoto Protocol to the Framework Convention on Climate Change which were scheduled to be held in Marrakech during October/November 2001, the Bush Administration decided to terminate United States (U.S.) participation in these proceedings. The Protocol was completed in Marrakech on November 10, 2001 (Revkin 2001) and is likely to come into force some time after Summer 2002 since all fifteen members of the European Union (EU) stated their intention to ratify the agreement en bloc (Environment News Service 2001). The EU ratified the Protocol on May 31, 2002 and Japan on June 4, thereby representing 35.4 percent of global emissions of CO₂ as of 1990. Fifty-five percent of global emissions of CO₂ as of 1990 is required for the Protocol to enter into force. In 1990 the U.S. accounted for 36.1 percent of global emissions of CO₂ (Showstack 2002).

Some, like the Bush Administration, opposed the draft Kyoto Protocol because they claim that its measures would hurt U.S. industry and society and, as such, the Protocol went too far. Others, like this author, argue that the Protocol was seriously flawed because it did not go far enough. Even so, the decision of the Bush Administration is to be welcomed because it gives the U.S. the opportunity to reappraise the problem and consider what suite of policies might make the most sense under the circumstances. This paper is an attempt to contribute to such a re-appraisal. Let us then go back to first principles.

Defining the Policy Problem Posed by Global Warming

The Intergovernmental Panel on Climate Change (IPCC) completed its Third Assessment in 2001. Among its major conclusions are the following points:

1. The global average surface temperature has increased over the 20th century by about 0.6°C.
2. Temperatures have risen during the past four decades in the lowest 8 kilometers of the atmosphere.
3. Snow cover and ice extent have decreased.
4. Global average sea level has risen and ocean heat content has increased.

5. Concentrations of atmospheric greenhouse gases and their radiative forcing have continued to increase as a result of human activities.
6. There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.
7. Human influences will continue to change atmospheric composition throughout the 21st century.
8. Anthropogenic climate change will persist for many centuries (IPCC 2001).

In response to this report, the White House requested that the National Academy of Sciences/National Research Council convene a panel of experts to vet the IPCC Report. This panel, entitled the Committee on the Science of Climate Change, issued its own report in 2001 (National Research Council 2001). Among its findings are the following two points:

1. Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability. Human-induced warming and associated sea level rises are expected to continue through the 21st century. Secondary effects are suggested by computer model simulations and basic physical reasoning. These include increases in rainfall rates and increased susceptibility of semi-arid regions to drought. The impacts of these changes will be critically dependent on the magnitude of the warming and the rate with which it occurs.
2. The committee generally agrees with the assessment of human-caused climate change presented in the IPCC Working Group 1 (WG1) scientific report, but seeks here to articulate more clearly the level of confidence that can be ascribed to those assessments and the caveats that need to be attached to them.

Now that it is clear that there is no significant scientific dissensus over the issue of whether the world is warming and will warm further we can see that the disagreements that do exist relate to the questions how much? When? And with what impacts? So let us begin this policy analysis by asking "What physical aspects of the global warming problem are most important initially for designing policy responses?"

Two aspects come readily to mind: the residence times of greenhouse gases in the atmosphere and the timescales of the global carbon cycle. These are shown in tables 1 and 2.

Table 1—Residence times of greenhouse gases in the atmosphere

GHG	Residence Times
Carbon dioxide (CO ₂)	50-200 Years (The range varies with sources and sinks and depends on the equilibration times between atmospheric CO ₂ and terrestrial and oceanic reserves.)
Methane (CH ₄)	12 years
Nitrous oxides (N ₂ O)	120 years
Chlorofluorocarbons	
CFC-11	50 years
HCFC-22	12 years
Perfluorocarbon (CF ₄)	50,000 years

Source: IPCC. 1990. Climate change: the scientific assessment, working group 1

The residence times of greenhouse gases in the atmosphere range from 12-200 years for the five most important gases and up to 50,000 years for a synthetic perfluorocarbon.

Table 2—Time scales of the global carbon cycle as determined by exchange between the atmosphere and the ocean

Mechanism	Time Required
Troposphere (lower atmosphere) mixing alone	1 year
Atmosphere to surface ocean layer	4 years
Surface ocean layer to intermediate layer below the thermocline	50-200 years
Venting from ocean above thermocline to atmosphere	100 years
Turnover time of deep ocean basins	1000 years

Source: IPCC. 1990. Climate change: the scientific assessment.

While there remains considerable uncertainty relating to the magnitude of terrestrial carbon storage, there is much less uncertainty over the magnitude of surface, intermediate and deep ocean storage of carbon (U.S. Global Change Research Program 1999). Annual fluxes between the atmosphere and the ocean and the atmosphere and the terrestrial biosphere vary widely, but there is no doubt that on decadal/interdecadal timescales the dominant influence on aggregate CO₂ concentrations in the atmosphere is the exchange of carbon between the atmosphere and the ocean. The lags in this exchange process are shown in table 2.

Why are these two sets of physical characteristics important for policy development? They demonstrate, first, that global climate change is a problem of long timescale and, secondly, that all policy measures will be indeterminate in their ultimate impacts. This combination, when linked to issues of costs, changing lifestyles, and distributive inequities creates large obstacles to significant policy action in the short run.

Scientists do not know and cannot say what thresholds of atmospheric concentrations of greenhouse gases are “harmful,” but we do know that human beings are modifying the planetary climate in ways that will render certain regions more or less vulnerable to the ensuing changes. We can therefore expect that all global intergovernmental attempts to develop policy relative to mitigation of and adaptation to global warming will be refracted through at least four major variables:

1. The dynamics of bureaucracy within national governments;
2. The rates and magnitudes of climate change experienced “on the ground”;
3. Perceptions of winners and losers; and
4. Societal capacity to learn.

We can also expect that, given the physical characteristics we have described, these problems will become critical in the 22nd century.

In the meantime, the data show that the U.S. accounts for a bit less than one quarter (22-24 percent depending on the year) of the carbon dioxide emitted into the atmosphere (NOAA 1997). This amount, which varies from 5.5 to 5.7 tonnes per capita, is currently twice the rate of non-OECD advanced industrial countries, more than twice the rate of OECD countries minus the U.S. (2.4 tonnes/year), a little more than five times the rate of China and India, and six times the rate of the rest of the world (Masood 1997). There is then no doubt that the U.S. stands out in the eyes of the world as the largest source of the problem by far. The corollary of that perception is that the U.S. bears the largest obligation to reduce its emissions of CO₂ in accord with international consensus.

There is therefore a very large gap between the ways in which the Bush Administration sees the problem (at least in 2001/2002) and the ways in which other advanced industrial countries see the problem. Moreover, most developing countries see the source of the problem as all advanced industrial countries, the governments of which bear the responsibility of doing something about the problem. The developing country coalition also insists that their development cannot be held hostage to a problem created by the advanced industrial world. However, a significant minority, calling themselves the Association of Small Island States (AOSIS), break from the majority on this point. Because their very physical existence is threatened by the consequences of global warming, they demand 20 percent cuts in aggregate emissions now. This lineup creates a very turbulent policy field and it implies that all attempts at international negotiation will be very difficult.

But the fact is that the world is now at an aggregate concentration level of 367 ppmv for CO₂, which is 31 percent higher than the pre-industrial ambient level of 280 ppmv (IPCC 2001). We know that if no mitigative actions are taken, we will double the 280 ppmv benchmark by the end of the 21st century and triple or even quadruple it by the end of the 22nd century. The problem is that increasing average global temperature has consequences in the form of climate impacts on natural and social systems (IPCC 2001). These consequences include:

- Increasing average global temperature in a range of 1.4 - 5.8°C by 2100;
- Dramatically decreasing the extent of snow cover and mountain glaciers;
- Increasing global average sea level as a function of thermal expansion;
- Intensification of precipitation as a function of increasing evapotranspiration; and
- Increasing the frequency and intensity of both floods and drought in different areas.

Data from ice cores and other paleoclimate indices indicate that the current level of CO₂ exceeds anything experienced over the last 420,000 years and maybe over the last 20 million years (IPCC 2001). The policy concern here is whether there are thresholds of change in impacts as the concentration is increased. The scientific community does not know the answer to that question and therefore cannot say.

We are faced then with a problem of long time scale which, at lower levels of concentration (i.e., doubling to tripling CO₂ levels) changes the distribution of costs and gains, that is, the Canadians and Russians “win” while the tropics “lose,” at the same time that it creates increased risks and costs for many natural and social systems in most regions of the world.

Uncertainties abound, but the outline of the risks as perceived to date justifies detailed planning to “buy some insurance.” But, because mitigation implies costs of a variety of kinds, and even lifestyle changes, governments balk at how big a bite on the problem they wish to take and what exactly they will do.

A reading of the relevant social science literature that can be brought to bear on managing environmental problems of long time scale yields the following assumptions (Lee and Miles 1991, Miles 1998):

1. Global environmental modifications originate in human activity, therefore social processes will be central to controlling, mitigating, and adapting to human impacts on the planet.
2. Societies learn via mass publics and organizations but governmental responses to perceived policy problems are always mediated through organizations.
3. Societal learning typically proceeds over long time scales (i.e. intergenerational). Major shifts in direction therefore take time. Governmental responses can shift markedly over much shorter time scales, particularly in times of crisis.
4. For long time scale problems, experience contains relevant lessons and permits predictions to be made.
5. The rate of change is crucial to whether and what type of learning occurs.

Developing the Policy, 1989-2001

Bodansky (1993) presents an overview of the evolution of the global warming issue from the time it emerged on the global agenda in the 1960's to the negotiation and successful conclusion of the Framework Convention on Climate Change in 1992. We will not repeat that history here but will focus only on some seminal events in the evolution of the issue.

We note that there was a large gap in time between the publication of the initial paper on CO₂ accumulations in the atmosphere by Revelle and Suess (1957) and the concerted moves of the international scientific community to alert governments to the implications which occurred in two conferences in 1985 (Villach) and 1987 (Bellagio). The mechanism which served to galvanize the scientists was Charles Keeling's continuous measurements of the atmospheric concentrations of CO₂ at the Mauna Loa laboratory in Hawaii (figure 1). Keeling's work was the immediate result of the Revelle and Suess paper.

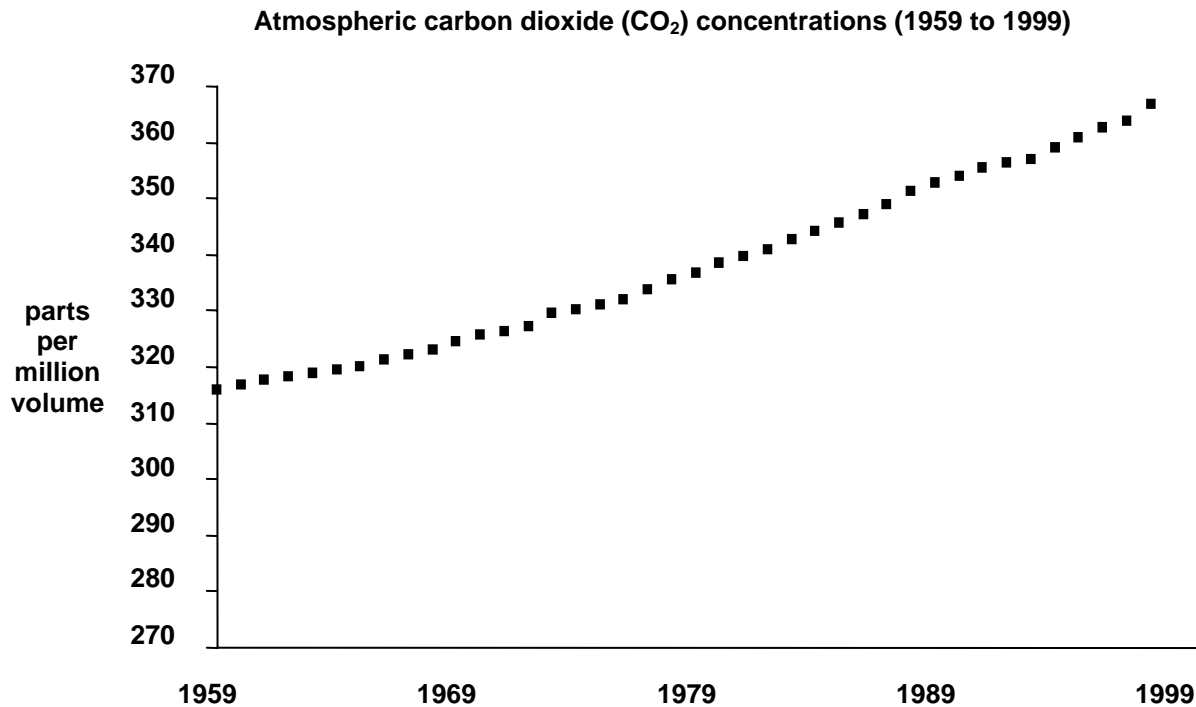


Figure 1—Atmospheric carbon dioxide (CO₂) concentrations (1959 to 1999). Data Source: C.D. Keeling and T.P. Whorf, Atmospheric CO₂ Concentrations (ppmv) derived from in situ air samples collected at Mauna Loa Observatory, Hawaii, Scripps Institute of Oceanography, August 1998. See <http://cdiac.esd.ornl.gov/trends/co2/contents.htm>.

At the 1985 and 1987 meetings, the scientists evolved into a full-fledged epistemic community (Haas 1992) since governmental and non-governmental scientists forged bonds to make governments aware of the dangers and to take action to mitigate the problem. Serendipitously, 1985-1987 was the point at which governments were earnestly negotiating the Vienna Convention (1985) and the Montreal Protocol (1987) to regulate the problem of the expanding ozone hole over Antarctica, which was itself discovered and reported thirteen years before in a paper by Rowland and Molina (1976).

Not surprisingly, the ozone experience captured the imaginations of both scientists and governments to the extent that ozone became the template for the design of the FCCC. These assumptions were explicitly stated by Prime Minister Margaret Thatcher in a speech to the UN General Assembly on November 8, 1989 (Thatcher 1989). Thatcher had by then emerged as the undisputed leader of the European coalition, in part because she was trained as an industrial chemist and the common language of the global warming problem is undoubtedly chemistry. In her speech, Thatcher said:

The most pressing task that faces us at the international level is to negotiate a framework convention on climate change – a sort of good conduct guide for all nations.

Fortunately we have a model in the action already taken to protect the ozone layer. The Vienna Convention in 1985 and the Montreal Protocol in 1987 established landmarks in international law. They aimed to prevent rather than just cure a global environmental problem.

I believe we should aim to have a Convention on global climate change ready by the time the World Conference on Environment and Development meets in 1992. That will be among the most important conferences the United Nations has ever held. I hope that we shall all accept a responsibility to meet this timetable.

In the face of this momentum, which had gathered significant speed in 1988 when the Prime Ministers of Canada and Norway had seized the initiative to convene the first non-governmental “governmental” conference combining scientists, policy makers, and non-governmental organizations (NGOs). The process at that time was still in the problem definition phase but significant divergence between the U.S. and its traditional European and North American Allies could already be seen. The U.S. pushed for institutionalizing the scientific epistemic community into what became the Intergovernmental Panel on Climate Change (IPCC) primarily seeking to slow down the push for economic regulation. The Europeans on the other hand wanted the IPCC to provide the scientific support for regulation. Thatcher, in her speech, explicitly called for prolonging the existence of IPCC beyond its expected 1990 assessment to perform such a role.

Additional divisions of great significance could also be detected at the time within the U.S. government as represented by the first Bush Administration. The Department of State took the problem seriously and was preparing for the FCCC negotiations under the leadership of Deputy Assistant Secretary of State for International Environmental Affairs William Nitze. In fact, at the opening ceremonies for the IPCC, Secretary of State James Baker (1989) himself represented the U.S. and in his speech made these important points:

1. Action should not be delayed until scientific uncertainties are resolved;
2. The immediate focus should be on steps that are justified on other grounds [i.e., “no-regrets” strategies];
3. Proposed solutions should be specific, cost-effective, and fair to all concerned.

These hopeful steps occurred on the cusp of a major internal revolution within the Administration in which certain high officials saw the global warming issue as involving highly sensitive issues with respect to the U.S. economy and the willingness of the public to accept strong regulation. The result was that the White House Domestic Policy Council wrested control of the issue from the Department of State under the dominant leadership of John Sununu, Chief of Staff to the President, and Richard Darman, then Deputy Secretary of the Treasury. The Domestic Council henceforth in the Bush Administration coordinated the Departments of Energy, Interior and Commerce, EPA, the Office of Management and Budget (OMB), and the Council of Economic Advisors. Nitze at State was fired and Secretary Baker was never heard to issue a public comment on the problem thereafter. While the U.S. did sign and ratify the FCCC, it did so with an explicit reservation against the binding target and timetable approach pushed by the Europeans which sought to stabilize emissions of CO₂ at 1990 levels by 2000.

While the FCCC negotiation process was successful, it gave hints nevertheless of how difficult negotiating implementing protocols would be. The process was simultaneously a three-level one occurring within the North (i.e., the advanced industrial countries [AICs]), the North vs the South (i.e., the lesser-developed countries [LDCs]), and within the South between OPEC countries, AOSIS countries, and the rest. Significant strains and conflicts were apparent at every level and some major conflict issues were dividing governments of AICs within their own countries, viz. the U.S. and Japan.

The regime that the FCCC creates (Bodansky 1993) contains basic institutions (the Conference of the Parties, the Subsidiary Body for Scientific and Technical Advice [SBSTA], and the Subsidiary Body for Implementation [SBI]); it enshrines the concept of differentiation of Parties based on their relative energy efficiency; weak obligations; and relatively strong reporting and review obligations which effectively provide for transparency. The latter is perhaps the most significant contribution of the FCCC, followed by avoiding intense politicization of the IPCC by creating SBSTA as a buffer.

Finally, the convention seeks to define a standard of performance as its major objective:

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow

ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

This objective is an admirable attempt to solve a very difficult problem. As such, it seeks to balance avoiding “dangerous anthropogenic interference with the climate system” with facilitating ecosystem adaptation, maintaining required levels of food production, and seeking to provide for sustainable levels of economic development. The only difficulty is that the standard is far in advance of what either the natural or social sciences can operationally establish. The standard therefore sets in train a comprehensive research program which can only be long-term. In the meantime, informally, the level referred to in Article 2 was taken to mean doubling the pre-industrial ambient CO₂ concentration to about 560 ppmv because preliminary analysis suggested the impacts would be manageable and global GNP would not be seriously affected.

However, given the long residence times of greenhouse gases, except for methane, in the atmosphere, the magnitude of present commitments and the difficulty of negotiation and implementing meaningful cuts in emissions in the short-term, it is a very serious question indeed whether any feasible mitigation policies can avoid doubling by 2100. Moreover, we have already made clear that the scientific community cannot now, and may never be able to, pronounce definitively on the issue of what specific concentration level constitutes dangerous interference with the climate system and where threshold effects may be.

Moving Toward Kyoto

1997 was a critical year in the attempt to negotiate the first binding Protocol to the FCCC. This was again a four-dimensional negotiating situation in which the fourth dimension was represented by the internal politics of the United States and Japan, with the former having a much bigger impact on the global negotiations. In the preparations leading up to what the States Parties hoped to be the final round of negotiations in Kyoto, Japan in December 1997, the original intent was to focus first on the AICs and only later seek to apply the provisions to the LDCs. This attempt to minimize the scope of the initial target was shot down by a Senate resolution which passed by a vote of 95-0 on July 25, 1997; it implied that the Kyoto Protocol would be “dead on arrival” if it did not include the LDCs (Mobile 1997).

A Republican-controlled Senate, with notably significant support from Democrats, was responding to great pressure from industry which argued that, while in 1995 AICs contributed almost 75 percent of global CO₂ emissions, by 2035 LDCs would be contributing 50 percent, with China as the world’s largest emitter (i.e., at 17 percent compared to 15 percent by the U.S.; down from 22 percent in 1995) (NOAA 1997). The effect of this letter, not surprisingly, was to galvanize the LDC coalition, the Group of 77(G77) into total opposition and to elevate this issue almost to the level of a conference-breaker. Internally, diplomats and others engaged in the process saw this letter as a most unhelpful move since the intent was to use 2010 as the cut-off date for the Kyoto provisions, at which time a successor Protocol would have to be negotiated and the LDC issue could be tackled then.

In addition to the LDC inclusion issue, there were eight other issues that were central to the Kyoto negotiations, six of the nine being very difficult indeed. These issues included the following:

Targets and timetable

The EU coalition proposed a 15 percent reduction below 1990 levels by 2010. The U.S., Japan, and Canada chose not to propose any target or timetable prior to negotiations, whereupon the EU refused to discuss any other issues until the U.S. disclosed its preferences for targets and timetables.

The EU “Bubble”

The “Bubble” was the idea proposed by the EU to permit EU compliance with the global standard as a collective unit, thereby allowing internal variation among its membership. More specifically, this proposal would allow the EU to present the global standard to its member states as a system of differentiated targets with internal emissions trading within the EU. This proposal was vigorously opposed by the U.S.,

Japan, and Australia, inter alios, as a scheme to give the EU an unfair advantage over other industrialized states.

Differentiation among AIC's

Japan, Australia, and Norway proposed that targets within the global standard be differentiated among AICs on the basis of their aggregate efficiency of energy use. On this issue the U.S. and the EU were united in opposition.

Emissions Trading

The U.S. was a strong supporter of this idea because its industries argued that the costs of compliance would be too high without the possibility of emission trading. They were supported by Australia, Canada, New Zealand and Russia. The EU and others were opposed on the grounds that the system would be too complicated. Moreover, it would be too favorable to Russia since its economy had collapsed. Russia's trading advantage later came to be referred to as "hot air."

Joint Implementation

This proposal was the initial idea that AICs could receive credit against their obligations by investing in "clean" energy projects in LDCs. The U.S. was a strong supporter along with the Central American countries, Canada, Australia, New Zealand, and Norway. The LDCs themselves and the EU objected. Later evolution would differentiate between joint implementation per se and the "clean development mechanism" available only for LDCs.

Policies and Measures

The EU, supported by Japan and Canada, pushed for harmonized and mandatory policies and measures. The U.S., preferring a voluntary approach, was strongly opposed.

Compensation

The oil-producing countries, members of OPEC demanded compensation for anticipated loss of income as a result of controls on petroleum hydrocarbons as a fuel. No other state supported such an idea.

Developing Country Actions

The U.S. proposed to advance LDC commitments immediately, but stopping short of specific targets and timetables. Emphasis was placed on the need for energy efficiency and the potential role of China. The G77 were adamantly opposed to being included.

Evolution

The U.S. argued that the LDCs must, in Kyoto, commit to participating in subsequent negotiations on binding targets and to a mechanism that allows for graduation from LDC status. In this instance the U.S. had China, India, and Brazil particularly in mind. Again, the G77 were adamantly opposed.

The outcome of the Kyoto negotiations, dramatically achieved at the eleventh hour, included inter alia the following provisions (UNFCCC 1997):

1. AICs were obligated as a group to achieve a 5.2 percent reduction from 1990 levels between 2008 and 2012. Contained within this provision was both a "Bubble" solution for the EU and the concept of differentiation among the AICs. Consequently, the required reductions for the major AICs differentiated between the EU as a group at -8 percent; the U.S. at -7 percent; Japan at -6 percent; and Canada at -6 percent.
2. There was to be demonstrable progress by 2005.

3. Three major provisions met the interests and demands of the U.S. explicitly:
 - a) A focus on net changes in greenhouse gas emissions from all sources and removal from such by including land use changes, afforestation, reforestation, and deforestation since 1990.
 - b) Rather than focus simply on CO₂, target a “basket” of greenhouse gases including CO₂, CH₄, N₂O, HFCs, PFC, and SF₆. The emphasis would be on their combined radiative forcing, a weighted sum.
 - c) Emissions trading and joint implementations.

Beyond these issues, strong provisions were included on reporting, independent review, and verification. There was no resolution on the enforcement issue and LDCs were not included.

The Inadequacies of the Kyoto Protocol

What then is the policy significance of the Kyoto outcomes in terms of finding solutions to the global warming problem? Objectively, Kyoto represents a very small step that cannot and will not prevent doubling of the CO₂ concentrations in the atmosphere by 2100. Supporters of the process will say that it was not meant to; that the fact of agreement in recognition of global warming as a major policy problem is the main message and that bigger bites of the problem must and will be taken in 2010 and beyond. The Economist (2000) clearly expressed this point of view:

The real significance of Kyoto was that rich countries had accepted that they should act to curb global warming, and that they should do it before requiring poor countries to do the same. They committed themselves to frequent updates and improvements of the treaty, the first substantive one of which is taking place in The Hague. And they agreed that cutting emissions might be so expensive that the treaty should allow countries innovative, flexible approaches to reduce compliance costs (<http://www.economist.com/printedition/displaystory.cfm?story>, p. 6).

This author’s view is different. The Kyoto Protocol undoubtedly contains policy ideas of significance, e.g., the market mechanisms (emissions trading, joint implementation, and the clean development mechanism) and the reporting, independent review, and verification provisions which facilitate transparency. But Kyoto demonstrates that there are severe problems in any attempt to negotiate a system based on targets and timetables (Victor 2001). The practical realities of implementing a global system of emissions trading are extremely difficult; the “basket” of differentially weighted greenhouse gases with sinks (forests and soils) as offsets underlying the targets contains provisions which are currently beyond our collective capabilities, and global coverage on the performance of forests and soils as sources and sinks of greenhouse gases is in its earliest stages. Moreover, the targets themselves represent the “law of the least ambitious program” (Underdal 1982) at work in this most difficult of collective action problems.

One month after the Kyoto Protocol as produced, Professor Bert Bolin, then Chairman of the IPCC, published a commentary on the technical implications of the agreement (Bolin 1998). He made five major points:

1. With respect to the “basket,” the increase of CO₂ alone would account for 70 percent of the total increase in radiative forcing of all greenhouse gases. Not many measures are currently available for decreasing methane and nitrous oxides and the other elements contribute only a few percent to radiative forcing.
2. Even if full compliance with the Protocol were achieved by 2010, AICs would still be contributing four times the CO₂ emissions of the LDCs to the atmosphere.
3. Even with full compliance, the accumulated emissions of CO₂ from 1990 to 2010 would amount to C.140 Gt of carbon, thereby implying an increase in atmospheric concentrations by about 29 ppmv to a total of 382 ppmv.
4. Therefore the Kyoto conference did not achieve much relative to limiting the buildup of greenhouse gases in the atmosphere.
5. Meeting the doubling standard (550 ppmv) by 2100 would require a 60 percent reduction in aggregate emission in two steps (30 percent reduction by 2050 and an additional 30 percent by 2100).

While the basic outlines of the Kyoto Protocol were achieved in December 1997, the job was certainly not done. Outstanding issues included coverage of the LDCs, and the details of measures of flexibility in the Protocol, particularly emissions trading, and compliance measures. Major conflicts arose in the AIC group on these issues between 2000-2001, particularly between the U.S. and the EU. The EU position was that the sanctity of the targets arrived at in Kyoto should be preserved at all costs and that Annex I Parties (the AICs) needed to reduce emissions domestically rather than by employing global accounting. The U.S. (Clinton Administration) position was that targets should be met in the most cost effective manner, even if all actions were non-domestic, that is, via offsets for forest and soil sinks plus emissions trading (“hot air”).

The reality was very different outside the negotiations. It was increasingly clear that of all the AICs, only Germany and the UK were on track to meet their 1990 targets and the U.S. was going in the opposite direction at a very rapid rate. The Energy Information Administration of the U.S. Department of Energy (Macilwain 1997) had published a report two months before the Kyoto negotiations which showed that the U.S. in 2000 would already be 18 percent above their 1990 emission levels and projected an additional increase of 16 percent by 2010. This report had a major impact on the position of U.S. industry which argued that Kyoto for them meant a 34 percent reduction, not 7 percent as the Protocol stated and this rate of reduction was unacceptably onerous. Thus the stage was set for the Bush Administration’s rejection of the whole Kyoto process in 2001.

Rejection stimulated a confrontation between an isolated U.S. and 178 states determined to prove that they could produce a Protocol nevertheless (Andrews 2001). But the price for “success” was high since it handed to the “laggards,” that is Japan, a club with which they could flog the “pushers,” that is the EU. The result was the Protocol was weakened significantly in two respects: a) enforcement was severely constrained since there was not legal liability for non-compliance; and b) obligations vis-à-vis the target could be offset from proven “sinks” which were limited to forests and agricultural soils only. Both of these provisions were adopted at the Seventh Session of the Conference of the Parties (COP7) held in Marrakech, Morocco from 29 October to 9 November, 2001. The result is that a much lower reduction from the original target is to be expected by 2010 (UNFCCC 2001). The changes to the Kyoto Protocol were negotiated at the sixth session of the conference of the parties held in Bonn in July 2001 and ratified at COP7 in Marrakech (UNFCCC 2001).

So what is the outcome? On the one hand, the Bush Administration has announced yet another voluntary program of controlling emissions by U.S. industry while the EU has enthusiastically ratified a severely flawed Kyoto Protocol (Revkin 2002). This means that the Kyoto Protocol has become a symbolic rallying point against potentially more effective alternative strategies as well as the Bush Administration’s voluntary controls idea. How do we get out of this bind?

Beyond Kyoto/Marrakech or Why We Have to Start Over

The point is neither Kyoto nor voluntary strategies. The point is cumulative atmospheric concentrations of greenhouse gases, most especially CO₂ and the fact that doubling the pre-industrial value seems to be inevitable by 2100. The real question then becomes whether or not we can put in place measures to avoid tripling the concentration or more between 2100 and 2200.

This is a significant question because the scientific community does not know where the thresholds of change lie and how quickly planetary-scale changes would occur in a warmer world. Schelling (2002), in a personal judgment after reading the available literature, suggests that that the range is probably between 600-1200 ppmv i.e., somewhere between doubling and quadrupling the pre-industrial atmospheric concentration. This range is probably correct but far too large to provide specific policy guidance and the chaos continues in the policy field.

Since neither targets and timetables nor voluntary controls will produce the necessary results, and the clock is definitely ticking, what can we do? I suggest that a “buying time” strategy makes sense, the objective of which is to push out the horizon of irreversible impacts (wherever that is), while the

international system struggles to mount an effective response. However, this strategy would still require U.S. leadership, albeit in a decentralized process. Given the immense scale of the problem we face, the strategy performance contains very large and difficult components.

The first component is increasing efficiency as a means of practicing conservation of fossil fuels. Our experience following the two OPEC "oil shocks" of the 1970's shows that conservation produces societal effects far in excess of personal virtue. In 1973, the time of the first oil shock, the nominal cost of a barrel of oil was approximately \$4.75 USD (OECD 1988). By 1979, the time of the second oil shock, the price per barrel was about \$12.00 USD and by 1981 the average market price of crude oil had shot up to \$32.00 USD (OECD 1988). At that time, consumers considered that the price was too high and they began to practice conservation. Consequently, by 1986, the price had declined to about \$13.00 USD a barrel before it started to climb again from 1987.

The moral of this story is that the market price of crude oil is a powerful lever for inducing conservation, and thereby for lowering emissions. The most immediate instrument for affecting the market price is a carbon tax (Grubb 1989, Nordhaus 1994, Cooper 1998) the purpose of which is to increase the market price of fossil fuels in proportion to carbon content. It is better to start modestly to avoid market dislocations but then ramp up over time. Such a tax would yield very large revenues which can be used for aiding coal mining communities and investing in energy research and development.

Internally within the U.S., the carbon tax could be combined with emissions trading and revenue recycling i.e. reducing taxes in other places. Emissions trading on the national level is far more manageable and is an aid to increasing efficiency without the distortions caused by large pools of "hot air" (Swift 1998). Expanding research and development investment also assumes a shift out of coal with emphasis on natural gas and nuclear power as transitional fuels for a century or so.

We need also to look very seriously at all options for sequestering carbon, e.g. forests and agriculture, iron fertilization of the surface ocean, sequestering in depleted hydrocarbon and salt reservoirs either on land or in the ocean, the possibility of deep ocean disposal of carbon, and potential biotechnology alternatives (U.S. Department of Energy 2000). All of the above components fall under the rubric of mitigation strategies. But, at the same time, because the planet is already committed to a substantial amount of warming, we need systematically to prepare for adapting to climate change and reducing the obvious vulnerabilities.

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