CHAPTER 14: THE ATMOSPHERE

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The atmosphere is like an ocean of gases that envelops the globe. It presents the same issues of a ``commons'' that we saw in the previous Chapter. But the stakes for humanity are much higher. For although we might be able to survive polluted and degraded oceans, we cannot breathe a polluted and degraded atmosphere and survive.

Chapter 8 has previously dealt with transboundary pollution. Here we examine the broad-scale atmospheric problems of ozone-layer depletion and climate change.

A. Ozone Layer Depletion

1. The Chemistry of the Atmosphere[1]

The atmosphere is a relatively thin protective gas blanket covering the earth which serves two functions of importance for planetary life: it filters the sun's ultraviolet radiation and protects the earth from its most dangerous wave lengths; and functions as a heat blanket, providing the heat necessary to maintain the stability of the stratosphere. Nearly two decades ago, Rowland and Molina postulated that the release of CFCs and halons harm the atmosphere.[2] Since that time, scientific investigations have confirmed their predictions.

The ecosystem must be protected from excessive solar ultraviolet radiation; otherwise, all species will face dire consequences. This phenomenon is caused by the depletion of the ozone layer, a result of man- made chemicals released into the atmosphere. Ozone, an oxygen molecule with three atoms instead of the normal two, is found throughout the atmosphere, but especially within the stratosphere. Ozone molecules are formed by the collision of solar ultraviolet rays with ordinary oxygen molecules. These collisions create free oxygen atoms that recombine with ordinary oxygen molecules to form ozone molecules. These ozone molecules are split again by solar energy-stimulated reactions. The natural balance of processes cyclically producing and breaking down ozone has been altered by human activities which introduce ozone destroying chemicals into the atmosphere.[3]

CFCs and halons are man-made chemicals with attractive characteristics, since they have significant commercial applications. Inert and immensely stable, neither flammable nor poisonous, easy to store and cheap to produce, they were a miracle discovery of the twentieth century. They are used extensively in foam-blown plastics, refrigerators, air-conditioning, as electronics industry solvents and as aerosol propellants. Their chemical properties, while so useful on earth, also attack the ozone layer. Both CFCs and halons have high ozone depleting potential (ODP) and as a result have been the targets of regulatory action to limit their use. These chemicals slowly percolate into the stratosphere, where they are photolyzed by ultraviolet light and release chlorine radicals. This free floating chlorine chemically attacks and destroys ozone. This destructive process has significant implications for human beings, plants, aquatic organisms and human-formulated materials.

Ultraviolet radiation emitted by the sun reaches the atmosphere in a range of varying wavelengths. Its most destructive radiation, long wave length UV light, or ultraviolet-B, is reflected back into space by the protective ozone layer. An ozone reduction of one percent in the stratosphere entails a two to three percent ultraviolet-B increase, jeopardizing human health as well as the environment in various ways.

The link between ultraviolet radiation and skin cancer is well established. The Environmental Protection Agency (EPA) estimates 153,587,100 additional cases of fatal melanoma cancers in the U.S. by the year 2075 if CFCs are not controlled. Also, epidemiological studies have identified a correlation between the prevalence of cataracts in humans and the flux of ultraviolet radiation reaching the earth's surface.[4] Excessive radiation attacks human and animal immune systems, increasing human susceptibility to infectious diseases. Depletion of the ozone adversely affects the food we eat and the air we breathe. Crop yields of several kinds of agricultural plants may be affected. Moreover, larval forms of several important seafood species might suffer appreciable die-off, thereby endangering the seafood cycle. Experiments documented the inhibition of the photosynthesis of phytoplankton, which is a natural link of CO_2. Ultraviolet radiation is also implicated in the degradation of polymers and the formation of tropospheric ozone (city smog). In addition to ozone depletion, CFCs also contribute to global warming by absorbing energy that is emitted by the earth back into the atmosphere.[5] Because of their two-fold capacity to attack the earth's atmosphere, CFCs clearly pose a threat to the global environment. A solution to the problem of ozone depletion depends on a quick abatement of the amount of chlorine reaching the stratosphere.

CFCs are emitted from a variety of sources. The major ones are: air conditioners, refrigerators, solvents in electronics industry, and plastic foams. New applications of CFCs continue to be introduced, and uses yet unforeseen could become additional sources of future emissions. Chemical producers consider hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) to be feasible alternatives to CFCs used in refrigerators and air-conditioners. HCFCs and HFCs have no significant effect on atmospheric ozone. The former

has no chlorine, so it cannot contribute to ozone depletion. The latter has only a 0.01 ozone depleting potential.[6] Extensive use of these chemicals does, however, delay the recovery of the ozone layer. The latter provision cautions producers against relying on these substances as appropriate substitutes and investing too heavily in them. These substances are, at best, an interim solution.[7]

2. The Ozone Protection Regime[8]

A diffuse layer of ozone in the upper reaches of our atmosphere has shielded life on the planet from ultraviolet radiation for millions of years. A seemingly unrelated event in 1928 was the development of chlorofluorocarbons (CFCs) by Dupont chemists. These extremely stable and consequently long-lived substances were hailed as technological triumphs. If one recurrent theme in the effort to protect the ozone layer is uncertainty as to the reality or extent of a threat, then it is noteworthy that for almost fifty years after the discovery of CFCs, the community was ignorant of the threat CFCs posed and, as a consequence, focused only upon the benefits they accorded. CFCs came to be used in a multitude of ways, and the amount and types of CFCs utilized grew dramatically, first after the World War II and again in the late 1960s.

In 1974 however, two scientists postulated that these stable substances, for the most part, ultimately reached the stratosphere; that once there, they finally became exposed to the ultraviolet radiation from which they had been shielded by the ozone layer; that this highly energetic radiation broke down the CFC molecule, releasing chlorine atoms; and that such chlorine atoms then served as catalysts in reactions which broke down ozone molecules. It was estimated that each chlorine atom released could destroy 100,000 ozone molecules, ultimately depleting the ozone layer and exposing the planet to increased harmful ultraviolet radiation.

Two responses to this theory quickly emerged. Some experts pointed to the dangers of failing to act quickly to protect the ozone layer. Others pointed to the costs of acting precipitously on the basis of a contested and yet unproven hypothesis. This confrontation became a key characteristic of the debate regarding CFCs and ozone depletion for most of the decade that followed. Moreover, because the issue became a clash of experts which was not accessible to laypeople, there was a lack of shared knowledge concerning the problem that in many ways foreclosed broader public participation. Public debate regarding regulation initially focused upon the use of CFCs as propellants in aerosols, a use that clearly resulted in releases of CFCs into the atmosphere. Not without difficulty, a number of states, including the United States, Canada, and Sweden, moved toward national bans on such aerosols. These efforts at unilateral action added new characteristics to the debate. First, the concern arose in U.S. governmental circles that these unilateral efforts might be counterproductive in that the actions of a few states took pressure off other states to do likewise. In other words, there was a free rider problem. Second, because lawmakers and the public often could not judge the debate of experts, governments began undertaking their own studies. These studies provided more impartial and authoritative sources of knowledge regarding the subject. They would take time to complete, but their eventual release would profoundly affect the debate. In some cases, such as in the United States, a study would strongly support regulation efforts, while in other states such as the United Kingdom, the study would have the opposite effect.

Even as the national debates proceeded, the groundwork for an international approach was laid. The United Nations Environmental Programme (UNEP) in 1977 convened a meeting to begin the international process. The meeting resulted in the adoption of the ``World Plan of Action on the Ozone Layer'' and the establishment of a Global Coordinating Committee on the Ozone Layer. In 1981 UNEP established an Ad Hoc Working Group of Legal and Technical experts charged with the task of drafting a framework convention for the protection of the ozone layer. A framework convention is a document that aims not at substantive norms, but rather at establishment of the institutional framework that will result in such norms. The Working Group released the first draft of its work in October 1983, and several further drafts were produced prior to the Vienna Conference in March 1985, which ultimately adopted a framework convention.[9]

Adoption of the Vienna Convention was bittersweet, however, because several states had sought more from the Conference. In particular, Finland, Norway, and Sweden circulated a draft protocol to the then developing framework convention (the Nordic Annex) that would have banned aerosol use of CFCs.

Even as work proceeded in anticipation of a second meeting to adopt a protocol, two important trends were occurring. First, a British research group in May 1985 announced that huge losses in Antarctic ozone had occurred in the springs of 1982, 1983, and 1984. By late summer 1985 American satellite measurements, free of certain previous interpretational errors, confirmed the British findings. The Antarctic ozone hole created quite a stir in the scientific community since none of the atmospheric models developed up to that point would have predicted such an event. As a result, a massive international research effort was undertaken to determine whether chlorine was responsible for the hole. In this instance, there would not only be theories, but actual measurements of the chlorine

in the stratosphere over Antarctica would be taken. In more general terms, the Antarctic hole was significant because, even before the scientific community could confirm that chlorine was responsible for the hole, the public had what in its view was tangible and comprehensible evidence that humanity could fundamentally alter the Earth's atmosphere. As the public increasingly voiced its concern, the states participating in the international negotiations became increasingly receptive not only to a ban on aerosol use, but, more generally, to across the board phased reductions in CFC and halon consumption and production.

The second trend also facilitated the inclination to adopt across the board phased reductions. Specifically, the major producers of CFCs had come to believe that environmentally safe substitutes for CFCs existed, and that it was for each of them in their individual interest to be the first to develop and offer such substitutes. Although it was thought that such substitutes would be several times more expensive than CFCs, it was also thought that there would be a market for them in a world that called for limits on the use of CFCs. Simultaneously, numerous large users of CFCs moved to eliminate their reliance on such substances.

For these reasons, the Montreal meeting was quite different from the one held only two years earlier in Vienna in that virtually all of the interested parties were now in agreement that some amount of phased reductions was appropriate. Thus, even though the final report of the international study of the Antarctic hole was not yet released, a Protocol to the Vienna Convention calling for a fifty percent reduction in the production and consumption of specified CFCs over an approximately ten year period was adopted in Montreal in September 1987.[10]

But even as states adopted the Montreal Protocol in September 1987, two major concerns were present regarding the instrument. First, the startling findings regarding the Antarctic ozone hole, officially confirmed only after the meeting in Montreal, had not been taken fully into account in the Protocol. The negotiators were frustrated by their apparent inability to draft regimes that kept up with the revelations emerging from the scientific community. They had taken a step forward in Montreal, but they felt that they were always two steps behind in their own understanding of the problem, and at least two steps behind in their response to the problem. Thus, there was a widespread feeling that the Protocol was inadequate and would require revision.

Second, the early indications by China and India, representing over one-third of humanity, that they would not become parties to the Protocol because of its failure to provide adequate assistance to developing countries, suggested that the international community might not be sufficiently cohesive to comprehensively regulate the matter. As with greenhouse gases, the international community was coming to realize that the atmospheric changes theorized were evidence of the increasing burden of a growing population on the planet, and that all such problems ultimately boiled down to a combination of the number of people in the world and the way they lived. It was apparent that any regime relating to protection of the ozone layer must include highly populated states, whether or not they presently were significant consumers or producers of ozone-depleting substances. This development was particularly important because it marked one of the few times that the industrialized world needed the cooperation and participation of the Third World. This need allowed the third world to raise development and international equity concerns they believed had been unaddressed for too long.

As to the adequacy of the Montreal Protocol, planning for its adjustment and amendment began almost immediately. The political focus on the global environment in general, and on the protection of the ozone layer in particular, was intense from the 1987 Montreal Conference of the Parties to the 1990 London Meeting of the Parties to the Montreal Protocol. Of particular importance at this time, although less publicly dramatic than the Antarctic ozone hole, was the release of a study by the U.S. Environmental Protection Agency asserting that even assuming one hundred percent global participation in the Protocol, the presence of chlorine in the stratosphere would, by the year 2075, increase by a factor of three.

Amidst these new revelations, the entry into force of the Montreal Protocol on January 1, 1989, was anticlimactic and hardly noticed. At that time, one nation after another was calling for swifter and deeper cuts in the production and consumption of ozone-depleting substances, and in some cases unilaterally adopting such measures. By the opening of the London Meeting in June 1990, the negotiating parties were in agreement not merely on accelerating the phased reductions, but on phasing out entirely the substances specified by the Montreal Protocol. The primary issue was whether this phase out should be accomplished by the year 1997 or the year 2000, the latter representing the adjustment ultimately made to the Montreal schedules. Simultaneously, evolving scientific knowledge regarding the threat posed by other substances led to the consensus to amend the Protocol so that it would require phase outs of other fully halogenated CFCs and carbon tetrachloride by the year 2000, and a phaseout of methyl chloroform by the year 2005. Increased understanding that the substitutes thought to exist at the time of the Montreal Protocol might also be ozone-depleting and significant contributors to the greenhouse effect, resulted in the designation of these substitutes as ``transitional ozone-depleting substances,'' and in the conclusion that the transitional substances should be phased out by the year 2040, or, if possible, by the year 2020.

The apparent willingness of nonparticipating countries such as China and India to operate outside of what they perceived to be an unjust regime, was pitted against the reluctance of some developed countries such as the United States, to construct new international structures, to recognize a right of such countries to assistance and technology transfer, and to encourage linkages between participation in regimes like the Protocol and recognition of the special situation of developing countries. This reluctance was particularly strong since, at this same time, the developing world was making analogous demands for a global climate change fund. In time, the United States, virtually alone, opposed the establishment of a financial mechanism. In May 1990 an apparently firm refusal to offer new monies to help developing countries phase out ozone-depleting chemicals threatened to derail the London Meeting planned for late June and early July 1990. In mid-June, however, the United States agreed to provide such monies, and shifted its focus to the mechanism for the disbursement of such monies, pressing for a controlling voice in how the fund would operate. Ultimately, the London meeting adopted amendments to the Protocol that provided for technology transfer, and established a fund under the supervision of a fourteen member committee drawn from the developed and developing world. At the conclusion of the London Meeting, the representatives of China and India indicated their countries would sign the Protocol in 1992. The reference by these delegates to the 1992 date is significant because it implies a further linkage between their willingness to join the Protocol and the development of a more general climate trust fund at the United Nations Conference on Environment and Development to be held in Brazil in 1992.

After the London Meeting, two major areas of concern remain. First, a number of groups assert that the Protocol even as adjusted and amended does not go far enough. Although the list of controlled substances has been increased and, for the most part, total phaseouts have been called for, an observer group at the London Meeting noted that the phaseout periods--generally of ten years--will allow the production of another seventeen million tons of ozone-depleting substances. Such arguments arise amidst continued findings by the scientific community that the ozone layer continues to deteriorate over Antarctica, the Arctic, and generally, and increasing evidence that the same substances that deplete ozone are major contributors to global warming.

Second, there is a growing sense that agreement upon the Protocol and its adjustments and amendments, even if not completely satisfactory, may have been an easier task than will be the facilitation, monitoring, and enforcement of its implementation.

a. A Restatement of the Regime

(1) The Organization of the Regime

There are two main strands to the international organizational scheme created by the Vienna Convention and the Montreal Protocol, as amended and adjusted. First, there are state parties (to the Convention, to the Protocol, and to the Protocol as amended) who meet on a regular basis and who in smaller groups meet more regularly for particular tasks. Second, there is a Secretariat which fulfills a number of duties, occasionally through ad hoc working groups, assigned to it by the state parties in the Convention and Protocol.

With respect to the parties to the ozone protection regime, there are three formal groups of parties. First, the Vienna Convention establishes a ``Conference of the Parties.'' Second, although no special name such as ``Conference'' is given, the term ``Parties'' in the Montreal Protocol means only the parties to that Protocol. Third, because the Protocol was amended in London, there may be slight divergences between those states party to the Protocol and those states party to the Protocol as amended. Inasmuch as a party to the Protocol or the Protocol as amended must also be a party to the Convention, the parties to the Protocol or the Protocol as amended are subgroups of the ``Conference of the Parties'' to the Convention.

Both the Convention and the Protocol provide that there shall be regular meetings of the parties to the respective instruments. As a practical matter, these groups of parties coordinate their meetings, and the Montreal Protocol generally calls for the meetings of Parties to the Protocol to be held in conjunction with the meetings of the Conference of the Parties to the Convention. The primary distinction between the groups of parties thus reduces their standing to vote upon, or have an official voice regarding, certain issues. In particular, only Parties to the Protocol, and not those who are solely members of the Conference of the Parties to the Convention, can vote on amendments to the Protocol. Similarly, membership on the Executive Committee, which is responsible for the Multilateral Fund established by the London Amendments to the Protocol is limited to Parties to the Protocol as amended.

Although there are various groups of parties, there is only one Secretariat for the Convention and the Protocol. The Secretariat functions are carried out by the UNEP and, in this sense, the Vienna Convention can be seen as merely formalizing the coordinating role held by UNEP before the Vienna Conference. The duties of the Secretariat are set forth both in the Convention and the Protocol, and both of these documents allow for the Conference of Parties to the Convention or the Parties to the Protocol to assign the Secretariat other functions.

Finally, the organizational structure created by the Convention and Protocol necessarily has extensive relations

with two other organizational clusters. First, in order to provide a better foundation for the timely making of policy, there are relations with the public international scientific community (namely, the World Meteorological Organization and the World Health Organization), leading national scientific agencies, and private international scientific organizations. Second, in order to provide financial and technical assistance, there are relations with organizations such as the World Bank.

(2) The Lawmaking Process

A number of innovative steps in lawmaking are contained in the Montreal Protocol. The general implications of these steps are discussed in Part III; the following discussion describes the formal structure of the regime as it presently exists.

The Protocol anticipates that continued revision may be necessary, and calls for the Parties periodically to assess the adequacy of the measures taken in the Protocol. The Protocol provides that the parties, on the basis of such an assessment, may decide to adjust the reductions called for in the controlled substances, and, if the parties are unable to reach agreement on such adjustments, two-thirds majority adoption of adjustments shall be binding upon all Parties to the Protocol. Thus, the Parties to the Protocol have limited legislative power in this area with an objector's recourse being withdrawal generally from the Protocol. Some of the actions taken at the London Meeting were adjustments.

In contrast to this legislative-like adjustment process, there is also the more commonly encountered amendment process that becomes binding only upon those states who accept such amendments. In this regard, it is particularly important to see that although the parties may make adjustments to the controlled substances already designated, they cannot use an adjustment to designate a new controlled substance. As a consequence, the actions taken at the London Meeting were in part also amendments. Many of the amendments relate to the creation of a financial mechanism, but many others relate to the addition of new controlled substances. The crucial implication, however, is that since amendments must be consented to in order to have application to any particular party, a confusing array of regimes may arise.

(3) The Normative Scheme

The Obligation to Phase Out Designated Ozone-Depleting Chemicals. The basic regulatory approach of the Montreal Protocol in 1987 was to require the Parties to the Protocol to reduce their production and consumption of five chlorofluorocarbons specified in Group I to Annex A of the Protocol, and three halons specified in Group II to Annex A of the Protocol. The London Adjustments to the Protocol accelerated this timetable and deepened the cuts by requiring the parties to phase out production and consumption entirely by the year 2000.

The London Amendments to the Protocol added new chemicals to the regulatory scheme, specifying them in a new Annex B. A phaseout by the year 2000 is required for other fully halogenated CFCs and for carbon tetrachloride, while a phaseout of methyl chloroform is required by the year 2005.

The scheduled reductions, leading ultimately to phaseouts, are expressed in terms of percentages of calculated national levels of consumption and production in either 1986, in the case of the substances originally regulated by the Protocol, or in 1989, for the substances added to the scope of the Protocol by the London Amendments. The national calculated levels thus are particularly important bench marks for the purpose of the regulatory scheme. It is important to note how the calculated level and the reductions in that level relate to baskets of substances. Group I of Annex A, for example, designates five different CFCs. It is up to each state to decide how they will mix reductions of the five so as to meet any particular scheduled reduction in the overall calculated level. To avoid false incentives in this scheme, the formula for the calculated level places all of the various designated chemicals on the same level by multiplying the amount of each chemical produced, imported, and exported by its ``ozone-depleting potential,'' such potentials also being specified in the annex.

The use of national calculated levels is also significant because it inherently gives value to historical usage and avoids the difficult issue of equitably allocating between states a limited resource, the right to emit ozone-depleting substances. Thus, the United States could be viewed as particularly advantaged under the Montreal Protocol since a fifty percent reduction in its production and consumption would still leave it with a disproportionate per capita share of such use. This significance of course diminished greatly when the Protocol was adjusted and amended so as to require phaseouts rather than mere reductions.

Two constructive exceptions to the reductions schedule are expressed in terms of the calculated level. First, any party may transfer to another party any portion of its calculated level of production, so long as such transfers do not cause the parties involved to exceed collectively the production limit applicable to them as a group. Second, if a party had contracted for a production facility prior to September 16, 1987, or provided for such expansion in national legislation prior to January 1, 1987, then that party may add such production to its calculated level.

Recognition of the Special Situation of Developing Countries. The special situation of certain developing

countries is recognized through the possibility of a delayed phaseout schedule for such countries. These special provisions apply to any party ``that is a developing country and whose annual calculated level of consumption . . . is less than 0.3 kilograms per capita . . . .'' The delay works in two ways. First, these parties are allowed to exceed the target percentage reduction at any point in the schedule by a specified percentage of their initial calculated level if such action is necessary in order to satisfy ``basic domestic needs.'' Second, such developing countries, in order to meet basic domestic needs, also are entitled to delay at every point their compliance with the schedule of reductions leading to phase outs by a period of ten years.

The Resolution of States to Act Beyond the Requirements of the Protocol as Adjusted and Amended. It is important to recognize that the reduction schedule set forth in the Protocol as adjusted and amended represents only the baseline. A number of states have accepted greater obligations, and the Protocol urges the parties to act with greater dispatch when possible. Particularly significant in this regard is the Declaration at the London Meeting by thirteen developed countries of ``[t]heir firm determination . . . to phaseout the production and consumption of all fully halogenated chlorofluorocarbons controlled by the Montreal Protocol, as adjusted and amended, as soon as possible but no later than 1997.'' Similarly, all the parties at the London Meeting resolved to do the following: refrain from using certain other halons except for essential applications; use ``transitional substances with a low ozone-depleting potential, such as hydrochlorofluorocarbons (HCFCs),'' with great care and with a view to their replacement by nonozone-depleting and more environmentally suitable alternatives no later than 2040 and, if possible, no later than 2020; phase out production and consumption of methyl chloroform as soon as possible; and express appreciation to those parties that have already taken measures more stringent and broader in scope than those required by the Protocol.

(4) Encouraging Participation and Facilitating Implementation

From the beginning, it was recognized that the shared nature of the ozone-depletion problem required widespread participation in the regime to be established by the Convention and Protocol. Encouragement of participation by developing countries, in particular India and China, required mechanisms to aid implementation of the regime by those countries. Thus, encouragement of participation and facilitation of implementation were and remain linked.

The regime encourages participation in a number of ways. First, because the reduction schedules are tied to either 1986 or 1989 levels of consumption and production, there is no advantage to waiting to join the regime. Second, although the parties to the regime during the phaseout periods may trade the controlled substances with one another, the Protocol, as adjusted and amended, progressively restricts trade involving controlled substances between parties and nonparties. Thus, for example, by January 1, 1993, the parties, having agreed upon a list of products containing the controlled substances specified in the Montreal Protocol, shall bar the import of those products from any state not party to the Protocol.

Third, the Protocol not only attempts to limit the advantages of remaining outside, but for developing countries, also provides incentives to join. The Montreal Protocol originally was vague on this point, providing that the parties, recognizing the particular needs of developing countries, ``shall . . . cooperate in promoting technical assistance to facilitate participation in and implementation of this Protocol.'' In response to the positions of India and China in particular, more specific and detailed provisions for financial assistance and technology transfer were adopted at the London Meeting.

(5) Noncompliance, Enforcement, and Dispute Settlement

Thus far, the Parties to the Convention and the Protocol have been concerned primarily with elaboration of and formal participation in the regime. As a result, enforcement procedures at this point are not particularly developed.

The key monitoring and enforcement device at present is the requirement for parties to provide to the Secretariat statistics on production, on imports and exports to parties and nonparties, and on amounts destroyed or recycled as feedstocks. Such reports will aid Secretariat and party monitoring, and will also further nongovernmental organization involvement since such data is not regarded as confidential. Unfortunately, not all parties have made such reports, or have submitted incomplete reports. The London meeting of the parties, noting these reporting difficulties, established an ad hoc group of experts to consider the reasons for the difficulties and to recommend solutions.

Investigatory and dispute settlement provisions are quite limited. The Convention, with application to the Protocol, provides that in the event of a dispute concerning interpretation or application of a provision, the parties (1) shall negotiate; (2) failing that, seek the good offices of, or request mediation by, a third party; and (3) failing that, submit the dispute to conciliation. The parties, in accepting the Convention also may declare that they accept as a means of dispute settlement either arbitration or submission to the International Court of Justice, or both. Against

that backdrop, the Parties to the Protocol have been considering procedures and institutional mechanisms for determining noncompliance and for treatment of parties found to be in noncompliance. Interim noncompliance provisions adopted at the London Meeting essentially provide for parties with reservations regarding implementation by other parties to report such concerns in writing to the Secretariat. The Secretariat shall transmit the submission to an Implementation Committee established by these same interim procedures, and that Committee shall consider the record with a view to securing an amicable resolution. The Committee shall report on its work to the Meeting of the Parties and the parties ``may . . . decide upon and call for steps to bring about full compliance . . . including measures to assist the Party's compliance . . . .''

b. The Evolving Structure of International Environmental Lawmaking

Reflection on the international effort to protect the stratospheric ozone layer illuminates the emerging structure of international environmental lawmaking. International environmental lawmaking is different from international lawmaking in general in at least three respects. First, environmental lawmaking must be conducted amidst great uncertainty about the reality, cause, and extent of the problem. Second, because the nature of environmental problems such as ozone depletion requires concerted action, it is necessary that at least the major contributors to the problem, present and future, be parties to the regime. Third, because it is difficult to separate environmental problems from one another and from development concerns generally, environmental lawmaking runs the risk of either being unmanageable or not system-oriented. This section discusses each of these differences in turn.

(1) Lawmaking Amidst Uncertainty: The Process as the Solution

We ordinarily might expect that states seeking to address an international problem would work towards a diplomatic conference where a treaty addressing an issue could be negotiated. Without in any way implying that this ``ordinary'' situation is easy, the international environmental context can be far more difficult because the views of the parties as to the nature of the environmental problem not only can be quite different, but moreover, the knowledge of all environmental problems is likely incomplete even though evolving. In the ``ordinary'' context a central task in the lawmaking effort is to improve communication between the parties so that they may better understand each other's objectives and concerns. In negotiations concerning environmental matters, however, there is the added and quite different task of the parties seeking to discover precisely what the environment requires. In this sense, the environment is an unobtrusive, but central presence in the negotiations. It is a party that does not volunteer information, but may answer questions if asked correctly. It is also a party that refuses to negotiate.

In the case of stratospheric ozone depletion, the international community initially confronted great debate as to whether there was a problem at all, followed by debate regarding the extent of the problem. As observed by many scholars in the past several decades, the nature of many environmental problems requires action by the relevant community before it has proof of the theory. In other words, the international community, despite uncertainty about the theory, must act to confront the danger indicated by the theory. Moreover, it must act knowing that its knowledge will continue to evolve and suggest further actions. These aspects of uncertainty and evolving knowledge lead to two major differences in international environmental lawmaking efforts from lawmaking efforts generally. Both of these differences evidence an emphasis on an ongoing process of lawmaking rather than, as ordinarily the case, the one time negotiation of a treaty at a particular conference.

The first difference is the explicit incorporation of scientific inquiry into the lawmaking process. Dealing with the uncertainty necessarily present in environmental problems requires that the process not only increase the shared knowledge of the parties, but that such knowledge also accurately reflect the state of scientific understanding of the problem. This requires much greater cooperation between the lawmaking community attempting to draft a response and the scientific community seeking to understand the phenomena. Imbedding this scientific effort in an international organizational structure or in international efforts that coordinate national efforts increases the perceived legitimacy, and hence shared nature, of the resulting description of the problem. Making the scientific inquiry an integral part of an ongoing lawmaking process serves both to educate the lawmakers and to speed up the incorporation of such knowledge into the process. In the case of the ozone regime, the Protocol institutionalizes this cooperation by requiring the convening of ``appropriate panels of experts'' (scientific, environmental, technical, and economic) at least one year before the parties meet to reassess the sufficiency of the Protocol's controls on ozone-depleting substances.

The second major difference is that the lawmaking effort that accommodates evolving knowledge through the establishment of an ongoing process of lawmaking continuously incorporates new knowledge and revises previous responses. In this sense, the Protocol calls for the parties to periodically ``assess the control measures provided for in Article 2 on the basis of available scientific, environmental, technical, and economic information.'' Thus, we see a transition from a one-conference effort to an ongoing process, and from ``two steps behind'' to action on the basis of evolving knowledge. In this sense, cooperation and education are recognized as important aspects of the lawmaking

process in the environmental area. For all these reasons, the solution to a threat such as ozone depletion is not the particular requirements of the Montreal Protocol or the London Adjustments and Amendments to the Protocol. Rather, the solution is the process which yielded the Protocol and which already looks ahead to the next adjustments and amendments.

(2) Consensual Lawmaking on Transcendent Problems

International environmental lawmaking is also distinct in that the nature of many environmental problems requires that at least those countries primarily contributing, or potentially contributing, to the problem participate in the regime. The environmental regime is dictated by the planet in the sense that the earth is not willing to negotiate the terms of a solution. In the previous section, it was asserted that states must negotiate a regime despite the fact that they are uncertain as to what precisely the earth requires. This section points to the need to encourage participation in global environmental regimes by at least those states which are, or potentially are, significant contributors to the problem.

In encouraging participation, the tools of the lawmaker are sticks and carrots. In other words, states either may be penalized for not joining the regime or rewarded for doing so. In the ozone protection regime, developing countries were encouraged to join through the recognition of their special needs. Moreover, although there are no sticks *per se*, the treaty does attempt to prevent those who remain outside from benefiting by doing so. First, there is no advantage in waiting to join the treaty since the baseline calculation from which reductions are to be made is fixed. Second, there is no trade advantage in remaining outside the convention since it restricts members from trading in areas involving the regulated substances with those outside the regime.

The more subtle implication of needing widespread participation, as discussed above, was the demand by China, India, and others for a linkage between their agreement to participate in the regime and satisfaction of other concerns, particularly, development assistance for the Third World. In the case of stratospheric ozone protection, linkage ultimately was made in the London amendments. The amendments provide for technology transfer and establish a fund to aid implementation of the Protocol by facilitating nonozone-depleting paths for growth in developing countries. The scale of linkage in the greenhouse gas negotiations will be an order of greater magnitude. The lawmaking risk presented by issue linkage is that it likely causes the scope of the agreement to increase. Moreover, the agreement, as a result, may embody compromises on linked issues and thus have the flavor of a package deal. This line of reasoning raises for some observers the possibility that greenhouse negotiations will bog down as did the Law of the Sea negotiations, and like the Law of the Sea, will result ultimately in an agreement that is too rigid because of the delicate balancing that is required. However, the sense of urgency which is associated with climate change did not exist with the Law of the Sea issue. In this sense, the urgency of climate change likely will push negotiations along despite the recognition of the special needs of developing countries. Other possibly even broader linkages to North-South questions, however, are perhaps best avoided so as to keep manageable the already broad scope of negotiations.

(3) The Tension Between Manageability of Negotiations and Systemic Thinking

One of the first lessons of environmental studies is the need to approach the environment as a system, an indivisible process. The lawmaker, however, can not approach the development of an environmentally sound relationship between humanity and the world all at once. Rather, negotiations must be limited so that the number of issues and interests involved remain at a manageable level. The danger with the slicing off of what appears to be a somewhat separable and manageable problem, however, is that systemic thinking may be lost. The question thus becomes how to best reconcile the need for manageable negotiations with the need for holistic thinking.

In the case of ozone depletion, the negotiations, at least initially, in moving to address the depletion problem did not consider whether their solutions might rest upon assumptions that would exacerbate the greenhouse gas problem. In particular, the reductions in CFC and halon use agreed to in Montreal were premised in part on the belief that ozone-safe substitutes existed. But, as already mentioned, not only did it later turn out that these substances also were ozone depleting, they also came to be seen as highly efficient greenhouse gases.

3. The Total CFC-Phase-out[11]

It is appropriate to evaluate the substance of the Protocol in light of three criteria: (1) environmental protection, (2) international equity considerations, and (3) economic efficiency. The environmental protection criterion concerns the degree to which effective implementation of the Protocol, with its existing reduction schedule, is likely to slow and/or prevent further depletion of the ozone layer. The international equity criterion focuses on the degree to which the Protocol equitably allocates the responsibility of limiting the production and use of ozone-depleting chlorofluorocarbons (CFCs) between the industrialized, industrializing, and less developed nations of the world. The economic efficiency criterion assess the adequacy of the economic incentives created by the Protocol's

consumption and production limits, with an eye toward stimulating the research for and development of environmentally sound, cost-competitive substitute chemicals and products by industrial firms, particularly those in the industrialized countries.

Overall, the Protocol marginally satisfies the international equity and economic efficiency criteria. The Protocol, as written, is vastly preferable to a lack of international controls on CFC use. Nevertheless, its terms are inadequate to prevent further significant degradation of the ozone layer. The environmental protection and international equity criteria would be greatly enhanced if the Protocol were to be revised, incorporating an international commitment to a significant, third-stage reduction by the industrialized countries. As industrialized nations develop substitutes, a commitment to third-stage reduction based on an accelerated schedule would benefit the economic efficiency criterion as well.

a. The Environmental Protection Criterion

From an environmental protection and public health point of view, any further deterioration of the stratospheric ozone layer is extremely undesirable. An interim global environmental goal, therefore, would be to halt further degradation of the ozone layer. A longer term goal would aim at the gradual restoration of the ozone layer.

Since CFCs already released into the atmosphere will gradually migrate to the stratosphere, thereby destroying ozone for decades to come, the US Environmental Protection Agency (EPA) has estimated that CFC emissions would have to be cut by 85% immediately to prevent further ozone layer deterioration. This would require an 85% reduction in global production and use until CFC recycling technologies are perfected and adopted. After this initial reduction, all ozone-depleting chemicals should be phased out.

The Montreal Protocol does not provide for this degree of reduction of CFC production and use. Rather, the possible results of the Protocol can be illustrated in three ways. First, the Protocol would be expected to lead to a 35% worldwide decrease in CFC production from 1986 levels by 1999. Yet it was predicted, based on model calculations, that this decrease in production would still result in an additional 2.5% deterioration of the ozone layer. This level of reduction falls short of the optimum goal of non-degradation. In fact, according to recent empirical data, this rate of deterioration would most likely exceed 2.5%.

A second environmental scenario factors in the Protocol's proposed forbearance of increased CFC production through the end of the century, since low-consuming countries (LCCs) are permitted during this period under the Protocol terms to increase consumption levels up to 0.3 kilograms per capita. Fortunately, this increase is unlikely to occur because many of the LCCs could not realistically be expected to reach the maximum annual consumption by 1999. Nevertheless, this allowance for increased LCC use indicates that even full compliance under the Protocol could result in a decrease in global production levels of significantly less than 35%.

A third, and more optimistic environmental scenario incorporates the possibility that worldwide production of ozone-depleting CFCs covered by the Protocol could fall significantly less than 35%. This decrease could be achieved if firms in the industrialized countries were able to develop safe and cost-effective substitutes for CFCs quickly enough to permit their substitution in all major CFC uses by the end of the century.

None of these three scenarios envisions the attainment of the environmental non-degradation goal suggested by the EPA. The third scenario, however, comes closest, depending on the rapidity with which the more dramatic reductions which it contemplates can be effectuated. Certainly, the first scenario's 35% reduction in global production by the end of the century would fall far short of this goal. It should, however, be emphasized that even the most pessimistic Protocol scenario should be deemed vastly preferable to the probable environmental impact in the absence of such an agreement: the EPA has recently estimated that, without intervention, worldwide ozone depletion rates could range from 4.32% to as much as 50% or more by the year 2050. The result of this degree of ozone degradation would be catastrophic.

b. The International Equity Criterion

The environmental protection problems outlined above arise, in part, out of the conflict between the Protocol's twin goals of ending ozone degradation and allocating the burden fairly. The Protocol tends to favor equity over ozone protection during the first ten years of its implementation. The provisions that foster equity have significant environmental ramifications, since a substantial increase in CFC use on the part of LCCs approaching the Protocol limit could lead to high rates of stratospheric ozone depletion regardless of the extent to which high-consuming industrialized nations reduce their own use.

The importance of the LCCs in solving the ozone depletion problem cannot be ignored. Scientists working under the aegis of United Nations Environment Programme (UNEP) concluded that, given the size and growth rate of the LCC population, the rate of ozone layer degradation over the next twenty to one hundred years will probably depend far more on LCC levels of CFC production and use than on the degree of reduction the industrialized countries accomplish. According to the scientists' predictive models, average global ozone depletion could range

from 6% to 12% by 2050, even if industrialized countries were to reduce CFC use by 20% to 50%, were LCC use to increase at a rate of 2.5% annually, until reaching a ceiling of 0.5 kilograms per capita. The models indicate that use of CFCs in all nations would have to be frozen at present levels to achieve a depletion rate of less than 2% by 2050.

Even gradual increases in LCC use will result in devastating reductions in ozone levels. Consequently, the models illustrate the critical importance of moderating increases in LCC use of CFCs. The Protocol should, therefore, implement control measures on CFC use by the industrialized countries which are compatible with imposition of stringent limits on CFC use in the LCCs. Conversely, forcing LCCs to assume sole responsibility for reducing global CFC use would operate against the Protocol's goal of international equity.

It is possible to assess the fairness of the Protocol's allocation of responsibility for limiting CFC consumption by comparing current levels of CFC use among high, moderate, and low consumption countries with the Protocol's likely impact upon these levels. The current disparities in per capita use of CFCs are enormous as they are due, in large part, to variations in per capita and national wealth. Industrialized countries, whose citizenry comprises less than 25% of the total world population, produce and consume close to 85% of the world's CFCs. The remaining three-quarters of the population consume only one-sixth of the world's CFCs. According to one estimate, China and India, home to over 35% of the world's five billion people, consume only 2% of the world's CFCs. A recent study conducted for the EPA discloses that annual per capita CFC use in China, Egypt, and Mexico is 0.02, 0.06, and 0.07 kilograms, respectively, while per capita use figures for Japan, the US, and the European Economic Community (EEC) are 0.48, 0.84, and 0.85, respectively. Thus, in the mid-1980s, industrialized nations of the EEC consumed forty times more CFCs than China, one of the lowest consuming countries on a per capita basis. Perpetuation of this level of disparity into the next century is unacceptable.

Under the Protocol, the highest CFC consuming nations the US and EEC countries are required to halve their 1985 consumption production and use levels by 1999. The would yield a permissible per capita use rate of between 0.4 and 0.5 kilograms. LCCs, however, are not subject to Protocol restrictions until 1999 unless they reach an annual level of 0.3 kilograms per capita before that date. The permitted level of CFC use in 1999 therefore ranges from 0.3 for the LCCs to slightly over 0.4 for the US and the EEC countries. Thus, full use at Protocol limits by all countries in the years prior to 1999 would result in a significant decrease in the current forty-fold differential in use levels.

After 1999, however, the Protocol allows the differences in CFC use levels between the highest and lowest consuming countries to increase once more. In that year, the LCCs must begin compliance with the ten year reduction schedule regardless of whether they have reached the 0.3 kilograms per capita limit. Therefore, the size of the differential will depend on the usage rates attained by the LCCs by 1997-98, since the reduction baseline is determined by the level of use during that period. LCCs that reach a per capita annual use rate of 0.05, 0.1, 0.2, or 0.3 by 1997-98, after the 50% reduction imposed during the next decade, would be permitted a per capita use rate of 0.025, 0.05, 0.1, or 0.15, respectively. Hence, the highest consuming industrialized countries, whose permitted per capita use will have remained at the 1999 level of 0.4, will consume almost three times what the highest consuming LCC will be permitted to consume in 2009. Furthermore, because most LCCs will not reach the 0.3 cap by 1999, the 2009 CFC use differential after these LCCs have complied with the 50% reduction schedule could be as high as 10 to 20.

The question remains whether the Protocol-authorized differences in per capita use are equitable. A proper answer to this question requires the establishment of a standard for the international equity criterion and an examination of the Protocol's satisfaction of that standard.

International equity does not necessarily require perfect equivalence in per capita CFC use. Rather, for the purposes of this analysis, we shall take the proper degree of international equity to be that level of difference in per capita use by nations that does not interfere with attainment of comparable levels in per capita economic performance.

One approach to assessing what degree in difference in per capita CFC use is compatible with comparable levels of economic performance among nations is to look at CFC use per unit of economic output in nation states today. In its study for the EPA, ICF Incorporated conducted this kind of analysis, and graphically compared the production and use of CFC-11 and CFC-12 per billion US dollars of GNP for various countries. According to this analysis, per capita use of CFC-11 plus CFC-12 for each one billion US dollars of GNP ranges from 33.0 kilograms for Mexico and 36.1 for Sweden to 49.6 for Japan, 51.5 for Thailand, 52.5 for Malaysia, 61.1 for China, 62.1 for the US, 77.6 for Austria, 95.3 for the EEC, and 96.2 for Egypt. If we bracket Norway, whose use per billion dollars GNP is below Mexico's by more than a factor of 2.5, the difference in kilograms CFC use per billion dollar GNP is approximately a factor of three.

These comparisons suggest that a range in per capita use of CFCs of a factor of three will not unreasonably distort or constrain comparable economic performance. Thus, under this analysis, the international equity criterion is

satisfied where the disparity authorized by the Montreal Protocol in per capita CFC use among the world's nations does not exceed a factor of three.

Measured against this standard, the Protocol probably will satisfy the international equity criterion in 1999 but may violate it from 1999 until 2009. The Protocol's authorized range of per capita use levels among states in 1999 is acceptable. After 1999, those LCCs at or close to the 0.3 cap in 1997-98 which comply with the ten-year reduction schedule will also be within the standard. However, the differential for those LCCs whose 1997-98 pre-50% reduction per capita use is below 0.2, 0.1, or 0.05 clearly violates the equity criterion. Thus, while the Protocol will be equitable at the end of the century in terms of authorized disparities in CFC use levels, it will become significantly less equitable after 1999.

c. The Economic Efficiency Criterion

The Montreal Protocol can be considered economically efficient in carrying out its environmental objective insofar as it creates incentives sufficient to stimulate development of environmentally safe substitute chemicals and products for all current CFC uses by 1999 and competitive prices.

The cost factor affects the substitute's suitability as replacements for CFCs covered by the Protocol, particularly in the LCCs. The availability of substitutes at competitive prices for all major CFC uses is crucial in making them attractive to the LCCs, particularly during the decade after 1999, when they will have to comply with the Protocol reduction schedule. If such substitutes are unavailable, the LCCs may resist continued compliance with the Protocol after 1999. Industrial incentives to develop substitutes for all major uses of ozone-depleting CFCs must be very strong if the LCCs are to find the Protocol truly feasible.

CFC uses likely to experience the highest rates of growth in the LCCs over the next decade include refrigeration and air-conditioning, and, to a lesser extent, electronics and plastics manufacturing. These forms of economic activity are central to economic growth and development. If the LCCs are to comply with the Protocol's proposed 50% reduction in use of CFCs between 1999 and 2009, they must be persuaded that alternative chemicals and products will be made available so that economic expansion in refrigeration, air-conditioning, electronics, and plastics technologies will not be significantly handicapped.

Thus, the key issue is whether the Protocol provides chemical and user industries with economic incentives sufficient to encourage the development of substitutes for all of the major uses of CFCs. This need is especially pressing in industries in which the LCCs are expected to experience the most rapid and continued increase in demand in the early 21st century. This is an open question for which only experience over the next decade can supply the answer.

The Protocol potentially can provide the necessary incentives. Actualization will depend, to a large extent, on the rate of increase in demand for CFC-type products in the industrialized world. For example, in the absence of the Protocol's use limitations, and if we assume a 2% to 5% CFC annual growth rate among industrialized countries, CFC use in those nations could increase 35% to 60% between 1986 and 1999. Applying the Protocol-mandated 50% reduction to this level of use would result in a 60% to 70% cut from the projected 1999 levels. Stated otherwise, the Protocol could produce permitted use levels in 1999 of 30% to 40% of use levels which could prevail in the industrialized countries absent regulation. Furthermore, for uses such as mobile air-conditioning and foam plastics, a 50% overall decrease in permissible use might not encourage the development of substitutes. However, a 70% reduction would probably be sufficient to spark development in these areas because these CFC uses account for 50% of total CFC use, even in western Europe where aerosol use generally still is allowed. Under this economic growth scenario, industry will have a strong economic incentive to develop substitutes for uses which account for 20% or more of CFC consumption insofar as projected growth in demand proves accurate. Absent a perceived or real rise in demand, the economic incentive to invest in the research and development of substitute technology will be diminished. Thus, the strength of incentives to conduct research and develop substitutes depends on the overall economic prosperity of the industrialized countries and the future demand for CFC-type products.

Another major incentive to conduct intensive substitute research and development stems from the Protocol's limitations on CFC use in LCCs after 1999. If the Protocol imposed no limits and no post-1999 reduction schedule on the LCCs, the major producers of CFCs could anticipate an expanding market for their CFC products until 1999 and a stable or expanding market thereafter. However, the Protocol requires LCCs to reduce their use of CFCs by 50% in the decade after 1999. Therefore, assuming Protocol ratification and compliance, producers can anticipate a period after 1999 when permissible LCC use of CFCs is contracting while LCC demand for CFC-related products will be growing substantially.

If LCCs have become dependent on CFC products by 1999 and are willing to comply with the Protocol, the market for substitutes will be enormous. Plants in the industrialized nations that produce CFCs for export to the LCCs will become increasingly obsolete after 1999. Similarly, firms making products dependent on CFCs covered

by the Protocol will not only find a shrinking market in the industrialized countries over the next twelve years, but in the rest of the world thereafter. Industrial firms that have not developed substitutes for major LCC uses of CFCs in advance of 1999 will be at an increasing disadvantage with respect to other firms. Finally, the potentially great LCC demand for substitutes constitutes an important incentive where EEC firms are concerned. In the absence of LCC demand, EEC firms would have far less incentive than North American firms to develop CFC substitutes because EEC nations could meet a substantial part of their reduction schedule solely through adoption of aerosol substitutes.

This reasoning suggests that industrial firms that develop acceptable substitutes for all CFC uses will prosper while firms which ignore the trend away from CFCs will be eliminated from the market. Thus, by strengthening incentives to develop substitutes for all CFC uses, an additional reduction phase beyond 50% could add to the economic efficiency of the Protocol.

d. Rationale for a Third-Stage 95-100% Reduction

Combined considerations of global environmental protection, international equity, and economic efficiency justify the initiation of a third stage of action: a further 45% to 50% reduction in industrialized nations' CFC use. This would result in a 95% to 100% total reduction from 1986 levels. This proposed third stage for industrialized nations could take place between 1999 and 2009 while the LCCs comply with their delayed 50% reduction schedule. The further reduction could be achieved in a one- or two-step process. Of course, based on a scientific reassessment of recent evidence of deterioration of stratospheric ozone, the Protocol should be revised to accelerate the timetable for all reductions, including such a third-stage cut.

A third-phase total reduction of 95% to 100% in the industrialized countries would make the objective of an 85% worldwide reduction in CFC emissions a practical reality. To accomplish a global 85% reduction, the industrialized nations would have to cut CFC use by more than 85%, since the LCCs could not be expected to reduce their use from 1986 levels. Thus, a third-stage reduction would go a long way to meet the environmental objective of preventing further deterioration of stratospheric ozone. The degree to which this goal would then be met would depend on the time schedule for implementation of the three stages of reduction.

A 95% to 100% industrialized-world third-phase reduction during the period when the LCCs are complying with the Article 2 control measures would greatly enhance the international equity of the Protocol. Such a reduction from 1986 levels would result in an eventual average CFC-11 and -12 use level in the industrialized nations of less than 0.05 kilograms per capita. The 95% reduction level of 0.05 kilograms per capita should satisfy the equity criterion; a 90% reduction level at 0.1 kilograms per capita would, at best, marginally satisfy it; any less stringent reduction would not.

Finally, a third-phase reduction for the industrialized countries during the LCC phase-down period would foster confidence in the LCCs that industrialized nations are committed to development of substitutes for all major uses, as well as alternative, non-CFC dependent technologies. At the same time, industrial firms would make major financial investments in substitute research and development, confident that those substitutes would find wide acceptance in the world market.

A revision of the Protocol to require a further, third-stage 95% to 100% CFC reduction for the industrialized countries would further the criteria discussed above. Certainly, a greater commitment on the part of industrialized countries would greatly enhance the equitable nature of the Protocol while simultaneously securing a higher and essential level of environmental protection.

B. Climate Change

1. The Climate Change Convention[12]

Each year, mankind injects approximately six billion tons of carbon into the atmosphere from the burning of fossil fuels,[13] as well as a substantial (although still uncertain) amount from deforestation.[14] Since the advent of the industrial revolution, atmospheric concentrations of carbon dioxide have risen by more than twenty-five percent, from 280 to more than 350 parts per million (ppm). Scientists estimate that if current patterns of emissions continue unchecked, the increasing concentrations of carbon dioxide, together with parallel increases in other trace gases such as methane and nitrous oxide, will cause an average global warming in the range of 0.2 to 0.5 degrees C per decade, or 2 to 5 degrees C (3.6 to 9 degrees F) by the end of the next century. Such a temperature rise, more rapid than at any time in human history, could have severe effects on coastal areas, agriculture, forests, and human health.

In response to this threat, the U.N. General Assembly established the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC) in December 1990, with the mandate to negotiate a convention containing ``appropriate commitments'' in time for signature at the U.N. Conference on Environment and Development (UNCED) in June 1992. The INC met six times between February 1991 and May 1992, and adopted the U.N. Framework Convention on Climate Change (Climate Change Convention, or

Convention) on May 9, 1992.[15] The Convention was opened for signature at UNCED, where it was signed by 154 states and the European Community. It requires fifty ratifications for entry into force.

To many, the Convention was a disappointment. Despite early hopes that it would seek to stabilize or even reduce emissions of greenhouse gases by developed countries, the Convention contains only the vaguest of commitments regarding stabilization and no commitment at all on reductions. It fails to include innovative proposals to establish a financial and technology clearinghouse or an insurance fund, or to use market mechanisms such as tradeable emissions rights. Furthermore, it not only contains significant qualifications on the obligations of developing countries, but gives special consideration to the situation of fossil-fuel producing states.

Nevertheless, given the complexity both of the negotiations, which involved more than 140 states with very different interests and ideologies, and of the causes, effects, and policy implications of global warming, reaching agreement at all in such a limited period of time was a considerable achievement. In fact, the final text is significantly more substantive than either the bare-bones convention advocated by some delegations or previous framework conventions dealing with transboundary air pollution and depletion of the ozone layer. While the Convention does not commit states to specific limitations on greenhouse gas emissions, it recognizes climate change as a serious threat and establishes a basis for future action. First, it defines as a common long-term objective the stabilization of atmospheric concentrations of greenhouse gases ``at a level that would prevent dangerous anthropogenic interference with the climate system.'' Second, to guide future work, it sets forth principles relating to inter- and intra-generational equity, the needs of developing countries, precaution, cost-effectiveness, sustainable development, and the international economy. More importantly, it establishes a process designed to improve our information base and reduce uncertainties, to encourage national planning, and to produce more substantive international standards should scientific evidence continue to mount that human activities are changing the Earth's climate.

a. Background

(1) Overview of the Problem

The greenhouse effect is a naturally-occurring phenomenon: certain trace gases in the atmosphere absorb infrared radiation (heat) and reradiate it towards the Earth, raising the Earth's surface temperature.[16] In effect, these gases trap heat in the atmosphere as does the glass of a greenhouse or a blanket on a bed.[17] By far the most important greenhouse gas is water vapor. Other greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Without this natural greenhouse effect, the Earth would be 33 degrees C (60 degrees F) colder and therefore uninhabitable for humans.

The vast expansion of human activities resulting from industrialization and population growth has led to substantially increased emissions, and ultimately to higher atmospheric concentrations of several greenhouse gases. These increased emissions have upset the equilibrium between emissions of greenhouse gases from natural sources on the one hand and removal of these gases by so-called ``sinks'' on the other, which had kept atmospheric concentrations relatively constant in pre-industrial times.[18] Most climate scientists believe that increased atmospheric concentrations of greenhouse gases will eventually produce an ``enhanced'' or ``anthropogenic'' greenhouse effect. However, the magnitude, timing, and geographical distribution of this warming are highly uncertain, as are its impacts, which may include a sea level rise of about sixty-five centimeters by the end of the next century, a greater number of hurricanes, drought, and deforestation.

Predictions of greenhouse warming are based primarily on computer models of the atmosphere, and, thus far, have not been clearly confirmed by direct temperature measurements. Although available records suggest a global average warming of 0.3 to 0.6 degrees C (0.5 to 1.1 degrees F) since the late nineteenth century, this temperature increase could be due to natural climate variability rather than greenhouse warming. Waiting until the evidence is unambiguous, however, may be tantamount to accepting a substantial degree of warming.

The two types of policy responses to the threat of global warming are abatement and adaptation. Although some warming may be inevitable because of past greenhouse gas emissions, reducing emissions or enhancing sinks could mitigate additional warming. Alternatively, we could wait to see what happens, and, if warming occurs, try to adapt to its adverse effects by, for example, building sea walls to prevent coastal flooding, switching to more heat-resistant agricultural crops, or using more air conditioners. Whether abatement or adaptation is preferable depends on various factors, including the relative costs of abatement adaptation measures (which are highly uncertain), the likelihood of obtaining new information that will reduce uncertainties, and the risk of catastrophe.

Because a vast array of human activities produces greenhouse gas emissions, all countries contribute to the buildup of these gases. However, the contributions of different countries vary markedly. At present, industrialized countries are responsible for approximately three-quarters of global carbon dioxide emissions; the United States alone contributes nearly one-quarter of the global total.[19] Developing countries, with eighty percent of the world's

population, account for the remaining quarter.[20] As developing countries such as China, India, and Brazil continue to grow, however, their emissions of carbon dioxide will increase dramatically. By some estimates, the carbon dioxide emissions of developing countries will at least equal those of developed countries by the year 2030. Assuming sinks cannot be dramatically increased, stabilization of atmospheric concentrations of greenhouse gases will require a two-prong strategy: first, limiting and reducing greenhouse gas emissions from developed countries, which historically have accounted for the bulk of emissions; and second, redirecting developing countries into a low-emissions growth track involving more efficient use of energy produced by ``cleaner'' technologies.

Although scientists have understood the general theory of greenhouse warming for more than a century, widespread concern emerged only in the last two decades. This resulted from several scientific developments. First, in the 1960s and 1970s atmospheric chemists conclusively established that concentrations of carbon dioxide were in fact increasing. Since 1958, when direct measurements first began, atmospheric carbon dioxide concentrations have risen from 315 ppm to more than 350 ppm today. Second, in the 1980s scientists began to focus on trace gases other than carbon dioxide that trap heat and contribute to the greenhouse effect, chief among them methane, nitrous oxide, and chlorofluorocarbons (CFCs). In 1985, the global warming effect of these gases was estimated to be roughly equal to the effect of carbon dioxide, indicating that the problem was twice as serious as previously believed.

Third, as computing power grew, climatic models became much more sophisticated and complex, increasing the credibility of global warming predictions. Models of the atmosphere must take into account many factors, including the heat-trapping characteristics of greenhouse gases, ocean and wind currents, soil moisture, the reflectivity of the Earth's atmosphere and surface to sunlight, and an array of feedback mechanisms. Early simulations of the atmosphere were very crude, and did not come close to approximating the complexity of atmospheric dynamics. The advent of supercomputers permitted the development of more realistic general circulation models, which represent the atmosphere in three dimensions and in greater spatial detail, and take better account of feedback mechanisms and ocean-atmosphere interactions. Although a high degree of uncertainty still exists, most climate scientists believe that general circulation models are now sufficiently reliable to provide a basis for policy decisions.

Finally, new studies in the 1980s indicated that the temperature record is broadly consistent with global warming forecasts. In the mid-twentieth century, such forecasts had had limited impact, given what appeared to be a cooling trend. As recently as the mid-1970s, when a series of climatological disasters drew attention to the climate change issue, scientists were still split between ``coolers'' and ``warmers,'' and some feared the onset of another ice age. Today, in contrast, a careful re-examination of the historical data has produced a general consensus that the Earth is warming.

b. Negotiating History of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change

(1) Obstacles to Agreement

Several factors complicated the INC's task. First, the stakes in the negotiations were very high, since the world economy depends heavily on fossil fuels. As one observer notes, ``[t]he causes of the greenhouse problem are deeply embedded in the central aspects of the world's economic and social activity: across transportation, industrial, agricultural, and forestry practices; from the developed to the developing world; and in the very growth of populations and economies.'' A convention on climate change has the potential to affect economic and social activities profoundly, much more so than other international environmental agreements dealing with problems such as depletion of the ozone layer or acid rain, which have more limited and easily addressed causes.

Second, the greenhouse problem still has a distant and somewhat speculative quality. Major uncertainties exist about virtually every aspect of the problem. Little is known about many of the sources and sinks of greenhouse gases or the timing, magnitude, and regional distribution of climate change resulting from increased greenhouse gas concentrations. Moreover, the impacts of climate change on forests and other natural ecosystems, agriculture, coastal areas, and human health are difficult to predict,[21] as are the relative costs and benefits of adaptation and abatement measures. Although the resulting ``veil of ignorance''[22] could potentially facilitate agreement, in practice it has tended to make governments more reluctant to act.[23]

Third, states have widely divergent interests that must be reconciled. They contribute to the climate change problem to varying degrees, have unequal costs of abating greenhouse gas emissions, and face different risks from global warming.[24] Consider, for example, the differences between major fossil-fuel producers, who fear that limitations on carbon dioxide emissions will depress oil prices, and small island states in the Pacific and Caribbean, who fear being inundated by rising sea levels. Although it is often stated that there would be no winners from global warming, some states in fact fear that the cure for climate change will be worse than the disease and are skeptical or even opposed to strong response measures.

Fourth, the climate change negotiations involved virtually every nation in the world. This was generally regarded as desirable, given the global nature of the problem. Indeed, developing country participation was actively promoted through the establishment of a trust fund to subsidize attendance. However, this inclusiveness had its drawbacks, because, as a general rule, the more countries involved in a negotiation, the more difficult agreement becomes.

Fifth, the climate change negotiators had less than eighteen months to conclude an agreement. Given the time needed for participants to formulate national positions and consult with other governments and for the INC Secretariat to translate documents into the six official U.N. languages, little time was left for the negotiations themselves. Most international environmental agreements have taken much longer to negotiate, even though they address less sensitive issues.

Finally, the factor that may have introduced the most complications was that the INC involved not merely a negotiation within the North, between the North and the South, or within the South, but all three simultaneously. In effect, the INC compressed into a single negotiation what had been a two-step process in the ozone negotiations. The Vienna Ozone Convention and Montreal Protocol had essentially been negotiations among developed countries; developing countries did not become heavily involved until the London Amendments were under consideration, after the initial agreements had already been adopted. In contrast, developing countries such as India, China, Brazil, Saudi Arabia, and the small island states participated actively in the INC from the start, disagreeing both with countries in the North and among themselves.

(2) State Interests and General Positions

OECD Countries. Because Western developed countries--which make up the Organization of Economic Cooperation and Development (OECD)--account for a disproportionate share of greenhouse gas emissions, both the North and South assumed that developed countries would take the lead in addressing the climate change problem. OECD countries generally agreed that the Convention should institutionalize a strong process to address climate change, including regular meetings of the parties, scientific and implementation committees, detailed reporting requirements, and procedures to resolve questions about a country's compliance with the Convention. The most pronounced split within the OECD concerned targets and timetables to limit greenhouse gas emissions, which were favored by the European Community and vigorously opposed by the United States.

To some degree, disagreements within the OECD resulted from perceived disparities in the cost of abatement measures. For example, the United States and Australia have large reserves of cheap coal (a relatively high source of carbon dioxide per unit energy), while Germany currently subsidizes coal production and could save money by switching to natural gas (a relatively low emitter of carbon dioxide per unit energy). Thus, it would be more costly for the United States and Australia to forgo the use of coal than it would be for Germany to do so. On a broader level, discord within the OECD can be attributed, in part, to the differing public perceptions of the climate change problem and differing attitudes towards regulation and taxation of the energy and transport sectors. Differences in OECD positions narrowed over time as economics and energy ministries in countries other than the United States began to recognize the potential implications of the climate change issue, and as industry began to mobilize against strong response measures.

Developing Countries. Although neither the North nor the South were monolithic,developed and developing countries tended to maintain quite different perspectives during the negotiations. Paralleling the split within the UNCED Preparatory Committee, the North tended to see climate change as an environmental issue, whereas the South saw it as a developmental issue. Despite widely divergent interests, the South, speaking through its political grouping--the so-called Group of 77 (G-77)[25]--was united in arguing that the Convention must not hinder its ability to develop. Since increased greenhouse gas emissions, particularly of carbon dioxide, have traditionally been a by-product of industrialization and improved living standards, developing countries insisted that their emissions of greenhouse gases must be allowed to grow, eventually reaching the same per capita level as the emissions of developed countries. Instead, industrialized countries should bear the main responsibility for addressing the climate change problem, since their excess emissions caused the problem in the first place.[26]

The differences between the North and South were manifested most consistently in the discussions of financial resources. In the South's view, if the North wanted developing countries to take abatement measures, the North should pay for the costs, since it was responsible for causing the climate change problem. OECD countries, while conceding that they should provide financial resources to the developing countries, preferred to characterize these transfers in forward- rather than backward-looking terms. Developed countries would undertake commitments to provide financial resources because of their greater capacity to pay, not because of their historical responsibility. Moreover, they insisted that their obligation to provide financial resources must be matched by corresponding undertakings by the South to develop and report on national policies and measures to limit greenhouse gas emissions

and enhance sinks. Finally, the North believed that the GEF should serve as the financial mechanism for the Convention, while the South argued that a new institution should be established to administer the funds, under the collective authority of the parties to the Convention.

In essence, this North-South debate echoed the controversy in the 1970s over the New International Economic Order (NIEO), in which the South demanded a more equitable distribution of wealth and a greater say in global economic institutions. Despite the South's lack of success then, many in the South felt that they now had some leverage because of the North's concern about global environmental issues.[27] This feeling of comparative strength led the South to maintain tough bargaining positions in both the INC and the UNCED Preparatory Committee.

Apart from the financial issues, however, developing countries had difficulty acting as a bloc. Three groups emerged as particularly important: semi-industrialized developing countries, oil-producing states, and AOSIS. The big semi-industrialized developing countries--India, China, and Brazil--emphasized the development and equity issues. In their view, if anyone should limit greenhouse gas emissions, it should be the North, creating the ``environmental space'' necessary for the South to grow. These countries also tended to prefer a minimal institutional structure consisting of a conference of parties and secretariat, because they feared that developing countries as a group lacked the resources and personnel necessary for adequate representation in other institutions. Finally, they regarded with suspicion proposals to establish strong monitoring, review, and enforcement mechanisms, since these would, in their view, be controlled by the North, which could use the mechanisms to criticize developing countries and interfere with their sovereign right to develop.

To one extreme of this widely shared ``Southern'' position stood the oil-producing states, who questioned the need for strong commitments by either developing or developed countries. They challenged, in particular, proposals for a stabilization or reduction target for carbon dioxide emissions. On the other extreme stood the small island states, who were more closely aligned with the North. Most immediately at risk from climate change, AOSIS supported the EC stabilization target as a first step towards eventual reductions in greenhouse gas emissions and pressed for the creation of strong institutional and implementation mechanisms. Although the island states ultimately had less influence on the negotiations than their numbers might have suggested they would, they nevertheless emerged as a potent political force and achieved many of their original goals.

In addition to these main groups, a number of developing country groups actively pursued particular issues. For example, African states sought to include references to the risks of desertification and drought, while large forest countries such as Malaysia and Brazil argued against singling out forests from among other greenhouse gas sinks. Finally, for many of the least developed countries, climate change remained a distant, hypothetical threat. Although most attended the negotiations, their actual participation in the discussions was nominal.

c. Commentary

Broadly speaking, the Convention can be separated into four parts: (1) the introductory provisions, setting forth the basic definitions, principles, and objectives of the Convention; (2) the commitments relating to the sources and sinks of greenhouse gases; scientific cooperation, public information, and education; and financial resources and technology transfer; (3) institutional and procedural mechanisms to implement the Convention; and (4) final clauses dealing with such matters as protocols and annexes, amendment, ratification, and entry into force.

The following sections do not attempt to provide a definitive interpretation of the Convention. Rather, they provide a reader's guide, explaining the background and rationale of the Convention's provisions, and highlighting the alternative formulations proposed and the compromises reached.

(1) Framework vs. Substantive Approach

Early proposals for the climate change negotiations focused on the framework convention/protocol approach, which had been used with considerable success to deal with the problems of acid rain and depletion of the ozone layer. Under this model, states first negotiate a framework convention, establishing general obligations concerning such matters as scientific research and exchange of information, as well as a skeletal legal and institutional framework for future action. States later develop specific pollution control measures (including emissions limitations targets) and more detailed implementation mechanisms in protocols.

The framework convention/protocol model serves two basic functions. First, it allows work to proceed in an incremental manner. States can begin to address a problem without waiting for a consensus to emerge on appropriate response measures, or even before there is agreement that a problem exists. Lawmaking can thus proceed ``amidst great uncertainty.'' For example, when both the ECE Long-Range Transboundary Air Pollution Convention (LRTAP) and the Vienna Convention for the Protection of the Ozone Layer (Vienna Ozone Convention) were adopted, some states remained unconvinced of the need for action. Nevertheless, even skeptical states acquiesced in the adoption of these conventions, since the conventions did not commit them to any specific measures. Later, when the scientific evidence became stronger, protocols could be adopted more quickly, since the framework conventions

had cleared away many of the preliminary procedural and institutional issues.

Second, the framework convention approach can produce positive feedback loops, making the adoption of specific substantive commitments more likely. Scientific research and assessments carried out under the convention help reduce uncertainties and lay a basis for action. The institutions established by the framework convention play a catalytic role by collecting data, providing technical assistance, and issuing reports. The meetings held under the convention provide a forum for discussions among the technical elites in different countries, and serve to focus international public scrutiny on countries that lag behind an emerging international consensus. In effect, once a framework convention is adopted, the international lawmaking process takes on a momentum of its own. States that were initially reluctant to undertake substantive commitments, but that acquiesce in the seemingly innocuous process set in motion by the framework convention, feel increasing pressure not to fall out of step as that process gains momentum.

Despite the advantages and historical successes of the framework convention/protocol model, many countries wanted the INC to produce more than a framework convention. Given the perceived urgency of the problem as well as the extensive preparatory work of the IPCC, they viewed the two-step, framework convention/protocol process as unnecessarily slow. In the end, the Convention lies somewhere between a framework and a substantive convention. It establishes more extensive commitments than those contained in LRTAP or the Vienna Ozone Convention, but falls short of the type of specific emissions control measures contained in the Sulfur Dioxide or Montreal Protocols. While there are few procedural or institutional innovations in the Convention, it does establish scientific and implementation committees and provides for scientific assessment, reporting and review of greenhouse gas levels, financial and technical support to aid implementation, and a financial mechanism.

Objective (Article 2). Article 2 establishes the ``ultimate'' objective of the Convention as stabilization of greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. This level is to be achieved ``within a time frame sufficient to allow ecosystems to adapt naturally to climate change . . . and to enable economic development to proceed in a sustainable manner.''

By recognizing the need eventually to stabilize atmospheric concentrations of greenhouse gases, the objective acknowledges climate change as a problem and helps legitimize it as a matter of international concern. Some commentators have interpreted Article 2 as favoring prevention of, over adaptation to, climate change. The text, however, appears to be neutral on this question, since it condemns only those interferences with the climate system that are ``dangerous.'' To the extent that adaptation to climate change is possible, such change could be viewed as benign.

The exact legal status of the Convention's stabilization objective may be the subject of future discussion. Some early proposals relating to the objective phrased it as a collective commitment, binding on all the parties. Although the Secretariat categorized the proposals on objectives as ``general obligations'' in a compilation document, as ultimately adopted Article 2 uses declarative language and does not characterize the objective as a commitment. Also unclear is whether Article 2 falls under the category of ``object and purpose'' contained in the Vienna Convention on the Law of Treaties. If so, signatories to the Climate Change Convention would have a duty not to defeat the stabilization objective. In what may have been an attempt to prevent ``objective'' from being equated with ``object and purpose,'' the Convention adds the qualification ``ultimate.''

Principles (Article 3). Most developing countries supported the inclusion of an article on general principles, arguing that such an article would serve as the lodestar or compass to guide the parties in implementing and developing the Convention. Some even argued that the Convention should include only principles and leave commitments to future protocols. In contrast, developed countries generally questioned the inclusion of a principles article. The United States in particular insistently opposed its inclusion, arguing that its legal status was unclear. The United States maintained that if the principles merely stated the intentions of the parties or provided a context for interpreting the Convention's commitments, they served the traditional functions of the preamble, and placing them in the operative part of the Convention would be unnecessary and even misleading. On the other hand, the United States argued, if the principles were themselves commitments, they should be designated in the Convention as such.

The U.S. reasoning, however, fails to take into account that principles may serve a third function, different from those of either preambles or commitments: unlike preambular paragraphs, principles embody legal standards, but the standards they contain are more general than commitments and do not specify particular actions. As Ronald Dworkin explains, both legal principles and legal rules point to particular decisions about legal obligation in particular circumstances, but they differ in the character of the direction they give. Rules are applicable in an all-or-nothing fashion. . . . [A principle] states a reason that argues in one direction, but does not necessitate a particular decision. . . . All that is meant, when we say that a particular principle is a principle of our law, is that the principle is one which officials must take into account, if it is relevant, as a consideration inclining in one way or another.[28]

Because of the open-ended character of principles, a government cannot be certain of where they will eventually lead. This may explain why the United States, which is deeply skeptical of the international lawmaking process, opposed a principles article and preferred more clearly enunciated commitments.

Although developing countries ultimately prevailed in obtaining the inclusion of a principles article, the United States successfully pressed for several changes to Article 3 to reduce its potential legal implications. First, a chapeau was added, specifying that the principles are to ``guide'' the parties in their actions to achieve the objectives of the Convention and to implement its provisions. Second, the term ``states'' was replaced by ``Parties.'' Finally, the term ``inter alia'' was added to the chapeau to indicate that the parties may take into account principles other than those listed in Article 3 in implementing the Convention. These three modifications were intended to forestall arguments that the principles in Article 3 are part of customary international law and bind states generally. Instead, the principles clearly apply only to the parties and only in relation to the Convention, not as general law.

Developing countries also had to compromise on the substance of the principles. In some cases, Western opposition led to the transfer of proposed principles to the preamble; in other cases, principles proposed by developing countries were not included in the final text at all. In general, Western countries were able to define the principles more narrowly than in the parallel negotiations on the Rio Declaration, possibly because the INC was a less politicized, less public forum than the UNCED Preparatory Committee.

As adopted, the first principle reiterates several concepts contained in the preamble: the principle that the climate should be protected for the benefit of present and future generations, the principle of common but differentiated responsibilities and respective capabilities, and the related principle of equity. The final sentence, which states that ``developed country Parties should take the lead in combating climate change and the adverse effects thereof,'' was supported by both developing and developed countries, although they disagreed on why developed countries should take the lead. Developing countries argued that developed countries should so do because they bear the ``main responsibility'' for the climate change problem. Developed countries (in particular, the United States) opposed this reasoning, but agreed to take the lead because of their greater financial and technical capabilities. Article 4, which defines the respective commitments of developing and developed countries, fleshes out this principle in further detail.

The second principle gives ``full consideration'' to the specific needs and special circumstances of developing country parties, especially those that are vulnerable to the adverse effects of climate change, and parties that would have to bear a disproportionate or abnormal burden under the Convention. The latter category singles out, but is not limited to, developing countries.

The third principle, the precautionary principle, states that where there is a threat of serious environmental harm, scientific uncertainty should not be used as a reason to postpone precautionary measures to prevent the harm.[29] Various formulations of the precautionary principle now appear regularly in international environmental agreements and declarations. In the INC, the main issue was whether to include a reference to ``cost-effectiveness'' and thereby introduce economic considerations into what otherwise is a purely environmental standard. The SWCC Ministerial Declaration had spoken of ``cost-effective'' precautionary measures, and the G-77 proposal on principles used a similar formulation. At the final session, the INC Chair dropped any reference to cost-effectiveness from the precautionary principle in his compromise draft, both because of opposition by some European states and because his draft included a separate principle on cost-effectiveness. After attempts by the United States and Saudi Arabia to reintroduce the concept were met with opposition, the United States proposed combining the precautionary principle paragraph with the separate paragraph in the Chair's text on cost-effectiveness, and the INC accepted this compromise. The principle, as adopted, also endorses the comprehensive approach and joint implementation.

The fourth principle is that of sustainable development. Initially, developing countries pressed for inclusion of a principle recognizing that ``the right to development is an inalienable human right'' and that ``[a]ll peoples have an equal right in matters relating to reasonable living standards.'' Meanwhile, some developed countries wished to include a principle that states have a duty to aim at sustainable development. Both proposals raised serious problems for some delegations. On the one hand, the United States has long refused to accept the ``right to development'' as advanced in the human rights field, on the grounds that it is vague and could be used by developing countries to demand financial assistance from developed countries.[30] In contrast, developing countries, fearing that ``sustainability'' might become a new conditionality on financial assistance and ultimately inhibit their development plans, have traditionally expressed doubts about the concept of ``sustainable development.''

The Convention finesses both issues by stating that ``the Parties have a right to, and should, promote sustainable development,'' thereby addressing the concerns of both developing and developed countries. The Convention speaks of a ``right,'' thereby satisfying developing countries, but the right relates to the ``promotion of sustainable development,'' which is arguably different from the traditional ``right to development'' of the 1986 U.N.

Declaration. With respect to sustainable development, paragraph 4 states that parties ``should promote sustainable development,'' an important recognition by developing states but less than the ``duty'' sought by developed countries. This paragraph also contains a number of caveats that address developing country concerns, including the recognition that environmental policies and measures should be ``appropriate for the specific conditions of each party'' and should be integrated with national development plans, and that ``economic development is essential for adopting measures to address climate change.''

(2) Commitments

Like other international environmental agreements, the Convention creates differentiated obligations for developing and developed states. The commitments are organized in a complicated structure, consisting of (1) general commitments, which apply to all parties, both developed and developing; (2) specific commitments on sources and sinks, which apply to the parties listed in Annex I (OECD member states and the former Eastern bloc); and (3) specific commitments on financial resources and technology transfer, which apply to the parties listed in Annex II (OECD countries). This structure reflects the INC's initial premise that developing countries would not assume the same commitments as developed countries. The general commitments are qualitative not quantitative in nature and relate to such matters as greenhouse gas inventories, national strategies, reporting, cooperation in scientific research, and information exchange. The specific commitments, on the other hand, include the obligations of OECD countries to provide financial resources and technology to developing countries. Although a weak set of specific commitments for developing countries were also suggested originally, they were eventually abandoned. Thus, the Convention includes specific commitments only for developed countries.

The linkages between the general and specific commitments proved troublesome during the negotiations. Virtually all delegations agreed that the ability of developing countries to undertake general commitments would depend upon the specific commitments of developed countries to provide financial resources and technology. Almost perversely, however, some developing countries also insisted on linking their general commitments with the specific commitments of developed countries to limit greenhouse gas emissions. As a result, when the compromise on targets and timetables reached by developed countries in the final round of the negotiations proved quite weak, a domino effect ensued. Developing countries, led by India, argued that the general commitments had to be correspondingly circumscribed, to preserve what they regarded as the proper balance and differentiation between the commitments of developed countries and those of developing countries.

Classes of Parties. Developing countries account for an increasing share of greenhouse gas emissions and are expected eventually to exceed the emissions of OECD countries. Nevertheless, it became clear at the outset of the negotiations that developing countries would not accept any quantitative limits on their greenhouse gas emissions for fear that such limitations would impede their economic progress. The negotiators therefore recognized a need to exempt developing countries from any quantitative limits. Until the final negotiating session, however, delegations still had not decided how to determine the classes of parties and the obligations of each. Most developing states argued that the Convention should recognize only two economic categories, ``developed'' and ``developing.'' Other developing states, including AOSIS, supported a more complex and multivariate differentiation, focusing on special vulnerability to climate change. Several developed states proposed the additional categories of ``newly industrialized states'' and ``countries with economies in transition'' (i.e., the states of eastern Europe and the former Soviet Union). In the end, although the Convention uses ``developed'' and ``developing'' countries as the primary categories, it also recognizes two additional categories: ``countries with economies in transition'' and ``least developed states.''

Proposals on how to define these categories broke down into three types: defining ``developed'' and ``developing'' countries by objective criteria, such as per capita income; listing particular states to which specific commitments would apply; or using a combination of the first two methods. The definition method has the benefit of flexibility, since, as countries meet the definition of ``developed country,'' they would automatically become subject to the specific commitments. On the other hand, the list method avoids ambiguities about whether a state meets the definition of ``developed.''

The INC ultimately decided to use lists rather than definitions to fix the scope of application of the Convention's specific commitments. The specific commitments on sources and sinks of greenhouse gases apply only to states listed in Annex I, which includes two general categories of states: members of the OECD and countries with ``economies in transition.'' The specific commitments on financial resources and technology transfer, in contrast, apply to parties listed in Annex II, which includes OECD members but not economies in transition. Although the lists have several anomalies,[31] the simplicity of the list method promises to minimize conflicts. Both annexes will be reexamined by the end of 1998 with a view to amendments, but a party may be added to an annex only with its approval.

Countries with economies in transition are indicated by an asterisk in Annex I. Although there was no question about which states qualify as economies in transition, their legal status posed a problem. Several eastern European states (Romania and Poland in particular) objected to being characterized as ``developed,'' fearing that such a label might subject them to financial or other additional obligations in the future. By referring to ``the developed country Parties and other Parties included in annex I,'' Article 4(2) allows these states to argue that they are not developed.

``Least developed states'' is not defined in the Convention, nor are states falling into this category listed. The term is likely to be interpreted by reference to the U.N. General Assembly's list of ``least developed countries.'' Least developed states are to receive special consideration for funding and technology transfer, and are allowed to file their initial report under Article 12 ``at their discretion'' rather than within a specified time frame.

General Commitments (Articles 4(1), 5, 6, and 12(1)). From the beginning, the negotiators viewed general commitments as qualitative rather than quantitative in nature. An extensive list of general commitments was proposed, including use of best available technology to limit greenhouse gas emissions; promotion of energy efficiency and conservation; development of renewable energy sources; promotion of sustainable forest management; removal of subsidies that contribute to global warming; harmonization of national policies, taxes, and efficiency standards; internalization of costs; and development and coordination of market instruments. During the negotiations, these proposals were slowly pared away (in some cases, becoming specific commitments) or watered down, and the general commitments became general not only in their application to all parties, but also in their content.

Perhaps the most important general commitments to survive the negotiating process are those designed to promote long-term national planning and international review of national actions--in essence, those embodying the concept of ``pledge and review.'' Article 4(1) requires each party to develop, periodically update, and publish national inventories of greenhouse gas emissions and removals by sinks, using ``comparable methodologies'' to be agreed on by the COP. These inventories are to lay the basis for national planning and to provide more accurate information for use in future scientific assessments of the greenhouse problem. Each party must also formulate, implement, and regularly update programs to mitigate and adapt to climate change, and communicate information to the COP on its national inventories and the steps it has taken to implement the Convention. The COP is then to review the national reports and assess the parties' implementation, the overall effects of the measures taken pursuant to the Convention, and the progress towards meeting the Convention's objective.

In contrast to these provisions, which survived the negotiations relatively intact, the general commitments relating to sources and sinks were progressively weakened. Oil-producing states such as Saudi Arabia and Kuwait objected to the regulation of sources, while countries with large forests such as Malaysia and Brazil fought substantial commitments on enhancing sinks. As a result, Article 4(1)(c) (dealing with greenhouse gas emissions) makes no mention of energy efficiency measures or renewable energy sources, and seems to place all relevant economic sectors (energy, transport, industry, agriculture, forestry, and waste management) on an equal footing. Similarly, Article 4(1)(d) fails to single out forests for special consideration in requiring states to promote the sustainable management and enhancement of sinks and reservoirs.

*Specific Commitments on Sources and Sinks (Articles 4(2) and 12(2)).*The Convention's provisions on specific commitments set forth three basic requirements relating to sources and sinks. First, each party listed in Annex I must adopt national policies and measures to limit greenhouse gas emissions and to protect and enhance its sinks and reservoirs. This requirement is similar to the general commitments discussed above (which are applicable to all parties). Second, Annex I parties are subject to more stringent reporting requirements, both in terms of timing and content. They must communicate initial reports within six months of the Convention's entry into force, whereas other parties have three years to complete their reports. Moreover, Annex I parties' reports must contain detailed information on policies and measures, as well as on the projected effects on emissions by sources and on removals by sinks, and should take into account the ``best available scientific knowledge.'' To this end, the COP is to adopt and periodically review methodologies for these calculations. Finally, Annex I parties must coordinate relevant economic and administrative instruments and identify and periodically review their policies and practices that contribute to increased greenhouse gas emissions (e.g., subsidies and energy pricing policies). These last commitments were originally proposed as general commitments, but were changed to specific commitments because of objections by several developing countries.

(3) Targets and Timetables

In connection with the specific commitments to adopt and report on national policies and measures, the Convention establishes a quasi-target and quasi-timetable for greenhouse gas emissions. The targets and timetables issue was perhaps the most controversial in the entire negotiation. Although, in common parlance, the term ``target'' means an object or goal,[32] in the context of international environmental negotiations the phrase ``targets and

timetables" means quantitative limitations, including those that are legally-binding commitments. In recent years, targets and timetables have become the preferred form of international regulation of atmospheric pollution. They tend to be easier to negotiate than uniform international regulatory rules, because they allow countries to choose how to meet overall national emissions levels, for example, by direct regulation, market mechanisms, or taxes. Several key precedents for the Convention used a targets and timetables approach, notably the Montreal Protocol and the Sulfur Dioxide and Nitrogen Oxide Protocols to the LRTAP. Significantly, both direct international regulation and taxation were discussed only marginally in the INC.

International targets and timetables for limiting greenhouse gas emissions could be set on a variety of bases. A per capita target would favor countries with populations that are large relative to their overall emissions, including most developing states and countries that rely on non-fossil fuels such as hydroelectricity or nuclear power. Alternatively, setting targets on the basis of gross domestic product (GDP) would favor countries that use energy efficiently (i.e., that use relatively little energy per unit output). Both the per capita and GDP approaches have strong policy justifications. Proponents of the per capita approach justify it on the equitable principle that ``every human has an equal right to use the atmospheric resource.'' A GDP-based target, in contrast, would promote the objective of economic efficiency. Both approaches, however, raise the same dilemma. On the one hand, if the per capita or per unit GDP target were set at a level that would stabilize global emissions, countries that have higher than average emissions rates, like the United States would have to reduce their emissions very substantially; such a target would therefore be politically infeasible. On the other hand, if the target were set high enough to make it acceptable to the United States, then global emissions could increase substantially, as states with low emissions rates increase theirs to U.S. levels. Because of such difficulties in obtaining agreement on a per capita or per unit GDP formula, states have tended to negotiate either country-by-country targets or uniform targets based on historical or current emissions levels (sometimes referred to as the ``grand-fathered emissions'' approach). The INC took the latter course, following the precedents of the Sulfur Dioxide, Nitrogen Oxide, and Montreal Protocols, all of which established targets keyed to a base-year emissions level.

Both before and during the negotiations, most Western states pressed vigorously for the adoption of an internationally-defined stabilization target and timetable to stabilize greenhouse gas emissions, particularly carbon dioxide emissions. For example, the European Community supported an immediate commitment by developed countries to stabilize carbon dioxide emissions at 1990 levels by the year 2000. In fact, many OECD countries unilaterally adopted national targets and timetables. The main holdout against the adoption of targets and timetables was the United States, which derided the targets and timetables adopted by most other countries as political in nature, not backed by concrete measures designed to achieve them. The United States opposed targets and timetables for greenhouse gas emissions as premature. It criticized the EC proposal as a rigid and inequitable ``top-down'' approach, given the differences between countries in national circumstances and implementation costs. The United States argued that the Convention should instead adopt a ``bottom-up'' approach that encourages the development of better information, national strategies, and action plans.

Although the target and timetable issue is often portrayed as a battle between the United States and the rest of the world, the situation was in fact more complicated. Other industrialized countries did agree with the United States about the need for a long-term planning process. Moreover, while the United States was one of the few industrialized countries to flatly oppose targets and timetables, other OECD states proposed varying formulations of the target and timetable. These differences concerned the strictness of the legal obligations, the types of gases covered, a focus on net or gross emissions, and joint implementation. For example, the CANZ group and Finland favored establishing a stabilization target for all greenhouse gases not controlled by the Montreal Protocol rather than for just carbon dioxide, while Japan supported a ``best efforts'' approach rather than a firm commitment to limit greenhouse gas emissions. The United Kingdom and, to some extent, Japan attempted to mediate between the European Community and the United States--Japan by proposing the ``pledge and review'' formula at the June 1991 session, and the United Kingdom by proposing the ``phased, comprehensive approach'' in the spring of 1991, by supporting ``pledge and review,'' and finally by brokering the ultimate deal of a ``quasi-target'' and ``quasi-timetable'' in May 1992.

A compromise was finally reached in two highly ambiguous subparagraphs of Article 4(2). By way of setting a quasi-target, Article 4(2) states that developed countries are to adopt and report on national policies to limit emissions and enhance sinks with the ``aim of returning to'' 1990 emissions levels. Although this phrase has been equated with stabilization, the term ``return'' unlike ``stabilize'' does not necessarily have an ongoing temporal dimension. Thus, a state could potentially argue that, once it had achieved a ``return'' to 1990 levels, emissions increases would be allowed. The ``time-table'' is even more ambiguous: the Convention simply states that developed countries recognize that a return by the year 2000 to earlier (unspecified) emissions levels would contribute to a

modification of longer-term emissions trends.

Article 4(2)'s quasi-target and quasi-timetable are not only highly ambiguous, but also heavily qualified. Because some eastern European countries were concerned about meeting the quasi-target (although most use energy inefficiently and have ample room for improvement), the COP is to allow countries with economies in transition ``a certain degree of flexibility.'' The Convention does not limit the type of ``flexibility'' that may be accorded, but identifies the baseline emissions level as a potential subject of flexibility. Additionally, the quasi-timetable is to take into account differences in the parties' starting points and approaches, economic structures, and resource bases; the need to maintain strong and sustainable economic growth; available technologies and other individual circumstances; and the need for equitable and appropriate contributions by each party to the global effort.

Indeed, it is questionable whether the Convention creates a legally binding target and timetable at all. Article 4(2) states that parties ``shall'' adopt national policies and take corresponding measures to mitigate climate change, and ``shall'' communicate information on these policies and measures and on the resulting projected emissions. For the quasi-target and quasi-timetable, however, the Convention uses less obligatory language. The target is phrased as an ``aim,'' and the verbs used to characterize the timetable are all descriptive rather than imperative. These ambiguous formulations allow states to put their own spin on the requirements imposed by Article 4(2). Indeed, within days after the Convention was adopted, various countries advanced divergent interpretations. For example, President Bush's domestic policy advisor stated, ``there is nothing in any of the language which constitutes a commitment to any specific level of emissions at any time.'' In contrast, the chief British negotiator characterized the provisions as ``indistinguishable'' from an absolute guarantee. These widely divergent interpretations illustrate the limitations of the quasi-target and quasi-timetable contained in Article 4(2).

The Convention does provide for the periodic review of the adequacy of the quasi-target and quasi-timetable. The first review is to take place at the COP's inaugural session (which will take place one year after the Convention's entry into force); the second, not later than December 31, 1998; and subsequent reviews, at regular intervals. The reviews are to be based on the best available scientific information, as well as relevant technical, social, and economic information. The COP is to take ``appropriate'' action based on the reviews, but the Convention does not stipulate whether such action is likely to lead (through an amendment) to stricter or more lenient targets and timetables, or whether protocols might be needed to supplement the parties' obligations.

(4) Comprehensive Approach To Emissions Limitation

Before the United States introduced the ``comprehensive approach'' in a submission to the IPCC in December 1989, the tendency in climate change discussions had been to consider each source and sink of greenhouse gases individually, focusing primarily on reducing carbon dioxide emissions from the energy and transportation sectors. In contrast, the comprehensive approach considers collectively all sources and sinks of different greenhouse gases in formulating policy. Under the comprehensive approach, global warming potentials are calculated for each greenhouse gas to permit emissions of different gases to be compared according to a single metric. States may then take measures to limit their net contribution to the greenhouse effect, either by controlling their aggregate emissions or by enhancing their sinks. Supporters of the comprehensive approach, which included CANZ and most Nordic countries, justified the approach on both economic and environmental grounds. Economically, the comprehensive approach allows states to choose which gases and sinks to focus on, so that they may determine for themselves which abatement measures are most cost-effective. Environmentally, it eliminates incentives to switch from one type of polluting activity to another by focusing on aggregate levels of greenhouse gas emissions rather than any specific gases, sinks, or activities.

Initially, supporters of the comprehensive approach differed about whether to include greenhouse gases controlled under other legal instruments. The United States sought to include CFCs in the comprehensive calculations, although they are already scheduled to be phased out under the Montreal Protocol. Others opposed the inclusion of these gases, arguing that crediting states under the Convention for actions already required under the Montreal Protocol would constitute ``double counting'' and would allow certain states to increase substantially their emissions of carbon dioxide. Ultimately, the INC adopted somewhat ambiguous language in Article 4(2), which refers to ``levels of anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol'' without specifying whether emissions levels of greenhouse gases should be considered collectively (i.e., the comprehensive approach), or whether each gas should be accounted for separately. In any event, the formulation is notable for singling out carbon dioxide and for clearly excluding greenhouse gases controlled by the Montreal Protocol.

The comprehensive approach raised anotherissue: some states argued that the Convention should focus on gross greenhouse gas emissions; others advanced a standard of net emissions, derived by subtracting the removal of greenhouse gases by sinks from total emissions by sources. The United States, CANZ, Finland, and Brazil were

among those nations that pushed for a net emissions approach, and successfully achieved its inclusion in Decision 1/1 of the INC. Others such as Switzerland, Germany, and Austria argued that a net emissions approach, like the comprehensive approach generally, is theoretically sound but impractical at the present time because of uncertainties about the amounts of greenhouse gases removed by sinks.[33] The net emissions approach also implicated highly contentious questions about whether to include sinks located in the global commons (i.e., ocean and atmospheric sinks), and, if so, how to allocate them.[34] The INC did not resolve these questions and ultimately rejected the proposal to define ``sinks."

As with so many other issues, the Convention reflects a compromise on the net emissions issue. Without explicitly setting either a net or gross standard, the Convention refers several times to ``emissions by sources and removals by sinks" as a package; nevertheless, Article 4(2)'s quasi-target and quasi-timetable relate only to emissions.

(5) Joint Implementation

Since greenhouse gases remain in the atmosphere for a long time and migrate globally, where emissions are reduced makes little difference to the greenhouse effect. This suggests a further extension of the comprehensive approach: namely, focusing on greenhouse gas emissions on a regional or group basis, rather than on a country-by-country basis, so that countries may implement their emissions limitations jointly. Joint implementation can take two forms: (1) setting umbrella or joint targets that apply to a group of countries collectively (creating ``bubbles"), or (2) granting credits to a party in achieving its own emissions target for projects it undertakes in other countries. The main rationale for joint implementation is cost-effectiveness. Because of differing national circumstances, the costs of abatement measures can vary substantially by country. If greenhouse gas emissions can be reduced more cheaply in country A than in country B, then allowing B to take advantage of this cost differential by funding an emissions reduction in A is more efficient than requiring B to achieve the same reduction at home.[35] Such a scheme would reduce the costs of implementing the Convention while advancing its ultimate goals.

A primary issue in designing a system of joint implementation is determining its scope of application. One approach would permit joint implementation at the regional level. For example, the EC policy of stabilizing carbon dioxide emissions at 1990 levels by the year 2000 provides for joint implementation within the European Community.[36] Alternatively, joint implementation could be permitted among all countries that are subject to specific quantitative commitments to limit emissions and enhance sinks--that is, among developed states.

A third option would permit joint implementation on a general basis, among both developing and developed states. Proposed by Norway, this last scheme would be most economically efficient, since developing countries tend to use energy less efficiently than developed countries and can attain emissions reductions more cheaply. It would also have the added benefit of encouraging the transfer of substantial financial resources and technology from developed to developing countries pursuant to joint projects undertaken in developing countries. To protect against possible abuse, however, the scheme would have to set clear baselines from which to measure the emissions reductions in developing countries that a developed country could count towards meeting its target. Otherwise, a developing country could simply say that it planned to increase its emissions, and then agree not to do so as part of a ``joint" project with a developed country seeking to reduce its calculated level of emissions. Besides raising the possibility of fraudulent collusive agreements, critics objected that joint implementation between developing and developed countries would be unethical, since it would allow a developed state to make its reductions abroad instead of taking responsibility at home. As a compromise, Germany suggested that the credits given for emissions reductions in developing countries be discounted so as to encourage developed countries to take domestic measures unless joint implementation is substantially cheaper. This would make joint implementation attractive only when the cost differential in developing countries exceeds the discount rate.

Ultimately, the proponents of joint implementation prevailed in the INC. The Convention endorses the general concept of joint implementation, by stating that ``[e]fforts to address climate change may be carried out cooperatively by interested Parties," and by permitting states to ``implement . . . policies and measures jointly with other Parties." Since these provisions do not restrict which states may participate in joint implementation schemes, the clear implication is that a developed country may implement its commitments jointly with any other country. To safeguard against possible abuse, the Convention provides that ``the Conference of the Parties shall, at its first session, . . . take decisions regarding criteria for joint implementation." These criteria could potentially include the German suggestion to discount the credits given for emissions reductions achieved through joint implementation.

Two complementary mechanisms to promote joint implementation were discussed in the INC but were not adopted. First, Norway proposed establishing a clearinghouse to match proposed projects in developing countries with sponsors among developed countries, and to monitor and verify emissions reductions. Although many delegations expressed support for this proposal, it was not incorporated into the Convention because of both a lack

of adequate time for consideration and a feeling that a clearinghouse mechanism was overly ambitious so early in the development of the Convention. Second, several delegations discussed establishing a system of so-called ``tradeable emissions rights.''[37] Under this scheme, states would initially be given an allocation of greenhouse gas missions based on some agreed criteria.[38] States would then have the right either to emit their allotment of greenhouse gases or to trade or lease their emissions rights to other states. Proponents argued that a tradeable emissions scheme could promote both efficiency (by inducing emissions reductions in those states where they can be made most cheaply) and equity (through the initial allocation of emissions rights).[39] Even more ambitious and complex than a clearinghouse mechanism, a tradeable emissions scheme was not seriously considered for inclusion in the Convention. The quasi-target and quasi-timetable actually contained in the Convention proved far too ambiguous to have been the basis for tradeable emissions rights. However, if protocols are eventually negotiated establishing firm targets and timetables, the tradeable emissions mechanism could be revived.

(6) Specific Commitments on Financial Resources and Technology Transfer

Along with targets and timetables, financial resources and technology transfer were among the most controversial issues in the negotiations. These North-South issues have become prominent in international environmental negotiations only fairly recently. The Vienna Ozone Convention, adopted in 1985, did not provide for the transfer of financial resources. Even the 1987 Montreal Protocol, which established specific control measures for developing countries, contained only a very weak commitment by developed countries to ``facilitate the provision of subsidies, aid, credits, guarantees or insurance programs.'' Following Montreal, however, developing countries began to assert that they would accept obligations to limit their use of ozone-depleting substances only if developed states agreed to provide them with additional financial resources and technology. The 1990 London Amendments responded by establishing a World Bank- administered fund to help developing countries implement the Montreal Protocol. For the most part, INC discussions on financial transfers picked up where the negotiations for the London Amendments left off, and, from the outset, Working Group I's mandate included the development of a text on ``appropriate commitments on adequate and additional financial resources'' for developing countries.

Transfers of financial resources to developing countries were proposed for two general purposes: (1) to offset the various costs of implementing the Convention's general commitments, and (2) to aid developing countries in adapting to the adverse effects of climate change if steps taken under the Convention fail to abate global warming adequately.

Although many observers believe that developing countries can reduce emissions and enhance sinks more cheaply than developed countries, developing countries' implementation costs are nevertheless likely to be high relative to their ability to pay.[40] For this reason, developing countries argued that they would assume general commitments to combat climate change only if they received financial resources from developed countries to cover their increased (or ``incremental'') costs. Developed countries generally accepted this position, but insisted in return that the channeling of money occur through an appropriate financial mechanism; that developing countries accept at least some binding commitments, in particular, commitments to report on their greenhouse gas emissions and national programs; and that developing countries agree to establish institutions with adequate authority to implement the Convention effectively. Although this quid pro quo was rarely stated explicitly, it shaped the package that ultimately emerged from the negotiations.

Also problematic was the demand by developing countries that financial transfers should cover their ``full incremental costs'' in implementing the Convention. Although the general concept of ``incremental costs'' is clear, identifying these costs can be very difficult, if not impossible, since for many types of actions there is no baseline from which to measure a country's incremental costs. For this reason, states in general can more easily agree on specific categories of costs to be funded rather than on a general definition of ``incremental costs.'' This was the approach taken under the London Amendments to the Montreal Protocol, where a list of categories of incremental costs was adopted by a decision of the parties.

Ultimately, the parties resolved the financial resources issue by distinguishing between two types of financial transfers: (1) transfers to help developing countries comply with their reporting obligations under Article 12(1); and (2) transfers to help developing countries implement other aspects of the Convention, such as mitigation measures, research, information exchange, education, training, and public awareness. Developing countries were most immediately concerned with the former category of costs, because those costs were their only definite costs of joining the Convention. Developed countries were amenable to underwriting these costs fully, both because they want developing countries to develop and publish inventories and reports and because the costs of doing so will be limited. In contrast, developed countries resisted underwriting the other costs that may be incurred by developing countries in addressing climate change, because such costs are open-ended and potentially great. They could include the costs of building hydroelectric or nuclear facilities to replace coal-fired power plants, or the opportunity costs of

not clearing forests for timber sales. Developed countries, particularly the United States and the United Kingdom, wanted to ensure that in accepting the Convention they would not be writing a blank check.

The Convention attempts both to protect developed countries' treasuries and to satisfy developing countries' concerns about bearing the costs of implementing the Convention. Under Article 4(3), developed countries will provide ``new and additional financial resources to meet the agreed full costs incurred by developing countries'' in fulfilling their reporting requirements. For other implementation measures taken pursuant to Article 4(1), developing countries may propose projects to the Convention's financial mechanism. If the financial mechanism approves the project, developing countries will receive the ``agreed full incremental costs'' of the project. If the financial mechanism rejects it, developed countries need not provide any funding.

d. Evaluation of the Convention

At the outset of the INC, many governments and commentators had very high, perhaps unrealistic, expectations for the Climate Change Convention. Compared to these ambitious proposals, the Convention is a modest achievement. Indeed, it falls short of existing agreements such as the Montreal Protocol and London Amendments. For example, the amended Montreal Protocol establishes stringent control measures, requiring a phaseout of most ozone depleting substances within a decade, while the Climate Change Convention does not even include a clearly binding stabilization commitment. While the Montreal Protocol contains innovative implementation mechanisms, including trade sanctions against non-parties and a multilateral non-compliance mechanism, the Climate Change Convention imposes no sanctions for non-compliance and calls on the parties merely to consider establishing an alternative dispute resolution mechanism. The Montreal Protocol permits its control measures to be adjusted by a two-thirds majority, binding even on dissenting parties; the Climate Change Convention, on the other hand, requires a three-quarters majority vote and allows parties to opt out of amendments to which they object. Finally, the Montreal Protocol amendments established a new financial mechanism in which developed and developing countries have an equal say, whereas the Climate Change Convention relies, at least initially, on an existing financial institution and contains only vague language about the need for ``equitable and balanced'' governance.

However, while the Climate Change Convention contains little that is new from a legal standpoint, it is inappropriate to hold it to the achievements of the Montreal Protocol. The Montreal Protocol was accepted only following the adoption of the Vienna Ozone Convention and was the culmination of a decade of international work. The international community is at a much earlier stage in addressing the climate change problem. Moreover, the climate change problem is considerably more complex and politically sensitive than the ozone issue, making international agreement especially difficult to reach.

In the voluminous literature appearing prior to the climate change negotiations, commentators identified several criteria for a successful convention. First, it should be politically acceptable to a wide variety of states, given the global nature of the climate change problem. Second, it should be equitable, that is, it should encourage burden-sharing and treat developing countries fairly. Third, it should promote economic efficiency, by encouraging states to consider the cost-effectiveness of measures to address climate change. Fourth, and perhaps most critical, the convention should be flexible. Flexibility is essential, given the long-term nature of the climate change problem and current uncertainties about both scientific predictions of global warming, and the costs and benefits of response measures. Fifth, it should lay a foundation for future work by reducing uncertainties, promoting consensus, and building a base of information. Finally, it should establish targets and timetables for greenhouse gas limitations.

The INC succeeded in negotiating a convention that was politically acceptable to a wide array of states by avoiding firm targets and timetables, which were opposed by the United States; limiting the obligations of developing countries and requiring that they be provided financial and technical assistance; and focusing attention on the climate change problem, which the European states and AOSIS certainly preferred to no convention at all. Ultimately, the proof was in the pudding: at UNCED, the Convention was signed by 154 states. Of course, political acceptability came at a price; in order to make the Convention acceptable, it was progressively diluted by the INC. If other countries had been willing to proceed without the support of the United States, the Convention would likely contain firm targets and timetables--in all probability, a commitment to stabilize emissions of greenhouse gases not controlled by the Montreal Protocol at 1990 levels by the year 2000. The question is, how meaningful would a climate change convention have been without the United States, the single largest emitter of greenhouse gases? Are we better off with a Convention that includes the United States but not firm targets and timetables, or one that contains targets and timetables but not the United States?

The Convention scores relatively high in terms of equity, as defined by the needs of developing countries. Although developing countries did not achieve all that they wanted with respect to financial transfers, the Convention repeatedly recognizes the developmental priorities of the South and the need for economic growth. It

exempts developing countries from any quantitative emissions limitations, and provides them with relaxed reporting requirements, which will be paid for by developed countries. The Convention does less well in dealing with OECD countries, since it treats them all more or less alike, despite their very different circumstances. Turkey, for example, is subject to the same commitments as other OECD countries, including the provision of financial assistance to developing countries, some of which may be considerably richer than Turkey. Understandably, Turkey is one of the few countries that has not signed the Convention.

Because the Convention does not call for specific control measures, its exact regulatory approach has not yet been defined and cannot be evaluated in terms of the third criterion, efficiency. However, by endorsing the comprehensive approach and joint implementation, the Convention lays the groundwork for cost-effective response measures, allowing parties to focus on those greenhouse gases and locations where limitations can be achieved most economically.

The Convention does preserve a certain degree of flexibility for the new climate change regime. On the positive side, the COP may establish new institutions or change the mandate of existing ones. Amendments, annexes, and amendments to annexes may be adopted by a three-quarters majority vote. In addition, the specific commitments on sources and sinks will be reviewed regularly for adequacy, with a view to their possible amendment. On the other hand, the Convention does not specify decision-making rules for the COP, where most important decisions will be made. If the rules of procedure adopted by the COP require consensus decision-making, this could lead to policy gridlock. More important, the Convention does not define a regulatory process for the adoption and amendment of emissions control measures that the parties may eventually decide are warranted. Because annexes are limited to descriptive material, the adoption of control measures would require an amendment to the Convention or the negotiation of a separate protocol, either of which would be cumbersome. Even with respect to annexes, the Convention does not establish any amendment or adjustment procedure like that of the Montreal Protocol, under which changes may be imposed by a qualified majority. Nor does it provide for periodic rounds of renegotiation similar to those that take place under the GATT.

The Convention does somewhat better in meeting the fifth criterion, laying a basis for future work. By requiring parties to develop greenhouse gas inventories, formulate national strategies and measures, and cooperate in scientific research, the Convention promotes national planning and will generate a better information base for future negotiations and decisions. Moreover, the newly-created scientific and implementation bodies will help the parties decide how to proceed. Nevertheless, the Convention falls short in several respects, all of which may impede timely responses to global climate change. For instance, the Convention does not establish in advance a baseline for possible future targets and timetables. This may make countries reluctant to take immediate actions to reduce their emissions or enhance their sinks for fear that they will not receive credit for these actions and will instead simply face a tougher starting point should the Convention later establish targets and timetables. Moreover, the Convention does not establish any timetable for the negotiation of protocols containing specific control measures. Nor was agreement reached, even informally, about the amount of money that will be made available to developing countries for national planning and mitigation purposes.

Finally, the Convention's failure to include strict targets and timetables was, for many, the greatest disappointment. Clearly, the inclusion of targets and timetables would have been a moral and political victory for supporters of stronger global warming policies and, as such, would have encouraged stronger national measures. It is unclear, however, how serious the omission of targets and timetables is as a practical matter. The most commonly proposed target and timetable, to stabilize carbon dioxide emissions at 1990 levels by the year 2000, would have been largely symbolic. To illustrate, environmental groups estimate that the United States will meet this target anyway, as a result of measures already planned. Indeed, that was a principal argument why the United States should have been able to accept such a target. By the same token, however, if the United States will achieve stabilization even without any international commitment, then the practical significance of the target and timetable is reduced. Instead, it is important primarily because it signals that more stringent measures may be on the way and that business will not continue as usual. That message is implicit in the Convention even without a firm target and timetable, and a cautious government or business should already be thinking about how to limit or switch away from its use of fossil fuels.

If scientists are right, the climate change problem will be with us for a long time. As first steps in addressing the problem, we need to reduce uncertainties about the basic science, develop an information base about national conditions and options, and establish a strong institutional structure. While immediate emissions stabilization would be desirable, establishing a dynamic international process is more important for the long-term. The U.N. Framework Convention on Climate Change makes a definite, albeit tentative, start along that road.

2. Equity and Considerations of the Third World[41]

To begin to solve the problems of global change, we must first identify the factors that have caused it. Three societal conditions or factors are primarily responsible for our current state of affairs: an unreasonable international economic order; the overconsumptive behaviors of the developed nations; and the conditions of poverty and population growth in developing nations.

a. Causes of Climate Change

(1) An Unreasonable Economic Order

Most developed nations were colonial powers in the past. During their own economic development, they exploited the resources of their colonies without regard to the colonies' economic welfare. In order to obtain quick profits, they sacrificed the colonies' long-term interests. This method of exploitation permitted developed countries to take almost all of the benefits and left developing countries to bear almost all of the burdens, especially the environmental destruction that such rapid resource development caused. When the colonies became independent in the twentieth century, the environment that they inherited was already severely damaged. The economic success of the developed countries has in large part been built on the poverty of their colonies, which are the developing nations of today.

In 1974, the United Nations General Assembly adopted the Declaration on the Establishment of a New International Economic Order and the Charter of Economic Rights and Duties of States. These declarations called for a reordering of world economic conditions, but this New International Economic Order has not been realized.

The current international economic order remains unreasonable because developing countries' economic capability is severely limited by historical and economic conditions. These nations have borrowed massive amounts of money primarily from banks in developed countries and must exploit their raw materials to repay their debts. Exploiting raw materials often involves processes that damage or destroy the environment. Because developed countries import a large percentage of the raw materials they consume, the environment of these nations is typically much cleaner than that of developing nations. Thus, the raw materials from developing countries subsidize the economies of developed countries because the latter countries often do not pay the environmental costs of the items that they import.

If we view the global environment as a shared resource that must be managed for the health and welfare of all of the people of Earth, then the exploitation of developing nations and the accompanying destruction of their environment is wrong. If we want to begin to solve the problems of global change, we must find a way to create a new, equitable international order one that will benefit developed and developing nations alike.

(2) Overconsumption in Developed Countries

On a per capita basis, developed countries consume more than their fair share of resources. Nearly three-quarters of the carbon dioxide emitted from fossil fuel combustion comes from developed nations compared to just over one-quarter from the entire developing world. If we consider that the population in developing countries is three-quarters of the population in the world, then the carbon dioxide production per capita in developed countries is far greater than in developing countries. For example, the per capita production of CO_2 in the United States is twenty-five times that of the average per capita production in South Asian countries.

The overconsumptive behaviors of the developed nations are also evident in other areas. Developed nations consume far more than their fair share of chlorofluorocarbons (CFCs) the major cause of ozone depletion and a significant greenhouse gas. More than ninety-eight percent of the CFC-11 consumed in the world is consumed in developed countries while less than two percent is consumed in developing nations.

These two examples indicate that the overconsumption of fossil fuels and CFCs in developed countries are both serious factors contributing to global change. They illustrate the fundamental imbalance in cause and effect of global environmental problems. Behaviors such as the disproportionate consumption of fossil fuels and CFCs in developed countries are the main causes of global change problems such as the greenhouse effect and ozone depletion.

(3) Poverty in Developing Countries

Developing nations also contribute to global change. In these countries poverty is a pervasive condition; many people cannot get enough food, clothing, and other necessities of life. This poverty, combined with rapid population growth, leads these countries to claim more and more land for the planting of basic food crops. In many countries, forest, grasslands, and wetlands are reclaimed for farming. In addition to these pressures, large debts owed to the banks in developed countries make it difficult for the developing nations to invest money to improve their own environments.

These are the main societal factors contributing to global change. If we wish to solve global change problems, we must find solutions to each one because they are interrelated. The poverty in developing countries is a problem

that will take decades to solve. If the world community fails to help developing countries to begin to solve their economic problems, then we will not find a way to begin to reduce the contribution of these nations to the problem of global change.

b. Developed and Developing Countries' Responsibilities for Solving Global Problems

Two principles are fundamental to the allocation of responsibilities among developed and developing countries in solving the problems associated with global change. First, each country must help solve the global change problem according to its role in creating or exacerbating it. This implies a principle of equity. Second, each country should contribute to the solution to the best of its ability. For the developing nations, this implies a principle of ``special consideration.'' Numerous UN conventions and declarations concerning global change call for member nations to give ``equity'' and ``special consideration'' to developing countries when seeking solutions to global change problems.

That all countries, whether developed or developing, are equal is a fundamental principle of human society and international law. Equity is one of the main principles that must be considered in solving global change problems. Equity has various meanings. It means, for example, that every country has the right reasonably to use Earth's shared natural resources and the responsibility to protect these resources. It means every country has the right to make decisions regarding how to use its own natural resources according to international law. In the context of global change, equity means that every country has the responsibility to do its best to help solve global change problems and most importantly, that those countries most responsible for the problem of global change must take more responsibility in working toward its solution.

Before we ask each nation to help solve the problems of global change, we need to determine each country's contribution to the problem. Needless to say, there is a close link between a nation's contribution and its economic development. As discussed previously, developed countries contribute almost three-fourths of the CO_2 that is believed to cause the greenhouse effect. They must therefore bear primary responsibility for solving that problem. In China, we have an old saying: ``Let the person who tied the ring on the neck of the tiger, take it off.'' Only the developed countries have the capability to take the ring off this tiger; to let these countries take the main responsibility is legally and morally just.

International environmental law has a concept that embodies the idea of this Chinese saying. The ``polluter pays'' principle is used to assign responsibility for pollution. It essentially requires that he who creates pollution must pay for its cleanup. As a general principle of law recognized by civilized nations within the meaning of Article 38 of the statute of the International Court of Justice, application of this principle to the problems associated with global change is reasonable. For example, if we apply this principle with respect to the issue of ozone depletion, since ninety-eight percent of CFC-11 is produced and used by developed countries, letting them solve this problem and show developing countries how to avoid falling into a similar problem in the future is fair.

Developed countries must take primary responsibility for solving problems associated with global change, including climatic warming and ozone depletion. Developing nations must also take some responsibility for dealing with the problems of global change. Population growth, deforestation, and other problems that are occurring in these nations also contribute to global change. Yet, in defining their responsibility, we must recognize that the developing countries are to some degree the victims of global change caused by developed countries. Moreover, because developing countries' economies are by definition still developing, the effects of global change on their economic and social development are much more severe than the effects on developed nations. Developing countries should assume their share, and only their share, of the responsibility for solving the problems associated with global change. If this occurs, the developing nations and the world will benefit.

c. Special Consideration for Developing Countries

Special consideration for developing countries is another principle that must be recognized by the world community. Special consideration means that in considering solutions to global change, we must give the developing countries special treatment and consideration because their economic development differs vastly from that of developed countries.

For example, in order to protect the ozone layer, we need to reduce the consumption of CFCs. The ideal solution would be to freeze production of CFCs at current levels and then reduce it as soon as possible. But almost all CFCs are produced and used in developed nations. At the same time, the people of the developing countries want to improve their living standards, which will include having more refrigerators and air conditioners in their countries. To do this, these countries will have to build factories to produce CFCs. If they do not do that, they will spend more and more money to import CFCs. So, requiring developing countries to freeze their CFC production really means either that there will be no refrigerators or air conditioners in these countries or that they will become much poorer through importing CFCs produced in developed nations.

Special consideration thus means that when considering the solutions to problems of global change, we must consider the economic development of the developing countries and their need to raise their standards of living. If global environmental protection requires freezing developing countries' economic development, those countries will remain economically underdeveloped and their people will be denied a modern life by Western standards.

Special consideration also has another meaning. When we consider the contribution that developing countries can make to solving problems of global change, we need to give special consideration to their economic and technological capabilities. Only then can we decide what developing countries can do to fulfill their responsibility for global environmental protection. The steps we ask developing countries to take must realistically correspond to developing countries' capabilities.

The developed countries must respect the right of developing countries to improve their standards of living. For example, environmental protection standards must be adjusted to each country's economic and technological capabilities. The result is that environmental protection standards in developed countries surely must be more strict than those in developing countries. Developed countries cannot require developing countries to adopt the same environmental protection standards as their countries have. Further, developed countries cannot use this difference in the environmental protection standards between developed and developing countries to transfer low technology, which will cause serious pollution, from the former to developing countries.

d. Specific Steps to be Taken for Solving Global Problems

To solve problems of global environmental change requires close cooperation among all nations. Both developed and developing nations need to fulfill their respective responsibilities in helping to solve the problems associated with global change. Both the responsibilities and the capabilities of developed and developing countries are different in solving these problems. These differences determine what steps should be taken by each of the nations of the world.

(1) Developed Countries

Research and development. It is essential that developed countries conduct more research into the scientific processes and laws that control global change. Such activities will provide scientific information to political leaders worldwide so that they can make informed decisions on how to solve global change problems. Scientists from developing countries must also be asked to take part in this process, and the information learned from such joint research must be shared with scientists throughout the whole world. The United States is beginning to set an example in its emphasis on global change research. Other developed countries should follow this lead and spend more money for basic research on the cause of global change.

Human activities that produce carbon dioxide and other greenhouse gases, along with certain natural processes, are the primary sources of the greenhouse effect. We must develop technology that will reduce the emission of these gases and also reduce the emissions of methane from certain agricultural processes. Because developed countries have a high level of technological development, these countries must be responsible for the development of new technologies to reduce the emission of these greenhouse gases.

New research and development activities are also needed to find substitutes for CFCs. Although CFCs provide the basic chemicals that allow air conditioning and refrigeration, they also cause ozone depletion and contribute to greenhouse warming. The most useful method to reduce the rate of ozone depletion and also help slow the greenhouse effect is to develop new chemicals that can be used in place of CFCs. Research is proceeding in both the United States and Soviet Union on a new chemical that can be used instead of CFCs.

Information exchange and technology transfer. To solve problems of global change, developed countries must share information about new technologies and materials with developing nations. Developing countries need increased information about new technologies that can reduce greenhouse gas emissions and new materials that can be used instead of CFCs. This will allow them to improve their standards of living without contributing as much as they might otherwise to the problem of global warming.

The transfer fees for new technology are typically very high, often more than developing countries can afford. Once new technologies relevant to dealing with global environmental problems are created, these technologies should be transferred to developing countries at little or no cost. To require developing nations to pay full price for these technologies will insure that they are not used for global environmental protection to the optimal degree because developing countries will not be able to afford them.

One possibility to help developing countries acquire new, less environmentally harmful technologies and materials is to create a foundation for the transfer of newly discovered technologies and materials. The foundation could use low-interest loans or other forms of financial assistance to provide compensation to developed countries that desire to use or adopt new materials and technology.

Another form of technology transfer is the dissemination of knowledge and expertise gained by developed

nations in the area of environmental protection. Almost all developing countries lack qualified scientists, scholars, administrators, and other experts in this field. Yet there is an increasing need for such trained personnel. The developed countries thus need to help developing countries train their people. This will also facilitate close cooperation between developed and developing countries in other aspects of global environmental protection.

Programs effecting technology transfer to developing countries in a timely manner will benefit all countries of the world. We must change the idea that to transfer such technology and materials to developing countries at a low price will benefit only the developing countries. Technology transfers must be viewed as being of benefit to the world community as a whole.

Reducing polluting practices. As mentioned above, disproportionate amounts of carbon dioxide and CFCs are emitted by developed countries. Overconsumption of fossil fuels and CFCs are two of the main causes of global change. Developed countries thus need to change their own manufacturing processes, energy-generating practices, and life-styles to accomplish reductions in the emissions of those gases.

Developing nations must also cease exporting pollution to developing countries. Many examples of direct and indirect exportation exist: exporting low-technology machines and equipment, heavily polluting industries, and toxic wastes to developing countries. Such exports make the developed exporting countries cleaner in the short term, but at the expense of the Earth as a whole and developing nations in particular. In fact, there may be a net increase even in the short term because the developing importing countries may not be as aware of the dangers and typically are less able to regulate the imports to prevent pollution.

To solve global change problems, therefore, developed countries must not export pollution to developing countries. When they export machinery or equipment to developing countries they must ensure that the emissions from that machinery and equipment meet with the developing countries' standards.

(2) Developing Countries

Although their economic and technological capabilities are more limited, developing countries can still take steps to help solve global warming. Developing countries must share with developed countries some responsibility for dealing with global warming. This responsibility exists in spite of the fact that developing countries' responsibility for causing the problem is much smaller than that of the developed countries. To adopt policies that will slow global change will benefit the entire world. The main policies and goals that can be adopted by developing countries are as follows.

Reducing population growth. Rapid population growth in developing countries has caused many serious social, political, economic, and environmental problems. It has contributed to the delay in economic and social development of those countries. Because of population growth, developing countries have had to claim more land, including forestlands, grasslands, and wetlands, to plant crops in order to produce more food. Deforestation and desertification are occurring in many developing countries. Those environmental degradations not only destroy the life-support systems in those countries, making it more difficult for them to raise standards of living, but may also accelerate the global warming process. Controlling rapid population growth is thus a main task faced by developing countries.

The Chinese experience indicates that birth control policies can be enforced fairly effectively by the governments of developing countries. National birth control programs require some money but are not inordinately expensive considering their long-run results. The world community should help developing countries fund birth control techniques and should assist in developing simpler and less-expensive birth control techniques.

Combining development and environmental protection. Because developing countries typically are poor, their desire to develop their economies is understandable. But in the past, many developing countries did not consider the need for environmental protection. For example, China in the 1950s-1970s succeeded in its attempts to develop the economy in the short term, but its policies harmed China's environment and reduced the base necessary for continued, steady development. China's ``sustainable development'' was sacrificed.

To ensure steady improvement of the standards of living in developing countries in the future, those countries need to change their focus in planning from short term to long term. For example, cutting down forests obviously can provide capital for present investment purposes, but it also contributes to increased environmental problems. Erosion, floods, and drought will be more frequent, with the result that the rate of development will decrease and the countries will face very difficult problems. Traditional agricultural practices are also used to produce food. For example, in many regions ``slash and burn'' agricultural practices are still used. At least in some locations, these methods waste many natural resources and produce little results.

In order to deal with global change, therefore, developing countries must encourage people to develop an agricultural system that takes into account environmental factors; i.e., a system sensitive both to the needs of the environment and to people's need for food. In this type of system, energy and resources can be recycled to produce

increasing amounts of agricultural products with decreased amounts of damage to the environment. In China, the government already encourages people to develop such systems. There are three counties that have been designated as model counties in this regard. In these counties, environmentally sensitive agricultural efforts have resulted in increased amounts of agricultural production and improved environmental quality. Developing an ecoagricultural system can thus help developing countries to solve the shortage of food and to improve their environment, and in the process will help solve global warming.

Improving technology. Because many factories and much of the equipment in developing countries use inefficient technology, producing products in developing countries often produces more carbon dioxide and other greenhouse gases than do more-modern processes. If this inefficient technology continues to be used, production activities in developing countries will result in more emission of greenhouse gases. Using more-efficient technology could produce more goods using the same resources while producing less carbon dioxide.

Inefficient technology also results in great energy consumption in developing countries. Unlike their more-developed counterparts, developing nations lose energy to inefficiency and poor management rather than to overconsumption. Corrective actions can be taken without large investments of capital.

More-efficient technology is very expensive, however, and the cost of such technology is frequently above the economic capabilities of developing countries. Developed countries must assist developing countries in this respect. For example, developing central heating systems and improving cooking stove efficiencies in cities can reduce fossil fuel consumption. By using more-efficient technology, the developing countries would benefit not only themselves by improving their standards of living but would also contribute to slowing the rate of increase for global warming. The use of cleaner, more-efficient energy resources in developing nations would also be useful to limit global change. For example, wind, tide, and wave energies are very clean; they do not emit any pollutants. Nuclear power may be an option to be considered here. There is, of course, much controversy about nuclear power, but nuclear power plants do not emit greenhouse gases. Thus, to help reduce global warming, the possibility of building nuclear plants for developing countries should be considered as one means to help solve this global change problem.

FOOTNOTES CHAPTER 14

[1] Katrien Vorlat, *The International Ozone Regime: Concessions and Loopholes?*, 17 FLETCHER F. WORLD AFF. 135, 137-39 (1993). Copyright 1993. Reprinted by permission.

[2] Sherwood F. Rowland and R. Molina, *Stratospheric Sink for Chlorofluoromethanes: Chlorine Atom Catalyzed Destruction of Ozone*, NATURE, Vol. 249, (1974), 810-814.

[3] Ivar Isaksen and Frode Stordal, *The Influence of Man and the Ozone Layer: Readjusting the Estimates*, AMBIO, Vol. 9, 1980, 10.

[4] Environmental Protection Agency, *Assessing the Risks of Trace Gasses That Can Modify the Stratosphere*, (Washington, D.C.: Office of Air and Radiation, U.S. Environmental Protection Agency, 1987), 7-11.

[5] R.A. WARRICK, E.M. BARROW AND TOM M.L. WIGLEY, The Greenhouse Effect and Its Implications for the European Community (New York: Cambridge University Press, 1990), 9.

[6] *See* RICHARD ELLIOT BENEDICK, OZONE DIPLOMACY: NEW DIRECTIONS IN SAFEGUARDING THE PLANET (Cambridge: Harvard University Press, 1991) 136.

[7] Armin Rosencranz and Bruce R. Scott, *Bringing the Developing World on Board*, ENVIRONMENTAL POLICY AND LAW, Vol. 20, No. 6 December 1990, 202-03.

[8] David D. Caron, *Protection of the Stratospheric Ozone Layer and the Structure of International Environmental Lawmaking*, 14 HASTINGS INT'L & COMP. L. REV. 755, 756-76 (1991). Copyright 1991. Reprinted by permission.

[9] Vienna Convention for the Protection of the Ozone Layer, opened for signature Mar. 22, 1985, U.N. Doc. UNEP/IG.53/Rev.1, at 11 (1985), S. TREATY Doc. 9, 99th Cong., 1st Sess. (1985), reprinted in 26 I.L.M. 1529 (1987).

[10] Montreal Protocol on Substances that Deplete the Ozone Layer, opened for signature Sept. 16, 1987, S. TREATY Doc. 10, 100th Cong., 2d Sess. (1987), reprinted in 26 I.L.M. 1550 (1987).

[11] James T. B. Tripp, *The UNEP Montreal Protocol: Industrialized and Developing Countries Sharing the Responsibility for Protecting the Stratospheric Ozone Layer*, 20 N.Y.U. J. INT'L L. & POL. 733, 738-52 (1988). Copyright 1988. Reprinted by permission.

[12] Daniel Bodansky, *The United Nations Framework Convention on Climate Change: A Commentary*, 18 YALE J. INT'L L. 451, 453-60, 475-81, 492-96, 499-509, 511-24, 526-27, 554-58 (1993). Copyright 1993. Reprinted by permission.

[13] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), 1992 IPCC SUPPLEMENT 11 (1992) (reporting that best estimate for annual global fossil fuel emissions in 1989 and 1990 is 6.0 +/- 0.5 billion tons of carbon).

[14] *Id*. at 12 (estimating annual net flux to atmosphere of 1.6 +/- 1.0 billion tons of carbon from land-use change during the 1980s).

[15] United Nations Conference on Environment and Development: Framework Convention on Climate Change, May 9, 1992, in *Report of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change on the Work of the Second Part of Its Fifth Session*, INC/FCCC, 5th Sess., 2d Part, at Annex I, U.N. Doc. A/AC.237/18 (Part II)/Add.1, *reprinted in* 31 I.L.M. 851.

[16] The wavelength at which bodies emit radiation depends on their temperature. The very hot sun emits radiation primarily as visible light, while the much cooler Earth radiates in the infrared region of the spectrum. The greenhouse effect is caused by the fact that the atmosphere is transparent to the visible light from the sun, allowing it to strike and warm the Earth, but absorbs the infrared wavelengths radiated by the Earth, reradiating them as heat into the atmosphere and towards the surface of the Earth. See Gordon MacDonald, *Scientific Basis for the Greenhouse Effect*, in THE CHALLENGE OF GLOBAL WARMING 123, 126-28 (Dean Edwin Abrahamson ed., 1989).

[17] However, unlike botanical greenhouses or blankets, which operate primarily by trapping air and thereby blocking heat transfer by convection, the greenhouse effect results from the blocking of radiative heat transfer.

[18] Carbon sinks include plants and trees, which sequester carbon through photosynthesis, and the oceans, which take up carbon at the surface and store it at great depths. Other greenhouse gases are removed from the atmosphere largely through atmospheric reactions. *See generally* Watson et al., *Greenhouse Gases and Aerosols*, in IPCC, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT 1, 7 (J.T. Houghton et al. eds., 1990)(on greenhouse gases and aerosols).

[19] U.S. DEP'T OF ENERGY, OFFICE OF ENVTL. ANALYSIS, LIMITING NET GREENHOUSE GAS EMISSIONS IN THE UNITED STATES 9 (Richard A. Bradley et al. eds., 1991).

[20] When all gases are considered, the contributions of industrialized and developing countries to the greenhouse effect are roughly equal in absolute terms. Still, industrialized countries have much higher emissions than developing countries on a per capita basis. For a discussion of different measures of greenhouse gas emissions, see Alternative Indicators of Greenhouse Gas Emission, Group on Energy & Env't, OECD Doc. ENV/EC/EN(91)12 (Apr. 16, 1991); SUSAN SUBAK ET AL., STOCKHOLM ENV'T INST., NATIONAL GREENHOUSE GAS ACCOUNT: CURRENT ANTHROPOGENIC SOURCES AND SINKS (1992).

[21] Irving M. Mintzer, *Living in a Warming World*, in CONFRONTING CLIMATE CHANGE: RISKS, IMPLICATIONS AND RESPONSES 1, 3 (Irving M. Mintzer ed., 1992) (arguing severity of regional impacts cannot be predicted with confidence).

[22] JOHN RAWLS, A THEORY OF JUSTICE 136-42 (1971) (discussing term and its significance).

[23] See Eugene B. Skolnikoff, *The Policy Gridlock on Global Warming*, 79 FOR. POL'Y 77, 78 (1990) (``[N]o major action is likely to be taken until [the] uncertainties are substantially reduced."); *see also* E. William Colglazier, *Scientific Uncertainties, Public Policy, and Global Warming: How Sure Is Sure Enough*?, 19 POL'Y STUD. J. 61 (1991).

[24] Matthew Patterson & Michael Grubb, *The International Politics of Climate Change*, 68 INT'L AFF. 293, 295- 96 (1992).

[25] The G-77 is a U.N. intergovernmental caucus that was formed in the early 1960s in preparation for the 1964 U.N. Conference on Trade and Development. *See* BURNS H. WESTON ET AL., INTERNATIONAL LAW AND WORLD ORDER 264 n.26 (1990). It derives its name from an original membership of 77 states, but the group now includes 138 states. China is not officially a member, but G-77 texts are typically introduced jointly on behalf of the G-77 and China.

[26] This has come to be known as the ``main responsibility principle." See Government of the People's Republic of China, Beijing Symposium on Developing Countries and International Environmental Law 4, Aug. 12-14, 1991 (symposium report, on file with author).

[27] SOUTH CENTRE, ENVIRONMENT AND DEVELOPMENT: TOWARDS A COMMON STRATEGY FOR THE SOUTH IN THE UNCED NEGOTIATIONS AND BEYOND 1-2 (1991).

[28] RONALD DWORKIN, TAKING RIGHTS SERIOUSLY 24, 26 (1977).

[29] The precautionary principle was supported most vigorously by AOSIS. At INC 1, AOSIS explained its support for the principle in eloquent terms: ``For us the precautionary principle is much more than a semantic or theoretical exercise. It is an ecological and moral imperative. We trust the world understands our concerns by now.

We do not have the luxury of waiting for conclusive proof, as some have suggested in the past. The proof, we fear, will kill us." Robert F. Van Lierop, Permanent Representative to the United Nations and Chairman of the Delegation of Vanuatu, Statement to the Plenary Session of the INC/FCCC, at 3, Feb. 5, 1991.

[30] In 1986, the United States voted against the U.N. Declaration on the Right to Development, G.A. Res. 128, U.N. GAOR, 41st Sess., 97th plen. mtg., Supp. No. 53, at 186, U.N. Doc. A/41/53 (1986).

[31] For example, Israel and South Africa, nations that some consider industrially and economically ``developed,'' are not included in Annex I. On the other hand, Turkey, by virtue of its membership in the OECD, is subject to the specific commitments although it is in many ways a ``developing'' state. At INC 5, Turkey unsuccessfully proposed using economic criteria, rather than membership in the OECD, to differentiate between developed and developing countries. Under the Convention, Turkey, as a ``developed'' country, would have an obligation to provide financial resources to Saudi Arabia, a ``developing'' country. In protest against its inclusion in Annexes I and II, Turkey was one of the very few countries that did not sign the Convention at UNCED.

[32] AMERICAN HERITAGE DICTIONARY 1244 (2nd College ed. 1982) (defining ``target'' as ``[a]nything aimed or fired at;. . . a desired goal'').

[33] Some sinks raise the problem of quantification: the carbon cycle is relatively well understood in qualitative terms, but ``the current quantitative estimates of sources and of sinks and of CO_2 do not balance; the atmospheric increase is less rapid than expected from carbon cycle models.'' Watson et al., *supra* note 18, at 17. Other sinks raise theoretical questions. One way around these problems would be to implement a net emissions approach in stages, beginning with those sinks that can be most easily quantified.

[34] India, for example, has suggested that global sinks should be allocated on a per capita basis. Under this approach, India has negative net emissions of greenhouse gases because of its large population and relatively low emissions. Pacific island states, in contrast, have argued that states should be allocated the sinks found within their exclusive economic zones. The INC declined to accept a proposed principle that states have an equal right to ocean sinks.

[35] On the other hand, joint implementation can readily be subject to abuse, if countries simply receive credits for projects already planned for other reasons. *See* Michael Grubb, *The Climate Changes Convention: An Assessment*, 15 INT'L ENVT'L REP. (BNA) 540, 541 (1992).

[36] EC Council Conclusions, supra note 122. Creating a bubble for the European Community's stabilization target was necessary in order to obtain the support of Ireland, Spain, Portugal, and Greece. These countries, like developing countries of the South, want room to grow and are unwilling to commit individually to stabilizing their greenhouse gas emissions. The Montreal Protocol established a precedent for an EC bubble, by allowing members of regional economic integration organizations to fulfill jointly their obligations respecting consumption, provided that their combined calculated level of consumption does not exceed the specified limits. Montreal Protocol, art. 2(8)(a).

[37] *Id*. at 17-20. The United States initially suggested the idea of tradeable emissions rights, but later turned neutral on the issue after realizing that a provision on tradeable emissions rights would make sense only if the Convention established quantitative emissions limitations (i.e., targets and timetables), which the United States opposed. Tradeable emissions rights have been used in some domestic environmental actions, including the 1990 Amendments to the Clean Air Act. 42 U.S.C. §§ 7651, 7661 (Supp. I 1992). For a general discussion of emissions trading, see T.H. TIETENBERG, EMISSIONS TRADITION: AN EXERCISE IN REFORMING POLLUTION POLICY (1985).

[38] Examples of such criteria include population, historical emissions, and gross national product.

[39] For example, if emissions rights were allocated on the basis of population, developing countries would start with a huge surplus, since their per capita emissions of greenhouse gases are very low compared to developed states. As developed states bought the surplus emissions rights of developing states, substantial resource transfers would occur. Michael Grubb, *The Greenhouse Effect: Negotiating Targets*, 66 INT'L AFF. 67, 84 (1990). Agreement on such an allocation formula would, of course, be extremely difficult politically.

[40] Implementation costs could include the costs of developing inventories of sinks and sources; designing and implementing national programs for emission reduction; conservation and management of sinks; research, education, and training; building new facilities and introducing new technologies; meeting reporting requirements; and participating in future convention activities and planning sessions.

[41] Cheng Zheng-Kang, *Equity, Special Considerations, and the Third World*, 1 COLO. J. INT'L ENVTL L. & POL'Y 57, 58-67 (1990). Copyright 1990. Reprinted by permission.