Prospects for a global greenhouse gas accord

Lessons from other agreements

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The authors begin with the premise that it would be instructive to examine the record of different international environmental agreements in order to highlight general lessons of possible relevance to a greenhouse gas accord. They review three different international agreements (or sets of agreements) on the environment: the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer and its 1990 amendment; a set of multilateral agreements to reduce acid rain in Europe; and the 1982 Law of the Sea Treaty. Their analysis sheds light on five factors that are important in achieving effective international agreement on environmental issues: the role of scientific and other knowledge in building consensus; the degree of flexibility provided in meeting obligations to the agreement; the role of incentives (both positive and negative) for widespread participation; the process of negotiation itself; and the role of public perception in influencing political action.

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Although the underlying science remains uncertain, there is increasing evidence of potentially damaging climatic and environmental consequences from uncontrolled growth in emissions of greenhouse gases, particularly CO_2. These consequences could entail significant costs for national economies world-wide. How to moderate the build-up of greenhouse gases (particularly CO_2) has become the subject of a major international policy debate. Clearly, meaningful pursuit of CO_2 and other greenhouse gas containment strategies can occur only within a multi-country context, and will require (for an environmental issue) unprecedented agreement in the international community. Yet the multi-country dimension of any effective reduction strategy confronts policy makers with formidable obstacles. These obstacles are rooted in the economic and political characteristics of different countries, and in their differing perceptions of the global warming issue.

While the potential scope and magnitude of the global warming problem sets this issue apart from other international environmental problems, valuable insights can nevertheless be gained from the examination of past international agreements on the environment. Indeed, this article begins with the premise that it would be instructive to examine the record of several different international environmental agreements to highlight general lessons of possible relevance to a greenhouse gas accord. To ensure a reasonable degree of comparability with the global warming issue, we examine agreements which involve multilateral participation to address environmental impacts on resources commonly shared among many nations or the world as a whole (eg the atmosphere or the oceans).

We review three different international agreements (or sets of agreements) on the environment: the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer and its 1990 amendment; a set of multilateral agreements to reduce acid rain in Europe, including the 1979 Convention on Long-Range Transboundary Air Pollution (and its protocols) and the 1988 European Community Directive on Acid Rain; and the 1982 Law of the Sea Treaty.

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Each of these agreements is an attempt to regulate economic activity to serve a collective interest in environmental and resource preservation. The Montreal Protocol, for example, is a landmark agreement outlining specific measures to protect Earth's stratospheric ozone layer. While there are important differences between greenhouse warming and stratospheric ozone depletion, both are long-term problems affecting the global atmosphere. The two multilateral agreements on reducing acid rain in Europe also provide many useful insights. While there are several reasons to presume that agreement to limit acid rain would be less difficult than establishing limits on greenhouse gases, efforts to reduce acid rain in Europe nevertheless offer a microcosm of how a number of countries might cope with a common threat that affects each country in varying degrees. Finally, the Law of the Sea Treaty represents perhaps the most ambitious effort to date to achieve international agreement on an environmental and resource management issue. The goal of achieving international agreement on controlling greenhouse gas emissions is, if anything, more ambitious.

In examining each of these case studies, we address five factors that we believe are key in achieving effective international agreement on environmental issues: the role of scientific and other knowledge in building consensus; the degree of flexibility provided in meeting obligations to the agreement; the role of incentives (both positive and negative) for widespread participation; the process of negotiation itself; and the role of public perception in influencing political action. Each case study reveals interesting and relevant insights regarding some or all of these factors. The analysis section that follows the discussion of the case studies examines the five factors in light of the case studies and with respect to how they might influence the process of reaching international agreement on controlling greenhouse gas emissions.

Montreal Protocol

The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (and its 1990 amendment) is perhaps the most obvious candidate for comparison with the global warming issue. Both ozone depletion and global warming are long-term problems affecting the global atmosphere, and both require balancing near-term costs with long-term benefits. Furthermore, the Protocol represents a remarkable effort at achieving compromise and consensus among the varied and competing interests of scientists, industry, governments, international agencies, and non-governmental organizations on the need to protect the stratospheric ozone layer from depletion by chlorofluorocarbons (CFCs) and other ozone-depleting compounds. Reaching agreement on the need to control greenhouse gas emissions will require a similar (if not greater) degree of compromise and consensus.

The Montreal Protocol stipulates that the production and consumption of ozone-depleting compounds – CFCs, halons, carbon tetrachloride, and methyl chloroform – are to be phased out by 2000 (2005 for methyl chloroform). These compounds have been widely used in the past 30 years as aerosol propellants, coolants in refrigeration and air conditioning, foam blowing agents, fire retardants, and solvents for cleaning electrical components. Scientific theory and evidence suggest that, once emitted to the atmosphere, the compounds could significantly harm the stratospheric ozone layer, the fate of which is of concern

because it shields Earth from damaging ultraviolet (UV-B) radiation. An increase in the amount of UV-B radiation reaching Earth's surface could increase rates of skin cancer and cataracts, cause suppression of the human immune system, and have damaging environmental effects.

The theory that CFCs pose a danger to the ozone layer was first postulated in the USA in 1974.[1] Against the background of a rapidly expanding environmental movement and growing public concern for environmental problems, the public and policy makers responded to the threat of stratospheric ozone depletion with great concern.[2] In 1978, based on recent scientific findings supporting the connection between CFCs and ozone depletion, and a clear political mandate to protect the ozone layer, the US Environmental Protection Agency (EPA) banned the non-essential use of CFCs as aerosol propellants.[3] Similar action was taken by Canada, Sweden, Norway, and Denmark;[4] however, the USA was the only major producer and user of CFCs to take substantial action. In general, the other major producer/user nations were less willing to control CFCs without strong scientific evidence linking them with stratospheric ozone depletion.

By the late 1970s, the stratospheric ozone depletion issue was beginning to receive the widespread attention of international environmental and scientific organizations. In 1981, the United Nations Environment Programme (UNEP) began laying the foundation for an international framework convention for the protection of stratospheric ozone.[5] The Vienna Convention for the Protection of the Ozone Layer, outlining the responsibilities of states for protecting human health and the environment against the adverse effects of ozone depletion, was adopted at a conference of 43 nations in March 1985. While the Vienna Convention did not succeed in defining specific controls on CFC production, it proposed measures for international cooperation on research, monitoring, and information exchange, and established a permanent Secretariat within UNEP. In addition, a resolution was adopted that called for the future negotiation of a CFC protocol.

Negotiations on a CFC protocol to the Vienna Convention began in December 1986. In September 1987, the Montreal Protocol on Substances that Deplete the Ozone Layer was signed. The original Protocol stipulated only a freeze in halon production and a 50% cut in the production and consumption of fully halogenated CFCs. The 1990 amendment, adopted at a meeting in London of the 56 parties to the Montreal Protocol, went considerably further, banning all ozone-depleting compounds.

Contributing factors

Several factors are important in understanding the negotiation of the Montreal Protocol and the adoption of the 1990 amendment. In 1986 and 1987 there was a sense of urgency about stratospheric ozone depletion that had not existed in 1985 during the Vienna Convention negotiations. In part, this sense of urgency was a product of a new level of public and political awareness of the issue resulting from media coverage of the recently discovered Antarctic ozone hole. The ozone hole, first reported in 1985, is a massive (in excess of 50%) seasonal reduction in the concentration of stratospheric ozone that occurs over Antarctica each spring (September and October).[6] It was widely hypothesized at the time that CFCs were responsible for the ozone hole. To the public and many politicians, the ozone hole was a powerful

[1]See M.J. Molina and F.S. Rowland, 'Stratospheric sink for chlorofluoromethanes: chlorine atom-catalysed destruction of ozone', *Nature*, Vol 249, 1974, pp 810–812.

[2]See P.M. Morrisette, 'The evolution of policy responses to stratospheric ozone depletion', *National Resources Journal*, Vol 29, 1989, pp 793–820.

[3]The 1976 Toxic Substances Control Act (TSCA) and the 1977 amendments to the Clean Air Act provided EPA broad regulatory control over ozone-depleting compounds and a clear political mandate to protect the ozone layer. See G.F. Wirth, P.W. Brunner, and F.S. Bishop, 'Regulatory actions', in F. Bower and R. Wards, eds, *Stratospheric Ozone and Man*, CRC Press, Baco Raton, FL, 1981; C.L. Bastian, 'The formulation of federal policy', *ibid.*

[4]T.N. Glawdin, J.L. Ugelow and I. Walter, 'A global view of CFC sources and policies to reduce emissions', in J.H. Cuberland, J.R. Hibbs and I. Hoch, eds, *The Economics of Managing Chlorofluorocarbons*, Resources for the Future, Washington, DC, 1982.

[5]P.H. Sand, 'Protecting the ozone layer: the Vienna convention is adopted,' *Environment*, Vol 27, No 5, 1985, pp 18–20 and 40–42.

[6]F.S. Rowland, 'Chlorofluorocarbons and the depletion of stratospheric ozone', *American Scientist*, Vol 77, 1989, pp 36–45.

symbol of the potential impacts of stratospheric ozone depletion, and it galvanized world opinion on the need for international action to protect the ozone layer.[7]

Another critical factor was the emerging consensus in the international scientific community on the role of CFCs as ozone depleters; the risk that ozone depletion posed to public health and the environment; and the need for international action to resolve the problem. This consensus was evident in several important international scientific reports.[8] In addition, a comprehensive EPA risk assessment further highlighted the potential for serious and costly health and environmental risks associated with ozone depletion.[9] These reports strongly influenced the outcome in Montreal.

Perhaps the most influential scientific report, however, was released after the Montreal Protocol was signed. In March 1988, the Ozone Trends Panel (an international panel of 100 scientists organized by the US National Aeronautics and Space Administration (NASA)) attributed reductions in ozone over the mid-latitude region of the northern hemisphere and the occurrence of the Antarctic ozone hole to CFCs and other atmospheric trace gases.[10] In explaining its decision to phase out the production of CFCs by the end of the century, Du Pont cited the Ozone Trends Panel report as the first conclusive evidence linking CFCs and stratospheric ozone depletion.[11] The Ozone Trends Panel report also provided the scientific evidence necessary to support measures stipulating a complete phase-out of CFCs and other ozone-depleting compounds that was adopted in 1990 as an amendment to the Protocol.

Coupled with this emerging scientific consensus were changing economic conditions and a shifting attitude on the part of industry towards the availability of acceptable CFC substitutes. CFC production, after having peaked in 1974 and fallen sharply, had started to increase rapidly in 1982, driven by demand in non-aerosol applications of CFCs. Production and use of other ozone-depleting compounds was also growing rapidly. In the 1970s, industry waged a bitter battle against the regulation of CFCs, arguing that acceptable substitutes were not available.[12] By the mid-1980s, however, this position had changed significantly. In 1986, the chemical industry proposed that it was lack of regulatory and market incentives, not the absence of a technical solution, that was blocking the development of CFC substitutes – and Du Pont (the world's largest producer of CFCs), citing the need for regulatory incentives, endorsed a world-wide limit on CFC emissions.[13] According to D.D. Doniger this shift in industry's position 'revolutionized the public policy options'.[14]

While consensus has emerged on the need for eliminating CFCs and other ozone-depleting compounds, sharing the burden of compliance costs remain a critical factor. The need for countries to balance the short-term costs of eliminating these compounds with the long-term benefits of protecting the ozone layer is an obvious constraint to international agreement and compliance. Some developing countries, for example, view limits on the production and use of CFCs as limits on their development. The developing world also claims that it is unfair to deny it access to a technology widely used in industrialized countries. Provisions were made in the original Protocol for developing countries (a ten-year delay in implementing the Protocol) to induce them to join. These provisions, however, did not fully satisfy the concerns of large developing countries with rapidly expanding economies, such as the

[7] *Op cit*, Ref 2.
[8] *Atmospheric Ozone 1985*, WMO Global Ozone Research and Monitoring Project Report No 16, 3 vols, World Meteorological Organization, Geneva, Switzerland, 1986; J.G. Titus, ed, *Effects of Changes in Stratospheric Ozone and Global Climate*, 4 vols, Environmental Protection Agency, Washington, DC, 1986.
[9] *Assessing the Risks of Trace Gases That Can Modify the Stratosphere*, 7 vols, Environmental Protection Agency, Washington, DC, 1987.
[10] Ozone Trends Panel, *Executive Summary of the Ozone Trends Panel*, National Aeronautics and Space Administration, Washington, DC, 1988.
[11] R. Monastersky, 'Decline of the CFC empire', *Science News*, Vol 133, 1988, pp 234–236.
[12] L. Dotto and H. Schiff, *The Ozone War*, Doubleday, Garden City, NY, 1978.
[13] L.R. Ember, P.L. Layman, W. Lepkowski and P.S. Zurer, 'Response to ozone depletion', *Chemical and Engineering News*, November 1986, pp 47–56.
[14] D.D. Doniger, 'Politics of the ozone layer', *Issues in Science and Technology*, Vol 5, No 3, 1988, p 88.

PRC and India, neither of which signed the original Montreal Protocol. The revised Protocol more directly addresses the concerns of developing countries by establishng a US$240 million fund to assist them in developing new technologies. The PRC and India, both potentially large benefactors of this fund (if they become parties to the Protocol), have indicated a willingness to join the revised Protocol.[15]

Another strong inducement to wide international participation in the Montreal Protocol (for both developed and developing countries) is provided by the sanctions imposed on non-parties to the agreement. The Protocol requires parties to ban the import of ozone-depleting products from non-parties and to 'discourage' the export of technologies used in producing and utilizing ozone-depleting substances to non-parties. Thus, there is an incentive for non-producers to join the Protocol to guarantee continued access to CFCs from the major producing countries which are parties to the agreement. Furthermore, because CFCs are widely used in industrial processes, including the manufacture of electronic and computer components and many foam products, non-parties are at risk of having their exports of these products barred by parties to the Protocol. While it is still uncertain if and how these particular provisions of the Protocol will be implemented, they are a potentially strong incentive for widespread international participation.

The negotiating process

A principal strength of the Montreal Protocol lies with the process by which it was negotiated. Two important elements characterized the process. First, the Montreal Protocol was the product of an incremental process by which past decisions and actions (both domestic and international) formed the political and scientific foundation on which agreement in Montreal was based.[16] Second, the negotiations themselves transcended narrow national interests and goals, in part by allowing participation by key stakeholders, such as scientists, environmentalists, industry representatives, and government officials.[17] Scientists and scientific agencies were particularly important in outlining, in a tangible and credible fashion, the risks associated with ozone depletion. The negotiations allowed for the integration of national goals with those of the scientific, industrial, and environmental communities. As a result of these two factors, the Montreal Protocol is firmly based on past policy and benefits from broad-based support among groups that have often had competing objectives.

In addition, UNEP, the international agency responsible for negotiating and implementing the Montreal Protocol, provided important credibility to the process. UNEP is a small UN organization established in 1972 and based in Nairobi, Kenya. In the past fifteen years, it has played a key role in staging negotiations of over 20 regional and global conventions and protocols on the environment. The agency has gained widespread respect among developing and developed countries. Its appeal to developing countries rests on the location of its base of operations in a developing country and its Egyptian director, Mostafa Tolba. Its credibility was instrumental in establishing the legitimacy of stratospheric ozone depletion among developing countries.

Acid rain controls in Europe

Control of acid precipitation (acid rain) provides another challenging

[15] 'The revised Montreal Protocol: good enough for India and China; some say its not enough for ozone layer', *Global Environmental Change Report*, 6 July 1990, pp 1–3.

[16] *Op cit*, Ref 2; D.L. Feldman, *Managing Global Climate Change Through International Cooperation: Lessons from Prior Resource Management Efforts*, Report ORNL/TM-10914, Oak Ridge National Laboratory, Oak Ridge, TN, 1990.

[17] *Op cit*, Ref 2; L.P. Gerlach and S. Rayner, *Managing Global Climate Change: A View from the Social and Decision Sciences*, draft, Oak Ridge National Laboratory, Oak Ridge, TN, 1988.

Table 1. Sulphur deposition from foreign sources as a percentage of total deposition: selected European countries, 1980 and 1987.[a]

	1980 (%)	1987 (%)
Austria	57	78
Belgium	45	52
Czechoslovakia	43	46
East Germany	31	23
France	32	38
FRG	46	52
Hungary	41	38
Italy	16	22
Luxembourg	75	71
Netherlands	65	70
Norway	40	46
Poland	42	43
Spain	13	8
Sweden	44	54
Switzerland	73	69
USSR	21	25
UK	10	10

[a]Since deposition in some countries could not be ascribed to either foreign or indigenous origin, the estimates are minimum percentages. (For example, deposition in Norway for 1980 was 40% foreign as shown; 10% indigenous; and 50% 'undecided' or 'background'.)

Source: For 1980, EMP data shown in H. Dovland, 'Monitoring European transboundary air pollution', *Environment*, Vol 29, No 10, 1987, pp 10–15 and 27–28; for 1987, estimates (based in part on EMEP data) shown in *Acid Magazine*, published by the Swedish National Environmental Protection Board, September 1989, pp 5–8. (EMEP is the acronym of the Cooperative Programme for the Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe.)

task for multi-country agreement, even if not on the global scale of ozone-depleting compounds or, prospectively, greenhouse gas controls. Nor does the fact that acid rain mitigation strategies in Europe focus on a group of adjacent countries, rather the world as a whole, obviate the need for painstaking and incremental policy advances.

Acidic precipitation occurs when certain gases – especially sulphuric and nitric acid – dissolve in precipitation and are then deposited on water bodies, vegetation and structures. Acid rain can cause damage to terrestrial and aquatic ecosystems, and to historical buildings and monuments. Key precursor emissions are sulphur dioxide (SO_2) and nitrogen oxides (NO_x) – both predominantly associated with fossil fuel combustion.

It seems reasonable to presume that agreement to limit acid rain would be less difficult than limiting greenhouse gas emissions. In contrast to global warming, scientific understanding of the acidification process is relatively robust.[18] Since impacts from acid rain are not delayed by decades but are beginning to be seen now, public support for corrective action is growing. Acid rain abatement costs, though non-trivial, scarcely compare with the burden of sharply curtailing greenhouse gas emissions. And as a regional problem, negotiating acid rain controls avoids the need for global action by numerous nations with varying economic capacity and environmental commitment. Nevertheless, multilateral efforts to limit acid rain in Europe, where countries are coping with a common environmental threat affecting each of them in varying degree, both as victim and offender, may offer a test case of the global greenhouse gas issue.

The transboundary aspect of the acid-rain problem, and the resultant need for multilateral approaches, is obviously fundamental. Data in Table 1 on the proportion of sulphur deposition attributable to foreign sources show significant flows of emissions across national boundaries, a finding that is not surprising, considering the intensity of industrialization in Europe. It is also clear that much deposition originates within national borders. Pressure for abatement therefore arises from both internal and external forces – something less likely to occur for greenhouse gas emissions where, for most countries, the domestic contribution to potential domestic impact is far smaller.

Multilateral policy responses to acid rain in Europe have operated in an evolutionary and incremental manner. Broad multi-country efforts, largely under the auspices of the UN Economic Commission for Europe (ECE), have involved research, monitoring, and non-binding commitments to abatement of acid rain precursors (SO_2 and NO_x). In addition, mandatory abatement targets have been prescribed within the twelve-member European Community (EC). Beyond these multilateral efforts, there have been independent national initiatives for emission reduction and bilateral mitigation arrangements between countries, thereby illustrating the capacity for countries to operate independently and, in some cases, ahead of multilateral efforts.

UN Economic Commission for Europe

Although episodic and localized concern over acidification goes back a number of decades, the ECE's 1979 Geneva conference was the first concerted multi-country effort to address the issue.[19] The 1979 forum resulted in the adoption (effective 1983) of the Convention on Long-Range Transboundary Air Pollution and several subsequent protocols

[18]This is not to deny that scientific understanding of acid rain's causes and especially its consequences remains incomplete, as pointed out by W. Harrington, *Acid Rain: Science and Policy, A Primer*, Resources for the Future, Washington, DC, 1989; and the report of the US National Acid Precipitation Program (NAPAP) (see Council on Environmental Quality, *Environmental Quality*, 20th Annual Report, Government Printing Office, Washington, DC, 1990).

[19]The ECE is composed of Western and Eastern Europe, and the USSR; the USA and Canada are participating members.

calling for a reduction of transboundary sulphur emissions in Europe by at least 30% by 1993.[20]

However arbitrary and severe, the 30% target was soon surpassed by a number of Western European countries and is expected to be substantially exceeded by a larger number by the mid-1990s. Spain was least able or willing to enunciate a significant SO_2 reduction commitment since it projected emission reductions (below 1980 levels) of only 6% by 1995. At the other extreme, Sweden predicted a 68% reduction. Several Eastern European economies indicated plans to fulfil the 30% cutback, although the credibility of these pledges is unclear.

Without sustained implementation measures, such target-setting remains only a dutiful expression of good intent: however, adherence to measures in the Convention and the promotion of joint acid rain research, providing evidence of a country's commitment, can be critical in their own right. Thus, monitoring programmes have been established in a number of Western and Eastern European countries to assess impacts on lakes, forests, structures, and crops, adding to the scientific basis for action. In addition, national abatement policies, tools of implementation, and progress towards the 1993 goals are reviewed periodically. Those assessments typically report on regulations and practices regarding sulphur content of fuels, flue-gas sulphur scrubbing equipment, the use of low-nitrogen oxide burners, and the extent to which requirements for control technologies apply to new or retrofitted capacity. This step-wise progression from cooperative research to active pursuit of specific targets is a process likely to be even more applicable to the more formidable challenge of greenhouse gas mitigation.

European Community

Directives by the EC provide insight into how effectively environmental objectives are pursued within a more formal political, economic, and judicial framework, particularly in light of complete economic integration, set for 1992 under the Single European Act. As an institution, the EC stands in contrast with the looser, consultative ECE arrangements described above. On acidification, the EC Council in 1980 fixed limits on SO_2 emissions for 1983, but from the start it allowed for contingencies that would cause slippage in achieving that short-term goal, insisting only that it be informed of member-country plans for 'progressive improvement' in emission rates.[21]

One of the most emphatic directives on acidification precursors, issued by the EC Council in November 1988, specifies national SO_2 and NO_x emission ceilings and reductions from 1980 levels, to be achieved in a staged sequence for existing combustion facilities by 2003 (for SO_2) and 1998 (for NO_x), and to set emission limits for individual new plants.[22] From the start, the pursuit of NO_x emission reductions has proved difficult, largely because of the intractability of the problem of controlling emissions from the transport sector. With respect to SO_2, the major industrial member countries are required to reduce emissions from existing plants by 60–70% from 1980 levels by 2003. The Directive does not define how national totals are to be achieved – presumably intra- and inter-plant emission offsets are permitted – but it does oblige member countries to provide details about compliance and implementation plans.

Given our interest in the effectiveness of multi-country environmental agreements and the inevitable trade-offs and caveats in any such

[20]This summary is based in large part on P.H. Sand, 'Air pollution in Europe: international policy responses', *Environment*, Vol 29, No 10, 1987, pp 16–20 and 28. A protocol calling for control of nitrogen oxide emissions was to take place in 1988, but consensus on NO_x reduction strategies – particularly in the transportation sector – appears to have been much more difficult to achieve.

[21]*European Community Environmental Legislation 1967–1987*, European Community, Brussels, 1988.

[22]'Council directives of 24 November 1988 on the limitation of emissions of certain pollutants into the air from large combustion plants', *European Community Official Journal*, 7 December 1988.

multi-country lobby, there are four qualifications in the 1988 EC Directive worth noting.[23]

- 'Substantial and unexpected changes in energy demand', unavailability of certain fuels, and technical problems in the installation of pollution abatement equipment in existing plants are grounds for 'modification' of the emission reduction targets.
- New plants burning 'indigenous solid fuel' whose characteristics demand 'excessively expensive' abatement technology may exceed prescribed sulphur dioxide emission limits.
- Member states whose use of indigenous lignite is an 'essential source of fuel for the plants' are likewise allowed to exceed emission limits.
- Countries whose plants' emissions affect the environment of another member state 'shall ensure that all appropriate information and consultation takes place . . .'

EC members are obliged through national 'laws, regulations, and administrative provisions' to bring themselves into compliance with the EC Council Directive by mid-1990. Clearly, however, the effectiveness of acid rain mitigation depends greatly on the extent to which countries resort to such waivers, exemptions, and modifications as those listed above. While the EC Directive obviously is more binding than the ECE Convention, it remains to be seen how that difference is borne out in practice.

Unilateral and bilateral initiatives

While our primary interest is in multilateral approaches to international environmental problems, in the case of the European acid rain problem it is interesting to note the role of unilateral and bilateral initiatives. A number of European countries have moved independently and, in some cases, ahead of the ECE Convention and the EC Directive, in pursuing acid rain mitigation strategies. For example, while the EC Directive calls for an EC-wide reduction in SO_2 emissions of 38% between 1980 and 2000 for existing and planned large combustion plants, national legislation enacted in a number of EC countries already stipulates a 24% reduction.[24] Reduction across countries, however, is far from uniform (eg Ireland, Portugal, and Spain would increase, not reduce, emissions). Commitments by the largest industrial countries, nevertheless, appear to be robust.

Bilateral approaches arise from the fact that long before the winding down of the Cold War, East–West transboundary pollutant flows in Europe were recognized as a nettlesome problem. Abatement practices in large coal and lignite using countries such as Poland, Czechoslovakia, and the former East Germany are, at best, rudimentary compared to those in the West. The prolonged stifling of environmental improvement and primacy given to physical production targets require that significant capital be deployed to achieve early progress in environmental clean-up. Under several bilateral arrangements, several Western European nations have willingly borne the cost of mitigating acid rain originating in Eastern Europe. Reversing the 'polluter pays' principle, donor countries perceive that the benefits outweigh the cost, provided steps are taken ensuring that the polluting country is not free-riding on the generosity of its neighbour.

In the final analysis, the concurrent pursuit of multilateral, national,

[23] *Ibid*, pp No L 336/3-/5

[24] H. Cesar and G. Klassen, *Costs, Sulfur Emissions and Deposition of the EC Directive on Large Combustion Plants*, Working Paper 90–006, International Institute for Applied Systems Analysis, Laxenberg, 1990.

and bilateral acid rain control policies in Europe reflects a commonality of interest in protecting a regional environment in which a continent-wide state of industrialization disperses pollutants in every direction. Although acidification may not yet engage public attention to the same degree as the Antarctic ozone hole, the issue is not an abstraction. Threats to the Black Forest, Scandinavian lakes, and historical architecture evoke strong emotions and help build consensus essential to supporting mitigative measures. Whether a similar degree of commonality can help energize joint greenhouse strategies is still to be determined – however, it will probably be necessary.

Law of the Sea

In its remarkable breadth and scale, the Law of the Sea (LOS) Treaty may represent the most ambitious attempt to date by the world's nations to develop a management scheme for global resources. It confronts many of the complex issues that arise in the international treaty process and thus provides a rich set of lessons for a greenhouse gas agreement. In particular, it demonstrates the vital role that perceived national interests, and particularly changes in these interests, can have on the treaty process. Because negotiations on a greenhouse gas treaty are likely to take considerable time, evolving national goals – shaped perhaps by further scientific evidence – may have an important impact on the final outcome. The LOS Treaty also reveals the difficulty of reaching consensus on the distribution of costs and benefits, particularly when that distribution has implications for national objectives outside the treaty process.

By the 1950s, it was clear to the world's nations that an international agreement was needed to resolve disputes over conflicting unilateral claims to the oceans. Although a series of treaties were adopted by the late 1950s,[25] concerted efforts to forge an international oceans agreement did not begin until 1973 with the Third United Nations Conference on the Law of the Sea. After lengthy negotiations, the LOS Treaty was adopted in 1982. To date, it has been signed by 159 countries (excluding the USA, the UK, and the FRG) and ratified by 39 of the 60 countries needed for it to enter into force. The Treaty grants coastal states sovereignty over adjacent waters out to 12 miles and rights to certain economic activities (eg fishing and mining) out to 200 miles – designated the Exclusive Economic Zone (EEZ). It specifies rules for transit by foreign vessels and scientific research within territorial waters and EEZs. Less explicit regulations address marine pollution and access to EEZs by landlocked countries. All countries have equal access to the waters beyond the EEZs, including any minerals found on the seabed. A regulatory body, described in more detail below, was established to administer the extraction of seabed minerals.

The negotiations for the LOS Treaty began with the goal of achieving agreement by as many countries on as many issues as possible.[26] Initially, the major powers were primarily concerned with securing navigation rights for commercial and naval fleets. The USA, for example, regarded submerged passage through straits to be critical to its military strategy. Other alliances emerged to promote common interests, often reflecting a departure from traditional regional and political alignments.[27] For example, alliances were formed of coastal, archipelagic, and landlocked nations, including both developed and

[25]The Convention on the High Seas (1958), The Convention on the Territorial Shelf and Contiguous Zone (1958), and The Convention on the Continental Shelf (1958).

[26]T. Koh and S. Jayakumar, 'The negotiating process of the Third United Nations Conference on the Law of the Sea', in M.H. Nordquist, ed, *United Nations Convention on the Law of the Sea*, Martinus Nijhoff, Dordrecht, 1985.

[27]B. Zuleta, 'The Law of the Sea: myths and realities', *Oceanus*, Vol 25, No 3, 1983, pp 28–30.

developing countries. By 1977, there was general agreement on the key territorial and navigational provisions. Consensus was relatively easy to reach on these issues, because most countries recognized the need for uniform regulations. Moreover, coastal nations – which represented about 85% of participating nations – naturally favoured steps giving them jurisdiction over coastal waters.

However, agreement on a seabed mining regime proved to be much more elusive. At issue was the disposition of manganese, copper, nickel, and cobalt nodules found on the ocean floor outside of EEZs. By 1981, after four years of negotiations, a regime for managing minerals extraction was provisionally adopted. It proposed the establishment of an international administrative body, designated the International Seabed Authority (ISA). Mining companies would be required to apply to the ISA for a permit to mine. They would submit proposals for two sites of equal size or value, one of which they could mine, the other being reserved for mining by the ISA on behalf of relatively poor and landlocked countries. Mining companies would be required to make mining technology available at fair market value and to pay taxes to the ISA. The revenues would be distributed to member countries or invested in ISA mining operations. Developed countries also would be required to make low-interest loans for mining operations to the ISA. Twenty-year production limits would be imposed to enable the economies of land-based producers to adjust.

Support for the mining regime was generally divided along North–South lines.[28] Developing countries strongly favoured the regime because it provided them access to minerals and helped to further the principles of the New International Economic Order, a UN proposal that the world economy be restructured to facilitate more equitable distribution of wealth. There was less support for the provisions among developed countries, although most felt that problems could be worked out by the Preparatory Commission (a committee assigned the task of establishing the ISA). However, the USA was strongly opposed to the mining regime, and despite efforts to make the mining provisions more acceptable it rejected the final version of the Treaty in late 1982. The UK and the FRG, at the urging of the USA, also did not sign.[29]

The USA opposed the mining provisions partly on ideological grounds.[30]The Reagan administration perceived the regime as counter to free-market forces, particularly with respect to production ceilings and technology transfer, and was unwilling to endorse the concept of the global commons (at least in its LOS application). Furthermore, the USA felt that the mining regime was not in the best interest of developed nations because of the unequal financial burden it placed on them. In this regard, it feared the precedent-setting potential of the regime.[31] The US decision to vote against the Treaty was also influenced by factors outside the Treaty process. The initial objective of the USA to secure navigation rights for military vessels became less important with the development of longer-range vessels during the 1970s (eg the Trident submarine). By the end of the negotiations, it perceived access to seabed minerals as crucial to its military strategy. It was thus unwilling to endorse measures aimed at evenly distributing these resources among nations.

The US decision to reject the LOS Treaty hinged on its belief that the territorial and navigational measures would become customary international law. Negotiations on the territorial and navigational measures

[28]R.L. Friedheim, 'The Third United Nations Conference on the Law of the Sea: North–South bargaining on ocean issues', in I. W. Zartmann, ed, *Positive Sum*, Transaction, New Brunswick, NJ, 1987.
[29]P.M. Fye, 'The Law of the Sea', *Oceanus*, Vol 25, No 4, 1983, pp 7–12.
[30]L.S. Ratiner, 'The Law of the Sea: a crossroads for American foreign policy', *Foreign Affairs*, Vol 60, No 5, 1982, pp 1006–1021.
[31]J.K. Sebenius, *Negotiating the Law of the Sea*, Harvard University Press, Cambridge, MA, 1984.

were completed for the most part by 1977 and gained increasing acceptance as negotiations continued on a seabed mining regime. Thus, the USA felt it could subscribe to the territorial and navigational provisions which it favoured without accepting the mining provisions, which it did not perceive to be in its best interest. For the USA, the separability of the two sets of measures was heightened by the shift in the focus of the negotiations from one to the other. Originally, negotiations were planned to proceed simultaneously on all topics to promote a package-deal concept. The collapse of this structure allowed the USA to select only those provisions in the Treaty that it favoured.

The conflict over the seabed mining regime was given a respite by a drop in minerals prices in the early 1980s. Since then, prices have stayed down while doubts about the economic feasibility of seabed mining have risen.[32] In the meantime, the Preparatory Commission has registered the first group of investors. After five years of difficult negotiations, India, France, Japan, and the USSR were granted the right to explore and mine the seabed within defined areas.[33] It is widely felt that US participation would greatly enhance the effectiveness of the LOS Treaty by providing financial assistance, technology, and leadership. Many developed countries that have signed the LOS Treaty are reluctant to ratify it as long as the USA dissents, because of the financial burden and the uncertainty of future US actions.

The international effort to adopt a greenhouse gas treaty currently bears some important similarities to the LOS Treaty process, particularly with regard to the US position. The USA is reluctant at present to endorse international greenhouse gas stabilization and reduction targets, and it may oppose an international agreement that includes such targets. It is also wary of mechanisms for the transfer of technology to developing countries. For example, the USA initially opposed the idea of a technology transfer fund under the Montreal Protocol – perhaps because it did not want to establish a precedent for a climate change treaty.

The outcome of greenhouse gas negotiations, however, may be different from that of the LOS Treaty. The US position, and the position of other countries, may shift over time. The LOS Treaty demonstrates that positions can change in response to evolving national priorities. On the other hand, the outcome of a greenhouse gas treaty is likely to be similar to that of the LOS Treaty if ultimately a major country (or countries) rejects the agreement. As the strength of the LOS Treaty was diminished by the dissension of the USA, the UK, and the FRG, so too will a greenhouse gas agreement be weakened if it fails to gain the support of major greenhouse gas emitters such as the USA, the USSR and the PRC.

Lessons for a global greenhouse gas accord

For efforts at international greenhouse gas mitigation to have a real chance, there must be widespread perception among countries that such an agreement is in their national interest, however that is defined. National interests may be broadly defined, and thus national participation may be strongly influenced by efforts to satisfy objectives not explicitly defined in terms of an agreement (eg diplomacy, protection of national sovereignty). The perceived benefits of any agreement, including a convention on greenhouse gas mitigation, must be seen as

[32]D.L. Larson, 'When will the UN Convention on the Law of the Sea come into effect?', *Ocean Development and International Law*, Vol 20, 1989, pp 175–202.

[33]See M. Hayashi, 'Registration of the first group of pioneer investors by the Preparatory Commission for the International Sea-Bed Authority and for the International Tribunal for the Law of the Sea', *Ocean Development and International Law*, Vol 20, 1989, pp 1–33.

significant relative to the perceived costs for a national political will to emerge in favour of agreement and compliance. This is particularly the case when any benefits may be realized well after the costs are incurred. To this end, the three international agreements that we reviewed reveal several lessons with regard to negotiating an international agreement on controlling greenhouse gas emissions.

Role of scientific and other knowledge

Progress towards agreement, particularly in the first two agreements considered, has been supported by growing understanding of the physical and environmental processes at work (eg stratospheric ozone depletion by CFCs, acid rain formation), the consequences of these processes (cancer, forest dieback), and their costs to society. The dissemination of knowledge is also important, as illustrated by technology transfer programmes for acid rain control, seabed mining, and CFC substitutes.

These cases might suggest that hope for early success in greenhouse gas mitigation should be tempered. In comparison to these other cases, global warming appears to be a problem where the benefits of taking action are quite uncertain. The costs of mitigation (constraints on fossil fuel use or adoption of more fuel-efficient technologies) can be at least crudely estimated and are thought by many to be substantial – much greater than the cost of mitigating stratospheric ozone depletion or acid rain. Moreover, the scientific uncertainty over global warming has proved to be highly divisive in efforts towards international agreement.

In particular, while there is clearly an emerging scientific consensus that some global warming from greenhouse gases can be expected by the middle of the next century, the range of credible estimates (roughly an increase of global mean temperature of 1.5-4.5 degrees Celsius) is broad.[34] Still less is known about the environmental consequences of such warming, and how they might vary geographically across the band of potential temperature increases. And even if a set of environmental effects is postulated, reliable estimates of social costs are very difficult to form – in part because so little is known about opportunities for effective human adaptation.[35]

In contrast, while both acidification and stratospheric ozone depletion first emerged amid substantial scientific uncertainty and controversy, a quite remarkable degree of consensus materialized within a relatively small number of years. It follows that critical components in any effort towards agreement on greenhouse gases are concerted national and international efforts to reduce uncertainty about the benefits of taking action. Where uncertainty persists, estimates of impacts under different conditions should be sought so that the risks of climate change can be better assessed.

Flexibility

A second important lesson from our analysis is the importance of flexibility in the means by which obligations are to be met. In the case of the CFCs, for example, it is difficult to imagine agreement being possible without the prospective availability of substitutes. The Montreal Protocol also allows for a degree of international burden-trading among participants. Inter-country SO_2 emissions trading embodied in the US Clean Air Act amendments of 1990, but not yet a feature of acid rain management in Europe, can be a way of meeting given targets at

[34]S.S. Schneider, 'The greenhouse effect: science and policy', *Science*, Vol 243, 1989, pp 771–781.

[35]N.J. Rosenberg, W.E. Easterling, P.R. Crosson and J. Darmstadter, eds, *Greenhouse Warming: Abatement and Adaptation*, Resources for the Future, Washington, DC, 1989.

least cost. And many developed countries believed that the mining provisions of the LOS Treaty were flawed, but accepted the agreement because of the opportunity to revise the measures.

Several conclusions regarding greenhouse gas mitigation agreements follow from these observations on flexibility. The first is the recognition that an optimal way to reach a stipulated ceiling on global greenhouse gas emissions is not to impose uniform percentage allowances across a wide band of countries, but to permit differential responses governed by cost considerations. While the prevailing policy focus has primarily been on CO_2 mitigation, in part because of the political momentum towards that objective, it may prove necessary to weigh the potential advantages of multiple-gas control strategies allowing trade-offs among emission sources and sinks. A related factor is the need to allow flexibility in compliance strategies (eg afforestation *v* fuel substitution) and, as noted below, in the allocation of burdens among countries.

Incentives for widespread participation

Because of the global nature of the greenhouse problem, broad international participation in devising mitigation strategies is essential. Sanctions for breaches of greenhouse gas limits, as intended in the Montreal Protocol on ozone-depleting substances, no doubt can play a useful role. However, there is a pervasive conflict in international environmental agreements between the goal of regulating the use of global resources and a general unwillingness to sacrifice national sovereignty. The LOS Treaty clearly illustrates the problem of trying to install an international regulatory body.

Of equal or greater importance are positive inducements for participation. For developing countries the desired inducements inevitably will take the form of lighter requirements for mitigation and provisions for technical and financial assistance, as we saw in the Montreal Protocol, acid rain guidelines, and the LOS deepsea mining provisions. To reach a broad international agreement on greenhouse gas mitigation, developed countries must address these equity concerns. If they do not find it in their best interest to do so, attention with probably shift from international efforts to mitigate greenhouse gas emissions towards national efforts to adapt to climate change. Because of the likely cost burden of mitigation, there clearly are limits to developed countries' *largesse* in responding to equity considerations. To make the prospects for agreement as broad as possible, any multilaterial programme will probably need to be as cost-effective as possible, subject to agreed-upon equity provisions. Here again we see the importance of flexibility in tailoring the mitigation strategies of individual countries.

The process of negotiation

Our case studies illustrate three important features of the negotiation process itself. Any credible agreement must build incrementally on its own history to establish a solid political foundation. The negotiation process also is greatly enhanced if there is widespread participation by countries as well as organizations and individuals on various sides of the issue (eg scientists, policy makers, business interests, environmental groups, and other non-governmental organizations). The participation of such parties can bring to bear a wider range of information and improve prospects for ratification of an agreement. Finally, international organizations may play a key role in bridging disparate national

viewpoints – as UNEP did between developed and developing countries in the CFC negotiations or as the ECE did in initiating the process of acid rain management in Europe – provided they are not themselves 'captured' by one or another faction.

With respect to the issues mentioned above, the record so far on a greenhouse gas agreement is promising. The Intergovernmental Panel on Climate Change (IPCC) is a multilateral effort initiated by two respected international organizations, UNEP and the World Meteorological Organization. Its purpose is to promote a more cohesive understanding of climate change processes, their impacts, and the merits of different responses. As such, it involves a wide range of non-governmental actors with national representatives. Finally, the IPCC has recommended the initiation of a framework convention on greenhouse gas mitigation, following a path successfully pursued in the negotiation of the Vienna Convention and the Montreal Protocol.

Perception and political action

Finally, the role of public perception can be a critical factor in making a global environmental issue politically meaningful. Public concerns (whether rational or irrational) over the health and environmental consequences of acid rain and stratospheric ozone depletion were essential in building the political will to support action on these issues. Certainly in the case of stratospheric ozone depletion, the perception of impending global catastrophe, symbolized by the ozone hole over Antarctica, was a critical factor in building political support for a CFC agreement. While the perception of imminent catastrophe is not a necessary pre-condition to action, it can be a very powerful catalyst. Public and political perceptions of the risks posed by global warming will likely be a strong determinant of the responses by different countries.

Concluding remarks

We conclude by raising two broad issues emerging from our review of other agreements. There is an inherent tension between comprehensive and piecemeal approaches to problems. The comprehensive approach may be more effective and provide many participants with at least something they like, but the piecemeal approach incurs less risk of 'hold-outs' that impede agreement. For example, to have forced mobile-source (NO_x) emission targets into the initial stages of European acid rain management might have engendered precisely such hold-outs by countries with too much at stake in automotive markets to submit readily to such constraints. The LOS Treaty, which attempted to address all ocean issues under one comprehensive agreement, was adversely affected by the dissension of a few countries. On the other hand, the Vienna Convention on stratospheric ozone depletion and the subsequent Montreal Protocol were the product of a piecemeal process. Indeed, most successful agreements on resource management (as well as arms control) have been piecemeal, so it may be reasonable to expect this kind of outcome with greenhouse gases as well.

There is also tension between fairly specific and more vague provisions. More specific provisions may have more impact and are more easily monitored, but vaguer terms may evoke more consensus and allow for easier modification as new information becomes available.

Past agreements have generally taken the latter approach. To date, most calls for international greenhouse action have followed the Montreal Protocol model by including fairly specific targets (eg stabilization followed by a 20% reduction in CO_2 emissions by certain dates). It will be interesting to see whether such targets survive the negotiation process, given prevailing scientific uncertainties and the disparate interests of individual countries.