CLIMATE CHANGE AND COLLECTION ACTION

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Introduction

Since the Intergovernmental Panel on Climate Change published its Fourth Assessment Report (FAR) in 2007,[1] the debate about climate change has shifted. That the earth has entered a period of significant climate change is no longer disputed. Nearly all climate scientists – and even a highly skeptical (if not downright cynical) President of the United States[2] – now agree that anthropogenic GHG emissions are, for the first time in the earth's history, forcing changes in the global climate. The most recent report of the Intergovernmental Panel on Climate Change (IPCC) concludes that anthropogenic emissions of greenhouse gases are 'very likely' responsible for 'most of the observed increase in globally averaged temperatures since the mid-20th century.'[3] To some observers, the changes signify the onset of a new geological era: the 'Anthrocene Age.'[4]

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[1] *See* <http://www.ipcc.ch/>.

[2] *See* <http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html>.

[3] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis: Summary for Policymakers (Feb. 2007), available at <http://www.ipcc.ch/SPM2feb07.pdf>.

Although several threshold issues about climate change have been settled, scientists continue to question the adequacy of models predicting future climate changes and their impacts. In addition, many social-scientific issues remain unresolved, including questions about the nature, extent, and variability of socio-economic impacts from climate change and appropriate policy responses. On one issue, virtually all observers concur: the Kyoto Protocol is inadequate to the task at hand. The Protocol's lone goal is to stabilize atmospheric concentrations of greenhouse gases (GHGs) by reducing global anthropogenic emissions.[5] However, most observers agree that the Protocol, as designed, cannot possibly achieve that goal.[6] Even on the doubtful assumption that all parties will meet their Kyoto emissions-reduction targets on schedule (between 2008 and 2012), global emissions are expected to increase for at least the next two decades, driven by increasing emissions from developing countries, which are not subject to binding obligations under Kyoto.[7] In any case, the Protocol is scheduled to expire in 2012, and the international community has only just begun to negotiations to extend or replace it.

Legal scholars, economists, and policy analysts are full of recommendations for international climate negotiators. Virtually all agree that the Kyoto Protocol is inadequate to the task at hand, and must be substantially amended, expanded, or replaced. A few recommend scrapping Kyoto entirely and starting from scratch.[8] Many favor extending and expanding Kyoto,

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[4] *See, e.g.* Andrew Revkin, *Global Warming: Understanding the Forecast* (New York: Abbeville Press 1992), p 55.

[5] Section I provides a detailed introduction to the United Nations Framework Convention on Climate Change, as well as to the Kyoto Protocol.

[6] *See, e.g.*, David Victor, *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming* (Princeton: Princeton University Press, 2001); Scott Barrett, *Why Cooperate? The Incentive to Supply Global Public Goods* (Oxford: Oxford University Press, 2007), p 7; Richard A. Posner, *Catastrophe: Risk and Response* (Oxford: Oxford University Press, 2004), p 126; Cass R. Sunstein, *Worst-Case Scenarios* (Cambridge, Mass.: Harvard University Press, 2007), pp 93-4.

[7] *See, e.g.*, Energy Information Administration, International Energy Outlook 2007, available at <http://www.eia.doe.gov/oiaf/ieo/emissions.html>.

[8] *See, e.g.*, Henry D. Jacoby, Ronald G. Prinn, and Richard Schmalensee, 'Kyoto's Unfinished Business,' (July/August 1998) 77 *Foreign Affairs* 45 (arguing that if developing countries refuse to accept

e.g, to control emissions from developing, as well as developed, countries.[9] Some claim that Kyoto's various cap-and-trade mechanisms for achieving emissions reduction should be replaced by a system of taxes on emissions or carbon-content.[10] Still others argue that attention should be refocused from GHG emission reductions to adaptation or technological solutions to climate change.[11] Whatever their differences, nearly all analysts (with a few notable exceptions[12]) share a common disregard for the collective action problems that confront climate change negotiators.

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binding emissions reduction targets, Kyoto should be completely scrapped); Gwyn Prins and Steve Rayner, 'Time to ditch Kyoto' (25 Oct 2007) 449 *Nature* 973.

[9] *See, e.g.*, *id*.; Robert N. Stavins, 'A Better Climate Change Agreement,' (Jan/Feb 2005) *Envtl F* 12, available at <http://www.env-econ.net/stavins/Column_5.pdf>; Sheila M. Olstead and Robert N. Stavins, 'A Meaningful Second Commitment Period for the Kyoto Protocol' (2007) 4 *Economists' Voice* Iss. 3, Article 1, available at <http://www.bepress.com/ev/vol4/iss3/ art1/>; Richard B. Stewart and Jonathan Baert Wiener, *Reconstructing Climate Policy: Beyond Kyoto* (Washington, DC: AEI Press, 2003).

[10] *See, e.g.*, William D. Nordhaus, 'Life after Kyoto: Alternative Approaches to Global Warming' (Dec 2005) NBER Working Paper No. 11889; N. Gregory Mankiw, 'One Answer to Global Warming: A New Tax' (16 Sept 2007) *New York Times* 6, available at <http://www.nytimes.com/2007/09/16/ business/16view.html>; Stephen H. Schneider and Lawrence H. Goulder, 'Achieving Low-Cost Emissions Targets' (4 Sept. 1997) 389 *Nature* 13; Richard N. Cooper, 'Toward a Real Global Warming Treaty' (Mar/Apr 1998) 7(2) *Foreign Affairs* 66; Deborah Solomon, 'Climate Change's Great Divide' (12 Sept 2007) *Wall Street Journal* A4; Nicole Gelinas, 'A Carbon Tax Would Be Cleaner,' (23 Aug. 2007) *Wall Street Journal* A11; William Nordhaus, The Challenge of Global Warming: Economic Models and Environmental Policy (2007) Ch. 8, available at <http://nordhaus.econ.yale.edu/dice_mss_ 072407_all.pdf>.

[11] *See e.g.* Daniel H. Cole, 'Climate Change, Adaptation, and Development' (2008) __ *UCLA Journal of Environmental Law and Policy* __ (calling for an adaptation protocol to the UNFCCC); Barrett, n 6 above, at __ (calling for an Research & Development protocol to the UNFCCC).

[12] The notable exceptions include Scott Barrett, n 6 above, and Sunstein, n 6 above.

Climate change is an extraordinarily complex problem about which many uncertainties (in the Knightian sense of the term[13]) persist. The international community is endeavoring to resolve a global-cost problem (*i.e.*, a social-cost problem affecting the entire world) that is not yet, and may never be, fully understood. Importantly, climate change will not have uniform effects throughout the world. If global mean temperatures increase by 2.5ºC by 2150, the mean temperature at each location in the world will not necessarily rise by precisely 2.5ºC. Temperatures may rise more at some locations than others; in some places, mean temperatures could even fall. Moreover, climate change could create net benefits for some countries or regions.[14] At the very least, some countries are expected to suffer more harm than others.

The unequal expected distribution of costs and benefits from climate change creates different incentives for different countries, and there is every reason to expect that countries will behave and bargain strategically in accordance with their perceived interests. As was the case with the Kyoto Protocol, some countries may rationally prefer, and negotiate for, a weaker regime or no regime at all (at least for the time being), while others favor a stronger regime. Differential incentive structures and resulting strategic behavior could well impede effective and efficient climate change agreements.[15] Thus, climate change presents a sizeable 'collective action' problem.[16] Indeed, it may be the greatest collective action problem the international community has yet faced.[17]

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[13] *See* Frank Knight, *Risk, Uncertainty, and Profit* (Boston: Hart, Schaffner, and Marx, 1921). Knight distinguished between 'risk'–outcomes to which probabilities could reasonably be assigned – and 'uncertainty' – risks for which probabilities could not reasonably be estimated.

[14] *See* n 53 below and accompanying text.

[15] For an excellent introduction to international treaty-making from a game-theoretic point of view, see Scott Barrett, *Environment and Statecraft* (Oxford: Oxford University Press, 2003).

[16] *See, e.g.*, Kenneth Arrow, 'Global Climate Change: A Challenge to Policy' (June 2007) 4(3) *Economists' Voice* Art. 2, available at <http://www.bepress.com/ev/vol4/iss3/art2/> ('[g]lobal climate change is a public good (bad) *par excellence*').

[17] *Cf.* Scott Barrett, n 6 above, at 9 ("Global climate change may or may not be the most important problem facing us today, but it is almost certainly the hardest one for the world to address").

Simply put, a 'collective action' problem is one that cannot be solved by a single individual or member of a group, but requires the cooperation of others who often have disparate interests and incentives, raising the costs of transacting or negotiating a cooperative solution. The most notorious collective problems arise with respect to the provision of public goods, including clean air and water. The global climate is a global public good.

This paper describes and offers some recommendations for ameliorating the sizeable collective action problems that impede efforts to introduce effective and efficient mitigation and adaptation regimes under the UN Framework Convention on Climate Change (UNFCCC). Section I begins with a brief history of the UNFCCC and Kyoto Protocol, which highlights the collective action problems that (a) explain the Protocol's obvious and disabling flaws and (b) continue to confront the international community as it attempts to improve upon the Protocol. Section II then offers some limited reason to hope that those collective action problems might be reduced, enough perhaps to allow more effective international action to stabilize the climate.

I. A Brief History of the UNFCCC and the Kyoto Protocol

A. The Model: The Vienna Convention and Montreal Protocol as Precursors to the UNFCCC and Kyoto Protocol

Any discussion of international efforts to deal with climate change must begin with the international community's earlier successful effort to protect the stratospheric ozone layer from chlorofluorocarbons (CFCs) and other ozone depleting substances (ODSs), under the 1987 Montreal Protocol[18] to the 1985 Vienna Convention for the Protection of the Ozone Layer.[19] The history of the ozone accords established a model that framers of the UNFCCC and Kyoto Protocol deliberately emulated. The model itself was not created deliberately, however, but was the serendipitous outcome of a contentious process that began in the early 1970s when scientists first theorized that chlorine-based chemicals, if released into the stratosphere, could destroy the

[18] Montreal Protocol on Substance that Deplete the Ozone Layer (16 Sept 1987) 1522 U.N.T.S. 29.

ozone layer, which protects the earth from dangerous levels of solar radiation.[20] Theories of ozone-layer depletion, like those relating to climate change, were initially controversial. The science was complex and the chemical industry steadfastly denied that chlorine-based substances affected the ozone layer.

It was not until the mid-1980s that an international research effort was launched to determine whether the theories of chemically-induced ozone depletion were valid. Coordinated by the US National Aeronautics and Space Administration (NASA), approximately 150 scientists from around the world spent a year preparing a report for the World Meteorological Organization and the United Nations Environment Program, which found that concentrations of CFCs in the upper-atmosphere had nearly doubled between 1975 and 1985. The report included scientific models indicating that high atmospheric concentrations of CFCs and other ODSs *could* deplete the stratospheric ozone layer, while increasing low-level ozone, which contributes to smog. But evidence of causation was still lacking. Specifically, there was no proof of actual depletion of the stratospheric ozone layer; nor was there evidence that increasing solar radiation was reaching the ground, *e.g.*, skin cancer rates were not rising. Thus, at the time the Vienna Convention was negotiated, there was far less scientific consensus about whether ODS emissions depleted the stratospheric ozone layer than there is today about the whether anthropogenic GHG emissions contribute to climate change. Despite the scientific uncertainty, however, concern about the potential global effects of ozone depletion was sufficiently deep and widespread for the international community to reach agreement on the Vienna Framework Convention.

1. The Vienna Convention

The 1985 Vienna Convention did not itself regulate ODSs because the parties simply could not agree on regulatory standards. They did not set out deliberately to create a mere

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[19] (22 Mar. 1985) 1513 U.N.T.S. 324.

[20] The history of the science and negotiations that to the Vienna Convention and Montreal Protocol is brilliant told in Richard Elliot Benedick, *Ozone Diplomacy: New Directions in Safeguarding*

'framework' convention, to which regulatory standards could later be added, but it was the best they could do under the circumstances. Those circumstances, in essence, boiled down to a dispute between the United States, which wanted to rapidly phase out the use of CFCs and other ODSs, and dominant member states of the European Community (now the European Union), which preferred a merely 'symbolic response.'[21] The reason for the opposed positions of the US and EC was, as Richard Benedick has explained,[22] essentially economic. For decades up until the 1970s, US chemical manufacturers dominated international markets for CFCs and other ODSs; but by the time of the Vienna Convention US production of ODSs was relatively unimportant for the national economy. By contrast, European production of CFCs was a far more significant component of national incomes. Rival chemical producers on either side of the Atlantic understood (evidently better than some of the Protocol's negotiators) that the outcome of the negotiations would structure markets in a way that would advantage either US producers or European producers, but not both.[23]

European chemical producers alleged that the US supported a rapid phase-out of CFCs only because the American chemical giant DuPont was preparing to market a non-ozone-depleting CFC substitute. The American negotiator Richard Benedick has denied those allegations,[24] but they appear to have been well founded. Benedick himself notes that prior to the Montreal meetings DuPont publicly announced that it was ceasing production of CFCs and preparing to market a non-ozone-depleting CFC substitute within five years, subject to suitable market and regulatory conditions (hint, hint).[25] When officials in the Reagan Administration subsequently attempted to weaken US support for strict ODS controls, 'major industry representatives declined to support them.'[26] Why? Because, as Peter Morrisette has written,[27] the

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the Planet (Cambridge, Mass.: Harvard University Press, 1991). *Also see* Barrett, *Environment and Statecraft,* n 15 above, at Ch 8.

[21] Benedick, n 20 above, at 24.

[22] *Ibid* at 26-27.

[23] *Ibid* at 33.

[24] *Ibid.*

[25] *Ibid* at 53.

[26] *Ibid* at 64.

Montreal Protocol was 'a useful mechanism for providing the necessary economic incentive to develop and market suitable alternatives,' which DuPont was already preparing. From a public choice perspective, it was a plain enough case of 'predation through regulation.'[28] According to John Baert Wiener, 'the United States manufacturers were farther ahead in the production of CFC substitutes than were their competitors, so a rapid CFC phase-out, although it would hurt them a bit, would hurt their rivals far more.'[29] In short, the US chemical industry viewed regulation of CFCs as a device for reasserting its market dominance. In this case, however, DuPont's self-interest coincided with the wider global interest – at least, it was consistent with a widespread and growing (but incomplete) consensus that ODS emissions had to be curtailed. Meanwhile, chemical companies in the countries that opposed ODS regulations–the UK, Germany and France–were engaged in counter-efforts at predation through anti-regulation., European chemical companies allegedly under-reported their CFC emissions in the hope of weakening political support for regulation.[30]

Because the US-EC conflict prevented agreement on a fully-fledged regulatory system, the parties to the ozone negotiations had two options: do nothing while awaiting more scientific evidence that might resolve the dispute between the US and EC; or take some present action to facilitate future negotiations toward a regulatory regime for ODSs. More or less fortuitously they chose the later option. The Vienna Convention established a 'framework' for future negotiations by committing the parties to engage in further scientific research (Art. 3), cooperate on efforts to resolve scientific, technical, and legal issues (Art. 4), and participate in a 'conference of the parties,' which included regularly scheduled meetings (Art. 6). The Convention created a 'secretariat' to facilitate negotiations and oversee cooperative efforts (Art. 7). Most importantly, the framework convention established procedures for adopting binding protocols and amendments. Finally, the framework convention provided procedures by which the convention

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[27] Peter Morrisette, 'The Evolution of Policy Responses to Stratospheric Ozone Depletion' (1989) 29 *Nat Resources J* 793, 816.

[28] John Baert Wiener, 'On the Political Economy of Global Environmental Regulation' (1999) 87 *Geo LJ* 749, 772-773.

[29] *Ibid.*

[30] Benedick, n 20 above, at 180.

itself and future protocols would be voted upon, ratified, and implemented. In essence, the Vienna Framework Convention established a governance structure and decision-making process, which, it was hoped, would facilitate further negotiations toward a fully-fledged treaty to phase out use of harmful ODSs.

2. A 'Catalytic' Event: A 'Hole' in the Ozone Layer

At virtually the same time as international negotiators were completing work on the Vienna Convention, scientists in Britain were in the process of discovering a large and growing 'hole' in the ozone layer above Antarctica. That discovery did not necessarily validate scientific theories linking CFC emissions to ozone depletion. Scientists initially were hard pressed to explain how CFC emissions from North America and Europe might cause an ozone hole above Antarctic; several credible theories unrelated to anthropogenic emissions might have explained its appearance at that remote location. So, as negotiations leading to the Montreal Protocol were about to start, substantial scientific uncertainty remained. Nevertheless, at a political level the ozone hole over Antarctica undoubtedly played a catalytic role at the Montreal negotiations.

3. The Montreal Protocol

In Montreal, the US position prevailed as the international community adopted a strict timetable for phasing out CFCs and other harmful ODSs. In part, this agreement grew out of legitimate international concern about the potentially severe harm that could result anywhere in the world from depletion of the ozone layer. But another important factor was political discord within the EC itself. While France, Germany and the UK sought a weakened treaty in the interests of their sizeable chemical industries, other EC member states that did not have significant economic interests in ODS production favored a stronger treaty. Consequently, the EC was unable to present a united front at the treaty negotiations. Indeed, as Richard Benedick has observed,[31] a shift in the EC presidency during the course of the ozone negotiations seems to

[31] *Ibid* at 36.

have made a substantial difference. Negotiations, which had stalled while the UK held the presidency during 1986, progressed rapidly once the presidency shifted to Belgium at the start of 1987.

As signed and ratified, the 1987 Montreal Protocol required the phasing out, over various time periods, of several ODSs. Importantly, the Protocol also required the parties to ban the export of ODSs to non-parties,[32] and provided that the Protocol could be amended as necessary to ensure protection of the stratospheric ozone layer.[33] Importantly, the Protocol created a special $400 million fund to compensate developing countries for their costs of compliance.[34] At the time, those countries produced almost no ODSs and consumed little, but they expected to increase consumption of refrigerants and other ODSs as their economies developed. In effect, their acquiescence was purchased by 'side payments' from the Fund. The Protocol entered into

[32] This use of trade restrictions to enforce compliance may, in theory, have run afoul of the World Trade Organization, but no country brought a test case. On the utility of trade restrictions as international law enforcement mechanisms, *see* Barrett, n 6 above, at 82-3. For a recommendation of trade restrictions for enforcing GHG emissions limitations under the Kyoto Protocol, *see* Joseph Stiglitz, 'A New Agenda for Global Warming' (2006) 3(7) *Economists' Voice* Art 3, available at <http://www.bepress.com/cgi/viewcontent.cgi?context=ev&article=1210&date=&mt=MTE5NzEyOTAzMA==&access_ok_form=Continue>.

[33] In fact, the Montreal Protocol was amended at London in 1990 to speed up the timetable for phasing out ozone depleting substances. The London Amendments, which entered into force in November 1992, called for zero production and consumption of regulated ODSs by 2000. The text of the London Amendments are available at <http://ozone.unep.org/Ratification_status/london_amendment. shtml>. Additional amendments were agreed to in Copenhagen (1992), Montreal (1997), and Beijing (1999). For brief introductions to each of these amendments, *see, e.g.*, <http://www.iisd.ca/process/ozone_regime_intro.htm>.

[34] *See* Rene Bowser, 'History of the Montreal Protocol's Ozone Fund' (1991), 14 *Intl Env. Rep.* 636; Cass R. Sunstein, 'Montreal Versus Kyoto: A Tale of Two Protocols' (Aug 2006) University of Chicago Public Law and Legal Theory Working Paper No. 136, available at <https://www.law.uchicago.edu/academics/publiclaw/136.pdf>.

force on 1 January 1989, after it was ratified by 11 parties representing at least two-thirds of global consumption of regulated ODSs. By May of 1989, 36 countries had ratified the Protocol.[35]

The ultimate measure of success, of course, is not the agreement itself, or its ratification, but its actual effect on the global production and consumption of ODSs. On that measure, the Montreal Protocol has indeed been a success.[36] According to the UN Secretary General,[37] by 2004 global production and consumption of regulated ODSs had declined by more than 90 percent. The ozone hole above Antarctica is shrinking and is expected to disappear entirely by the middle of this century.[38] According to one cost-benefit analysis, measures to protect the stratospheric ozone layer (including subsequent adjustments and amendments to the Montreal Protocol) were expected to provide global net benefits of more than €2 trillion through 2060.[39] No wonder, then, that the framers of the UNFCCC and Kyoto Protocol sought to emulate the ozone treaty process when the international community's attention turned to climate change.

B. Applying the Framework-Convention-and-Protocol Model to Climate Change

Climate change was always going to be a difficult and contentious issue for the international community to resolve. As with efforts to protect the ozone layer, climate change is a global issue, requiring the participation of virtually all countries. Also like the ozone problem, climate change has been subject to substantial scientific uncertainty and controversy, providing

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[35] Morrisette, n 27, at 817.

[36] The Montreal Protocol was subsequently expanded in strengthened by the 1990 London Adjustment, the 1990 London Amendment, the 1992 Copenhagen Adjustment, the 1992 Copenhagen Amendment, the 1995 Vienna Adjustment, the 1997 Montreal Adjustment, the 1997 Montreal Amendment, the 1999 Beijing Adjustment, and the 1999 Beijing Amendment. *See* Barrett, n 6 above, at 78, Table 3.1.

[37] 'Secretary General Says Success of Montreal Protocol Protecting Ozone Layer Should Inspire Parties to Other Environmental Agreements,' Press Release SG/SM/9471, ENV/DEV/792, OBV/434, 9 Sept. 2004, available at <http://www.un.org/News/Press/docs/ 2004/sgsm9471.doc.htm>.

[38] Barrett, n 6 above, at 83.

[39] *See ibid* at 79, Table 3.2

grounds for the US and other countries to argue that actions to reduce GHG emissions would be premature. No one expected the international community to resolve climate change issues quickly and easily in a single treaty based on a short course of negotiations. Thus, it made sense that international negotiators would rely on the model provided by the Vienna Convention and Montreal Protocol. However, the issue of climate change posed special problems for the framework-convention-and-protocol model, which should have tempered expectations for success.

1. More Parties with Important Interests at Stake

Among the special problems posed by climate change was the fact that many more parties would be directly affected by a treaty regulating GHG emissions. Developing countries had relatively little at stake in the ozone negotiations, especially after a compensation fund was established to offset their costs of compliance.[40] Even if we set aside issues relating to compensation for climate change damage, developing countries are keenly interested in *increasing* energy production and consumption to facilitate economic growth. In theory, they could also be compensated to forego economic development and growth, but as a practical matter that is unthinkable; the level of required compensation would be enormous compared to the compensation required to purchase their acquiescence to the ozone accords. Because the problem of climate change implicates many more highly valued economic and political interests, climate change negotiations were always likely to be more tendentious than the ozone negotiations.

2. Countervailing Considerations: Reducing GHG Emissions While Ensuring Adequate Energy Supplies for Growth and Development

It is not just the *number* of economic and political interests involved that sets climate change apart as an issue. Unlike the ozone case, the climate change problem also involves several countervailing concerns including energy security and basic issues of economic

[40] *See* Sunstein, n 34 above, at 14.

development. At bottom, the problem of climate change is not simply about reducing GHG emissions but about reducing GHG emissions while ensuring that (a) developing countries can continue developing and (b) developed countries will not be left without adequate supplies of energy to maintain high levels of production and consumption. An environmental moralist might argue that adequate supplies of energy are irrelevant when the health of the planet is at stake, but it would be unrealistic to expect the international community to ignore economic considerations in negotiating a climate change treaty. It is precisely because the climate change issue requires a balancing of competing interests–reducing GHG emissions while ensuring adequate supplies of energy–that it constitutes perhaps the most difficult collection action problem the international community has yet confronted.

3. No Affordable and Reliable Substitutes (Yet) for Fossil Fuels

An even more significant difference between the ozone case and the climate change case is the lack of reliable and cost-effective substitutes in the pipeline (no pun intended) to replace fossil fuels, which make up the lion's share of global GHG emissions. Earlier we saw that international markets were able to reduce ODS consumption by 90 percent within less than two decades at fairly low social cost because effective substitutes were readily available at reasonable prices and without the need for wholesale changes in infrastructure (for instance, non-ODS-based refrigerants worked in existing appliances). The same cannot be said, at least not for the near future, for replacing GHG emissions from fossil fuels. Currently feasible production levels of low-carbon energy substitutes could not possibly compensate for large-scale reductions in fossil fuel use.

Lately, attention has focused on the potential of bio-fuels, such as ethanol, to replace fossil fuels, but that attention is largely misplaced. Corn-based ethanol, for example, is not a low-carbon substitute for gasoline because, given currently technologies, it takes more fossil fuels to create a gallon of ethanol than the ethanol generates. To be precise, ethanol from corn requires

29% more energy from fossil fuels to produce than the final product contains.[41] 'Ethanol contains about 76,000 British Thermal Units (BTUs) of energy per gallon, but producing that ethanol from corn takes about 98,000 BTUs. By comparison, a gallon of gasoline contains about 116,000 BTUs per gallon. But making that gallon of gas — from drilling the well, to transportation, through refining — requires around 22,000 BTUs.'[42] Because corn-based ethanol requires so much more energy than gasoline to produce, it is also much more expensive to produce. In fact, ethanol would not be available in the market today without massive government subsidies. One recent study puts the total 2006 subsidy for ethanol production in the US at $5.1 to $6.7 billion.[43] That comes to $1.05 to $1.38 per gallon of ethanol produced in 2006.[44]

In Brazil, ethanol is produced from sugarcane, which is a far more energy-efficient source than corn. Sugarcane-based ethanol produces 8 times more energy than is required to produce it (a better output-to-input ratio even than gasoline). It is also much cheaper to produce than corn-based ethanol.[45] The United States does not, however, import large quantities of sugarcane-based ethanol because the government has imposed high import tariffs which make Brazilian sugarcane-based ethanol more expensive than home-grown corn-based ethanol.[46] This trade barrier indicates that ethanol policy in the US is driven not by a desire to reduce dependence on fossil-fuels but to subsidize farmers. Even if the trade barrier did not exist,

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[41] *See* 'Ethanol and Biodiesel from Crops Not Worth the Energy' (6 July 2005) *Sci Daily*, available at <http://www.sciencedaily.com/releases/2005/07/ 050705231841.htm>.

[42] Robert Bryce, 'Corn Dog: The Ethanol Subsidy Is Worse Than You Can Imagine' (19 July 2005) *Slate*, available at: <http://slate.com/id/2122961/>.

[43] *See* Doug Koplow, *Biofuels: At What Cost? Government support for ethanol and biodiesel in the United States* (Geneva: Global Subsidies Initiative of the Institute for Sustainable Development, 2006) p 51, Table 5.1, available at <http://www. globalsubsidies.org/ IMG/pdf/biofuels_subsidies_us. pdf>.

[44] *Ibid* at 52, Table 5.2.

[45] *See* Emma Marris, 'Sugar cane and ethanol: Drink the best and drive the rest' (7 Dec 2006) 444 *Nature* 670, available at <http://www.nature.com/nature/journal/v444/n7120/full/44670a.html>.

[46] *See* Colin A. Carter and Henry I. Miller, 'Why Ethanol Backfires' (17 May 2007) *Los Angeles Times*, available at <http://www.latimes.com/news/opinion/la-oe-miller17may17,0,7603395.story?coll= la-opinion-rightrail>.

surgarcane-based ethanol could not presently satisfy more than a small fraction of energy demand in the US (let alone global energy demand). According to the Sierra Club, an area the size of Wisconsin (about 41 million acres) would have to be planted with sugarcane just to replace 5% of US gasoline consumption.[47] The prospects for replacing gasoline consumption with corn-based ethanol are even worse. 'For corn ethanol to completely displace gasoline consumption in this country, we would need to appropriate all U.S. cropland, turn it completely over to corn-ethanol production, and then find 20 percent more land for cultivation on top of that.'[48]

Even assuming counterfactually that alternative fuels could be produced in sufficient quantities to replace fossil fuels, the costs of production and consumption, including infrastructure changes, would in all likelihood greatly exceed the costs of producing and using coal, oil, and natural gas. The bottom line is that substitute technologies are currently far more expensive than fossil fuels and are likely to remain so for some time to come.[49] Increasing fossil fuel taxes would help to close the gap and increase incentives for innovation, but in the absence of some unanticipated technological breakthrough it will likely be decades (at least) before the global economy can be weaned from fossil fuels without significantly reducing *net* social welfare, especially in developing countries, where energy demand is rising fastest.[50] The

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[47] *See* <http://sierraclub. org/sierra/200709/biofuelschart.pdf>.

[48] Jerry Taylor and Peter van Doren, 'Ethanol Makes Gasoline Costlier, Dirtier' (27 Jan 2007), *Chicago Sun Times*, available at <http://www.cato.org/ pub_display.php?pub_id =7308>.

[49] *See, e.g.*, Jeffrey Chow, Raymond J. Kopp, and Paul R. Portney, 'Energy Resources and Global Development' (23 Nov 2003) 302 *Sci* 1528, 1531 ('With energy choices driven by relative prices, fossil fuels will dominate energy use for many years to come.'); Vijay Vaitheeswaran, *Power to the People: How the Coming Energy Revolution Will Transform an Industry, Change Our Lives, and Maybe Even Save the Planet* (New York: Farrar, Straus, & Giroux, 2003), p 6 ('there is no immediate solution, because there is no practical alternative to oil-fired transport').

[50] International Energy Agency, *World Energy Outlook 2006* (Paris: International Energy Agency, 2006), p 1.

International Energy Agency projects that fossil fuels will remain dominant sources of energy until at least 2030.[51]

4. Lack of Significant Corporate Support

Because of the lack of affordable and available fossil-fuel substitutes, no alignment of private and public interests appears to exist in climate change negotiations. This marks an important difference between the climate change case and the ozone case, in which powerful economic interests – notably DuPont – strongly supported the Montreal Protocol out of corporate self-interest, which in that case happened to align with environmental interests and, most would argue, the global public interest. In the climate change case, manufacturers of wind turbines, among other alternative energy industries, presumably would support strict GHG regulations, but they hardly bring the financial and political clout of a DuPont.

A simple thought experiment illustrates the point. Suppose a well-heeled and politically well-connected corporation, such as General Electric, announced in 1997 that it was in the process of perfecting a proprietary,[52] clean and affordable fossil-fuel alternative, which would be ready for the market by 2002, without the need for massive infrastructure changes. Consider the affect that announcement might have had on negotiations over the Kyoto Protocol. Would the US government have pushed for more or less stringent restrictions on GHG emissions? Subsequently, would President Bush have denounced the treaty in an effort to prevent its international ratification? At the very least, the existence of private commercial interests supporting international regulation of GHG emissions would have increased US government

[51] *Ibid.*

[52] By 'proprietary,' I mean a product in which it could assert and enforce intellectual property rights to capture a good deal of producer surplus, in the absence of which innovators are unlikely to bring new technologies to market. However, Intellectual property rights are not always necessary to secure provision of a global public good; Jonas Salk never patented his polio vaccine, which, through a massive international inoculation effort, eradicated that disease. *See* Barrett, n 6 above, at 17. However, corporations, unlike scientists like Jonas Salk, typically do not possess motivations unrelated to profit. As we saw in the case of the ozone accords, that is not necessarily a bad thing.

support for a strong Kyoto Protocol and reduced the likelihood of a subsequent withdrawal of that support. On the other hand, it is conceivable that US corporate interest in the Kyoto Protocol would have inclined other countries oppose the treaty, in order to protect the interests of their own petro-chemical industries.

5. Winners and Losers: The Distribution of Climate Change Costs

Finally, the fact that some countries are likely to suffer far more than others from climate change complicates negotiations. As we saw earlier, by the time the Montreal Protocol was signed, most parties were convinced that depletion of the ozone layer was truly a *global* problem, creating significant risks for *all* countries. The same cannot be said, even today, of climate change. The scientific basis of anthropogenic climate change is now well established, but substantial scientific uncertainty persists with respect to the effects of climate change, and those effects are not expected to be uniform throughout the world. Some countries are expected to suffer little or even benefit on net from moderate increases in global mean temperatures,[53] creating a significant impediment to successful collective action.

C. The UNFCCC

In the UNFCCC, developed countries committed themselves to mitigating GHG emissions "with the aim of returning individually or jointly to their 1990 levels."[54] But the UNFCCC's main objective, specified in Article 2, was to provide a framework for the adoption of legal instruments that would stabilize concentrations of GHGs in the atmosphere so as to 'prevent' dangerous anthropogenic interference with the climate system. Article 2 further calls

[53] *See, e.g.*, William D. Nordhaus and Joseph Boyer, *Warming the World: Economic Models of Global Warming* (Cambridge, Mass.: MIT Press, 2000) p. 91, Table 4.10; Richard S.J. Tol, Thomas E. Downing, Onno J. Kuik, and Joel B. Smith, 'Distributional aspects of climate change impacts,' *Global Environmental Change* (Oct 2004) 14(3): 259-72; Thomas C. Schelling, 'What Makes Greenhouse Sense?' (2005) 38 *Ind L Rev* 581, 586.

[54] UNFCCC, Art. 4.2.

for stabilization to occur 'within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.' The rest of the Convention in essence obligates the parties to cooperate in further negotiations to accomplish the objectives set forth in Article 2.

Article 3 begins with a general statement of principles, including in paragraph 3 that 'precautionary measures' should be taken 'to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects.' Paragraph 5 of Article 3 requires the parties to cooperate in building adaptive capacity of developing country parties, 'enabling them better to address the problems of climate change.' Most importantly, Article 3, paragraph 3 provides that scientific uncertainty should not be used as an excuse for postponing actions to deal with threats of 'serious or irreversible damage.'

Building on the principles set out in Article 3, Article 4 of the UNFCCC imposes more specific 'commitments' on the parties, including: collecting and reporting annual inventories of GHG emissions; preparing national or regional GHG mitigation plans; cooperating in the development, diffusion and transfer of mitigation technologies; and preparing for adaptation, *e.g.*, by adopting plans to control coastal flooding and protect agricultural lands from droughts and desertification. Like the Vienna Convention on Protection of the Ozone Layer, Article 4 of the UNFCCC requires cooperation in joint scientific research and sharing of research to improve understanding of climate change, its causes, effects, and response strategies. Paragraph 2 of Article 4 obligates developed countries to adopt actual GHG mitigation 'plans' to demonstrate that they are taking the lead in efforts to stabilize the climate. Although the UNFCCC imposed no substantive regulatory standards on those plans, the developed countries were obliged to make regular progress reports on their mitigation plans to the Conference of the Parties (COP). But those developing-country commitments are only binding if developed countries fulfill their own mitigation plan obligations. In addition, Article 4, paragraph 8 expressly commits the developed countries to assist developing countries to meet climate change adaptation requirements through funding and technology transfers.

The rest of the UNFCCC basically mimics the administrative provisions of the Vienna Convention, establishing a Secretariat to facilitate the exchange of scientific information and to

schedule meetings of the COP, at which procedures could be adopted and, hopefully, agreements reached on substantive Protocols to the Framework Convention. In view of scientific uncertainties that surrounded the issue of climate change in the early 1990s, Article 9 of the UNFCCC established a 'Subsidiary Body for Scientific and Technological Advice,' to oversee the work of the IPCC, which was created in 1988 by the World Meteorological Organization.[55] Article 14 established mechanisms for resolving disputes that might arise among the parties, and Articles 15 -18 provided procedures for amending the UNFCCC and adding binding Protocols. Finally, Article 23 provided that the UNFCCC would enter into force on the nineteenth day after ratification by the fiftieth party. That occurred on March 21, 1994.

Like the Vienna Convention on Protection of the Ozone Layer, the UNFCCC established only a skeleton of a regulatory regime for climate change. Like a building under construction, the framework was vitally important but the ultimate value of the climate change regime would depend on how it was finished. To date, the structure remains unfinished.

D. The Kyoto Protocol

The Montreal Protocol was adopted only two years after the Vienna Convention on the Protection of the Ozone Layer. By contrast, it took the parties to the UNFCCC nearly three times as long to adopt the Kyoto Protocol, which on any measure was weaker than its ozone counterpart. This should not be surprising given the important differences, discussed earlier, between the two cases. The scientific uncertainties and collective action problems posed by the stratospheric ozone problem were minor compared with the climate change problem.

At its signing, the Kyoto Protocol was hailed as a major achievement, and practically speaking it may have been the best treaty for which the international community could

[55] The work of the IPCC and its sub-units since the early 1990s has greatly improved our understanding of climate science and climate modeling by leaps and bounds. The IPCC released its first assessment report in 1990. That report paved the way for the adoption of the FCCC at Rio in 1992. The IPCC's successive assessment reports not only have provided a strong scientific basis for action on climate change, but have helped to galvanize popular support for action. Because of the great social value of its work products, the IPCC was co-recipient (with Al Gore) of the 2007 Nobel Peace Prize.

reasonably have hoped at that time. But, frankly, the mitigation goals it set were modest, even in light of contemporaneous understanding of the climate change problem. Those rather meager goals were to be achieved by elaborate, technically challenging, and administratively expensive mechanisms, which were adopted (at the behest of the United States, in the case of emissions trading, and Brazil, in the case of the Clean Development Mechanism) without a great deal of discussion of their relative merits, let alone a full-blown comparative institutional or cost-effectiveness analysis. Meanwhile, issues of adaptation, which were central to the UNFCCC, were not even on the table. In short, the Kyoto Protocol is a slap-dash agreement, reflecting (not surprisingly) the lowest-common denominator of party interests, the chief value of which was merely to prove that the parties were making progress, however meager, toward a fully-fledged international climate change regime.[56]

The Kyoto Protocol establishes two classes of Parties. Annex I parties are developed countries; and Annex II parties are less developed countries (or LDCs). The main difference between the two classes is that only Annex I parties have legally binding limits on their GHG emissions. Annex II countries, which include two of the world's four largest GHG emitters, China and India, can increase emissions at will. The countries themselves–not economic enterprises within them–are legally responsible for meeting the limits. After defining various terms of art in Article I, the Protocol sets forth substantive requirements and means of achieving them. Article 2 calls on the Annex I parties to, among other things, enhance energy efficiency, promote forests and other carbon 'sinks,' research new low- or zero-carbon energy technologies, reduce subsidies to GHG producers and emitters, and cooperate with other parties in meeting the Protocol's objectives. Significantly, section 3 of Article 2 requires Annex I parties to minimize the 'adverse effects' of meeting Kyoto obligations, including effects on international trade that might have negative economic impacts for other countries.

Article 3 commits Annex I parties not to exceed their assigned emissions limits, which in the aggregate are designed to reduce global emissions of GHGs by approximately 5% below 1990 levels with a 2012 deadline (the date on which the Kyoto Protocol expires). Because Annex I countries could not agree on a common emissions reduction goal, different countries negotiated

[56] For an even more pessimistic assessment of the Kyoto Protocol, *see* Victor, n 6 above.

various targets through hard bargaining. The United States agreed to reduce its emissions by 7% and Canada by 6%. The EU and its member countries agreed to reduce emissions by at least 8% below 1990 levels. EU member states acquiesced in this relatively ambitious target after the EU promised to create an 'EU Bubble,' which is specifically authorized under Article 4, to share emission reductions among member states. Within the bubble, some poorer member states such as Ireland and Portugal, are allowed to increase their emissions (despite the express limitations published in Annex B of the Kyoto Protocol), while other, wealthier member states commit to even greater emissions reductions.[57]

The Kyoto Protocol authorized some Annex I countries to increase their GHG emissions, for instance Norway by 1%, Iceland by 10%, and Australia by 8%. Russia, the Ukraine, and New Zealand committed to zero increase in 1990 emissions levels. This was, in effect, a huge subsidy for Russia and the Ukraine, which experienced substantial reductions in GHG emissions during the 1990s, while their economies struggled to transition from socialism to free markets. In effect, the zero-increase emissions standard left those two countries with tons of excess emissions allowances, which they could sell, pursuant to the Kyoto Protocol's emissions trading schemes (discussed below), to other countries in exchange for much-needed cash. The purchasing country, in exchange, would receive a higher emissions quota. But the trade would not reflect any actual reduction in emissions in any country. This has become known among climate change analysts as the problem of 'hot air.'

All Annex I members were to 'have made demonstrable progress' toward achieving their mitigation targets by 2005. As for how the targets are to be met, Article 3 provides some flexibility. For example, sections 1, 10 and 11 of Article 3 expressly contemplate emissions trading between two or more Annex I countries. Section 3 of Article 3 expressly allows for offsetting emissions by the use of carbon sinks, including forests. On the other hand, section 7 requires that emissions from deforestation (that is, the destruction of carbon sinks) are to be included in calculating net emissions.

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[57] *See* Clare Breidenich *et al*., 'The Kyoto Protocol to the United Nations Framework Convention on Climate Change' (1998) 92 *Amer J Int'l L* 315, 321.

Article 4, along with Article 6, creates the 'Joint Implementation' (JI) program, which allows parties to fulfill their Article 3 commitments through joint programs and projects, beyond emissions trading, so long as such joint programs and projects lead to aggregate emissions reductions in accordance with Annex B. The Protocol secretariat must be notified of the terms of JI projects.

Article 5 is the first provision in the Kyoto Protocol to focus at all on issues of implementation and compliance. It requires that all Annex I parties have in place national systems for 'estimation' of anthropogenic GHG emissions prior to 2008. Guidelines for estimating national emissions were to be established in accordance with IPCC practice, but the precise methodologies were left to be determined at a subsequent meeting of the COP.

Article 6 fleshes out the emissions trading program authorized in Article 3 and the JI program authorized in Article 4. However, Article 6 does not add much substance. It simply specifies that 'further elaborate guidelines for the implementation' of emissions trading between Annex I parties, 'including for verification and reporting,' should be established by the COP 'as soon as practicable.' In this article, as in Article 5, the parties to the Kyoto Protocol postponed the most difficult, but also arguably the most important, issues of compliance monitoring and enforcement. However, Article 7 takes some steps toward a compliance regime by requiring the parties to communicate annual emissions inventories to the COP, which under Article 8 was to establish expert review teams to evaluate the information. This was at least a small step toward rendering the Kyoto Protocol enforceable. However, as with the guidelines for implementing the mandates of Articles 5 and 6, the evaluative criteria to be used by the expert review teams were left for subsequent determination by the COP.

The first quasi-substantive provision of the Kyoto Protocol that applies to both Annex I and Annex II countries is Article 10.[58] That article recognizes the 'common but differentiated responsibilities' of the Annex I and II parties, and calls on all parties to take reasonable and cost-

[58] I refer to this provision as 'quasi-substantive' because it seems to call on all parties to create national programs for cost-effective GHG emissions reductions, but it expressly disavows imposing actual commitments on Annex II parties and purports only to reiterate the commitments imposed on Annex I parties under Article 4.

effective steps, consistent with those responsibilities, to reduce GHG emissions. Significantly, Article 10 is the only provision of the Kyoto Protocol that even mentions the issue of adaptation, calling on all parties to '[f]ormulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures ... to facilitate adequate adaptation to climate change.' Section (c) of Article 10 calls for cooperation in the development and diffusion, including to developing countries, of 'environmentally sound technologies.' Other sections call for broader cooperation in scientific and technical research, as well as education and training programs. In recognition of the financial problems LDCs might have in fulfilling the various mandates of Article 10, Article 11 requires developed countries to provide them with financial assistance.

Article 12, which Brazil promoted, creates the so-called 'Clean Development Mechanism' (CDM), which in essence is an extension of Kyoto's emissions trading program to Annex II parties (developing countries without binding emissions reduction targets). The CDM permits Annex I parties to engage in activities in Annex II countries so as to meet their emission reduction obligations under Annex B. To qualify, the projects have to yield '[r]eal, measurable, and long-term benefits related to the mitigation of climate change,' and any resulting emissions reductions must be certified. Article 12 expressly authorizes CDM projects to prevent emissions increases that would have occurred in the absence of those projects. The drafters did not, however, explain how such counterfactual emissions might be measured and certified.[59]

Missing from all the substantive provisions of the Kyoto Protocol are provisions for compliance monitoring and enforcement. The failure of the parties to agree about monitoring and enforcement issues is most evident in Articles 17 and 18. The former reiterates Article 3's authorization of emissions trading between Annex I parties, but does not specify any mechanisms for verifying trades or keeping track of changeable emissions quotas. Instead, it

[59] On this problem, *see, e.g.*, Michael Toman, 'Establishing and Operating the Clean Development Mechanism' (Sept 2000) Resources for the Future Climate Issues Brief No. 22, 6, available at <http://www.rff.org/Documents/RFF-CCIB-22.pdf>; A. Danny Ellerman, 'Report #42. Obstacles to Global CO2 Trading: A Familiar Problem' (Nov 1998) Massachusetts Institute of Technology, Joint Program on the Science and Policy of Climate Change, available at <http://web.mit. edu/globalchange/ www/rpt42.html>.

merely specifies that the COP 'shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading.' Likewise, Article 18 merely provides that the COP will 'at its first session' take up the issues of noncompliance and enforcement.

The remaining provisions of the Kyoto Protocol are administrative housekeeping measures, concerning meetings of the COP (Art. 13), equal voting rights of the parties (Art. 22), the use of the UNFCCC Secretariat to organize meetings and take care of other administrative details (Art. 14). Articles 9, 20, and 21 together provide a mechanism for amending or replacing the Protocol.[60] Finally, Article 25 provides that the Kyoto Protocol would enter into force 90 days after ratification by the 55th party, but only if the ratifying parties together accounted for 55% of global emissions in 1990. These conditions were met when Russia became the 55th party to ratify the Kyoto Protocol in November 2004.[61]

E. Post-Kyoto Negotiations

The COP has been meeting annually since the Kyoto Protocol was signed. Those meetings have made only modest progress towards filling in the Protocol's gaps. For instance, at the first post-Kyoto meeting was held at Buenos Aires in 1998, the parties adopted a 'vague resolution' covering several issues under the UNFCCC and Kyoto Protocol, including financial assistance, technology transfers to developing countries, and the JI mechanism.[62] In April 1999, the COP met in Bonn, Germany for what was labeled a 'Technical Workshop on Mechanisms.' The goal was to provide a forum in which the parties could openly discuss difficult and contentious issues under the Kyoto Protocol, such as the setting of emissions baselines and verification and reporting of emissions reductions, emissions trades, and CDM projects,[63]

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[60] For a more complete overview of the Kyoto Protocol, *see, e.g.*, Breidenich *et al*., n 57 above.

[61] *See* 'Kyoto Ratification' (6 Nov 2004) *Washington Post* A22, available at <http://www.washingtonpost.com/wp-dyn/articles/A29459-2004Nov5.html>.

[62] Sophia Tsai, 'UNFCCC Technical Workshop on Mechanisms of the Kyoto Protocol' (1999) *Colo J Int'l Envtl L YB* 220, 221.

[63] *Ibid* at 221-2.

without any pressure to immediately adopt binding annexes or amendments to the Protocol. Relieved of that pressure, the parties were able to more forthrightly address issues of implementation, monitoring and enforcement. For example, they discussed alternative mechanisms for validating CDM projects, including comparative administrative costs, and how JI projects required some form of external verification, even though the Kyoto Protocol itself did not provide for it.[64] 'While no formal conclusions resulted from the Workshop, many participants praised it as 'a step forward in the development of the Kyoto Protocol."[65] It was, perhaps, a small step forward, but more than two years after the Protocol was signed, virtually all of its original gaps remained unfilled.

The informal discussions in Bonn in 1999 were expected to lead to more concrete actions and finally did at the COP meeting in Marrakech in 2001. Prior to that meeting, the United States withdrew from the Kyoto Protocol in a way that antagonized many US allies and, ironically, may have improved the likelihood that the Protocol would take effect.[66] If the Bush Administration calculated that US repudiation would 'kill' the Kyoto Protocol, it was sorely mistaken. The withdrawal of the world's leading emitter of GHGs apparently caused the COP to work harder at Marrakech to reach agreement on contentious issues in order to ease the way for ratification by the remaining parties.[67] To be sure, Kyoto became an even weaker treaty, as the COP was forced to make additional concessions to large emitters, including Russia and Japan, to gain their support, which became absolutely critical following the US government's repudiation of the Protocol.[68] Russia, in particular, held out for massive increases in its allocation,[69] exacerbating

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[64] *Ibid* at 222-6.

[65] *Ibid* at 229.

[66] *See, e.g.*, Worldwatch Institute, *State of the World 2002* (New York: W.W. Norton & Co., 2002), p 25.

[67] *Ibid*.

[68] *See, e.g.*, Matthew Vespa, 'Climate Change 2001: Kyoto at Bonn and Marrakech' (2002) 29 *Ecol LQ* 395, 417 (noting that Japan, Russia, Canada and Australia used their leverage at Marrakech to weaken the compliance system and other Kyoto mechanisms).

[69] *See* Donald Goldberg and Katherine Silverthorne, 'The Marrakech Accords' (Jan 2002) 5 Sustainable Development, Ecosystems, and Climate Change Committee Newsletter, available at <http://

the problem of 'hot air,' which remains one of the Kyoto Protocol's most troublesome defects.[70] However, such concessions might well have been necessary even if the US had remained a party because the US Senate was never likely to ratify the Protocol.[71] So, Japanese and Russian ratification still would have been crucial for the Protocol to take effect, under the terms of Article 25. If, however, the US had been at the negotiating table in Marrakech (instead of observing from the back of the room),[72] it might have exerted its influence to obstruct the concessions that paved the way for ratification. Ironically, the Kyoto Protocol might not be in effect today, had the US not repudiated it. That, of course, is speculative. What is not speculative is that US played no role in the Marrakech negotiations, and President Bush's condemnation of the Kyoto Protocol did not have the desired nullifying effect.

Several provisions of the 'Marrakech Accords'[73] added content to the Kyoto Protocol's mitigation policies.[74] Most important among them were the eligibility requirements for participation in the Kyoto Protocol's various 'flexibility mechanisms,' including JI and CDM, and the creation of an incipient compliance regime. In order to participate in the flexibility mechanisms, Annex I parties must have in place: an emissions inventory to use as a baseline for

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www.abanet.org/environ/committees/climatechange/newsletter/jan02/goldberg.html> (discussing how Russia held up the Marrakech Accords with demands that the COP double its allocation of carbon allowances for forest management).

[70] The problem of 'hot air' will be discussed further in the next section.

[71] By contrast, the Senate ratified the Montreal Protocol unanimously because of the different structure of incentives relating to ODS emissions and their control. *See* Cass R. Sunstein, 'The Complex Climate Change Incentives of China and the United States' (July 2007, Rev Aug 2007) Joint AEI-Brookings Joint Center for Regulatory Studies Working Paper 07-14, 6-7.

[72] The US sent a contingent to Marrakech, but only as observers; they did not participate in negotiations.

[73] Available at <http://unfccc.int/cop7/>. Goldberg and Silverthorne, note 69 above, provide a useful summary of the accords.

[74] Other provisions of the Marrakech Accords relating to adaptation policies set forth in the UNFCCC are discussed *infra* in Section III.

determining compliance with emissions limitations; a national system for estimating emissions and reductions in emissions; and a national registry for keeping track of trades and quotas.

The COP also addressed the issue of carbon sinks ('land use, land use change, and forestry') at Marrakech. Annex I countries were allocated a specific number of tons of 'carbon uptake' that could count towards their Kyoto targets. However, the parties at Marrakech limited the use of carbon sinks in the CDM program to afforestation and reforestation projects. Unfortunately, the parties could not agree on several of the most difficult questions relating to carbon sinks, including the establishment of baselines (*i.e.*, what the emissions profile would be in the absence of the project), definitions of what counts as 'afforestation' or 'reforestation,' problems of impermanence (reforested areas can, of course, be re-cut) and leakage (even an uncut forest will eventually decay and emit carbon dioxide).

The Kyoto Protocol's most serious gap was in the area of compliance and enforcement. The COP at Marrakech began to fill that gap. It established a 'Compliance Committee' of 20 members, which was to meet twice a year to develop compliance and enforcement policies which, hopefully, could gain the assent of all the parties. Two sub-groups of the Committee, the 'Facilitative Branch' and the 'Enforcement Branch,' were charged with, respectively, promoting compliance and detecting and punishing noncompliance. The COP established a fairly detailed set of enforcement procedures, including an appeals process; and, most importantly, it introduced substantial penalties for noncompliance. If a party's emissions exceed the specified amount during the compliance period, that party's emissions allowance is reduced by 30 percent for the subsequent compliance period. In addition, the party is required to develop and submit a 'compliance plan' to the 'Enforcement Branch,' and is ineligible to participate in emissions trading until it comes into compliance. The effectiveness of these penalties remains questionable, however, in light of the fact that any party can withdraw from the Kyoto Protocol at any time, without penalty, and then start emitting however much GHG they like.

To facilitate the compliance regime, the Marrakech Accords required, but did not define 'adequate monitoring.' As noted above, Annex I parties are only allowed to participate in emissions trading if they have a sound national emissions inventory, but the Protocol does not establish clear standards for assessing whether a party's inventory is or is not accurate. However, if it is somehow determined that a party's emissions inventory is not accurate, the inventory must

be adjusted. Moreover, the Marrakech Accords create an elaborate–some might say Byzantine–international bureaucracy and accounting system for all the 'flexibility mechanisms,' including a 'transaction log' to record all transfers of emissions credits, 'executive boards' to certify CDM transactions, 'accreditation teams' which advise 'accreditation panels' on the bona fides of private entities ('designated operational entities') seeking to participate in CDM projects, and 'designated national authorities' (DNAs) to approve CDM projects.

Since the 2001 Marrakesh Accords, the COP has focused on implementation of the Kyoto Protocol, while negotiating to extend the Protocol beyond its initial 2012 deadline. At its first post-ratification meeting in Montreal in 2005, the COP adopted an 'action plan' for increasing the stringency of the Protocol's mitigation regime while extending its life. Meanwhile, Kyoto's 5-year compliance period begins in 2008, and parties have been preparing to meet their commitments. Some emissions trades, including several projects under the CDM, have been registered. For example, in 2007 Evolution Markets, Inc. brokered a CDM transaction between the Government of Luxembourg and Biothermica Energy, a Canadian company that operates a land-fill gas-to-energy project in El Salvador. Biothermica agreed to sell 325,000 'certified emissions reductions' to the Government of Luxembourg between 2006 and 2012, which will offset GHG emissions in Luxembourg.[75] The European Union has put into effect its own internal trading program, which promises GHG emissions reductions in excess of its Kyoto obligations.[76] So far, however, neither Kyoto nor any domestic GHG reduction policy has accomplished much. In fact, carbon dioxide emissions increased by 19 percent between 1990 (Kyoto's base year) through 2003.[77] The contrast with the success of the Montreal Protocol is stark. As Scott Barrett explains, '[f]rom 1985 to 1990–a period of 14 years–international cooperation to protect the

[75] *See* <http://www.evolutionmarkets.com/scripts/pr_full.php?pr=65>.

[76] *See, e.g.*, A. Denny Ellerman and Barbara K. Buchner, 'The European Emissions Trading Scheme: Origins, Allocation, and Early Results' (Winter 2007) 1 *Rev Envtl Econ. & Pol'y* 66; Joseph Kruger, Wallace E. Oates, and William A. Pizer, 'Decentralization in the EU Emissions Trading Scheme and Lessons for Global Policy' (Winter 2007), 1 *Rev Envtl Econ & Pol'y* 112; Claudia Kemfer *et al*., 'The Environmental and Economic Effects of European Emissions Trading' (Nov 2005), German Institute for Economic Research Discussion Paper 533.

[77] Barrett, n 6 above, at 92.

ozone layer achieved almost as much as was technically possible. From 1992 to 2006–another period of 14 years–international efforts to limit global climate change achieved approximately nothing.'[78]

II. Resolving Collective Action Problems in Climate Negotiations

A. The Problem: How to Get Nearly 200 Countries to Agree to a More Effective Climate Treaty?

Arguments about the merits of various approaches to GHG mitigation and climate-change adaptation are more or less moot if the international community is unable to agree on a new protocol to replace Kyoto, when it expires in 2012.[79] I am not so pessimistic as to assume that no new agreement will be reached (alternatively, Kyoto could be extended and, perhaps, expanded); rather, my concern is with reaching an agreement that improves substantially upon the flawed Kyoto Protocol. This concern has less to do with the state of climate science than the strategic politics of climate change. It is incumbent on anyone who advocates a substantive and effective international climate change accord to confront the collective action problems that inevitably will arise–indeed, they have arisen already.

As noted earlier, climate change is likely to create winners (at least relatively speaking, and perhaps nominally) as well as losers among nations.[80] Those who expect to 'win' obviously have different incentives in climate change negotiations from those who expect to 'lose.' This is not the place for an extensive introduction to game theory or the myriad ways that theory might

[78] *Ibid* at 100.

[79] I say 'more or less' moot because, even in the absence of a global climate change regime, individual countries or regions might implement their own regimes, which may be more or less well coordinated. For example, the European Union already has adopted an ambitious emissions trading program, which imposes quotas in excess of the EU-countries' obligations under the Kyoto Protocol. For such national or regional regimes, arguments about the merits of this or that mitigation or adaptation strategy would still matter.

[80] *See* n 53 above.

be applied in the context of climate change negotiations.[81] One does not need a formal game theoretic model, however, to recognize the problem.[82] It is, however, important to recognize that the extent of the collective action problem does not depend solely on the number of players, although most analysts would predict higher transaction costs for reaching agreement among a larger number of players. That may well be the case in climate change negotiations, but it arguably was not the case in negotiations over the ozone accords. Had the US and UK had been the only two participants in those negotiations, a favorable outcome could have been less likely because the divergent interests of the two players might have canceled each other out. Arguably, the successful ozone negotiations were facilitated by the participation of many other countries (that is, players) with less at stake, including other member states of the EU, which joined the US position, rendering the UK's position untenable, and forcing a political accommodation. As already noted, however, in the climate change negotiations, many more countries have a significant stake in the outcome, and there are countervailing considerations that did not exist in the case of the ozone negotiations.

Anytime some members of the international community expect to win while others lose, negotiating treaties that would distribute gains and losses while balancing conflicting imperatives, such as climate stability and energy security, will be problematic because of the lack of any obvious equilibrium solution or focal point toward which all parties are likely to gravitate. In such cases, the result of negotiations will be, at best, agreement around a lowest common denominator, *e.g.*, something like the Kyoto Protocol.

The key to gaining agreement on a substantial and effective international climate change agreement is to better align the currently disparate incentive structures of the players. Recently, Cass Sunstein has recommended one way of doing this: if the international community wants the cooperation of countries, like Russia, that expect (rightly or wrongly) to benefit from moderate and gradual climate change as well as countries, like the US and China, that do not expect to

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[81] Among the most accessible introductions to game theory is Avinash K. Dixit and Barry J. Nalebuff, *Thinking Strategically* (New York: W.W. Norton, 1993). For applications of game theory to climate change, *see* Barrett, n 15 above, and Barrett, n 6 above.

[82] *See* Section II.B.

suffer much harm from climate change, then the international community should pay those countries to play.[83] In fact, the international community has already "paid" both Russia and China. As we saw earlier, the parties to the Kyoto Protocol bought Russia's participation with a generous emissions quota that virtually ensures that Russia will gain financially from its participation. China's participation, meanwhile, was bought by the decision not to impose mandatory emissions reduction requirements on developing countries, including China, plus various provisions of the Kyoto Protocol that require developed country assistance to developing countries, including China. The United States did not receive any subsidy to gain its allegiance to the treaty, which was not otherwise in its perceived economic self-interest; so, not surprisingly, it withdrew from the Kyoto Protocol. While positive political-economic theory might well suggest that the Kyoto Parties should 'buy' US participation, there would understandably be deep-seated reluctance among other Kyoto parties to do so on ethical grounds, given America's dual status as the richest country on earth and the country that has contributed most to the problem of anthropogenic climate change. Moreover, if the US received in-kind or financial subsidies, incentives would be created for other countries, especially larger emitters that do not expect to suffer high costs from climate change, to hold-out for their own side-payments. Having the main beneficiaries of climate stabilization, mainly poor countries, subsidize the participation of richer countries that likely to suffer less harm from climate change does not seem either just or a likely solution to the collection action problem posed by climate change.

There are, however, a few other possible strategies for better aligning incentives to achieve collective action. They are addressed in the next two subsections.

B. Potential Climate Catastrophes as a Focal Point for Negotiations

1. The Utility of 'Catalytic Events' (and the Problem of Waiting for Them To Occur)

Environmentalists have long understood the political value of environmental catastrophes. In the US, a 'killer fog' in Donora, Pennsylvania in 1948 spurred public support for federal and parliamentary intervention in what was previously the state and local domain of air

[83] Sunstein, n 71 above, at 3.

pollution control.[84] Oil spills off the coast of Santa Barbara, California and fires on the Cuyahoga River in Ohio, both in 1969, had a similar impact on the federalization of water pollution control.[85] The publication in 1962 of Rachel Carson's *Silent Spring*[86]– the classic (if flawed) account of the effects of pesticides on songbird populations and aquatic ecosystems–served as a catalyst for public demand to regulate chemicals and protect endangered species. Since Congress enacted the Endangered Species Act in 1973,[87] political support for the Act has been sustained in part by advertising campaigns from environmental groups that focus not on obscure plant species like the Dwarf Lake Iris (found in Wisconsin, Michigan, and Ontario, Canada) or ugly insect species like California's Delta Green Ground Beetle, though such species are fairly representative of the current Endangered Species List. Rather, environmental campaigns focus on so-called 'charismatic mega-fauna'–large and impressive animals like grizzly bears and eagles–that capture the public's sympathy.[88] At the international level, we saw in Section I that negotiations on the Montreal Protocol were facilitated by the discovery of the ozone 'hole' above Antarctica.[89]

Climate change has been a difficult issue for individuals to grasp in large part because its effects are mostly in the future and difficult to pin down with any precision. Was anthropogenic climate change responsible or not for Hurricane Katrina or the December 2004 tsunami in the

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[84] *See, e.g.*, Robin Kundis Craig, *Environmental Law in Context: Cases and Materials* (St. Paul, Minn: Thompson West, 2005), pp 521-2.

[85] For more on these and other 'catalytic' events leading up to the enactment of the federal Clean Water Act in 1972, *see* Richard J. Lazarus, *The Making of Environmental Law* (Chicago: University of Chicago Press, 2004), pp 58-9.

[86] Rachel Carson, *Silent Spring* (New York: Fawcett Crest, 1964).

[87] 16 U.S.C. §§ 1531-1544.

[88] *See, e.g.,* Jason Scott Johnston, 'The Tragedy of Centralization: The Political Economics of American Natural Resource Federalism' (2002) 74 *U.Colo. L.Rev*. 487, 565-66 (describing the use of "charismatic megafauna" to promote endangered species protection).

[89] Scott Barrett suggests a second possible catalytic event in the case of the Montreal Protocol: US support for the Protocol may have been strengthened when, a month before the Protocol was signed, then-President Ronald Reagan had skin cancer removed from his nose. Barrett, n 6 above, at 76-7.

Pacific? Contrary to widespread public opinion, neither of these events can be attributed to climate change.[90] In fact, no specific weather or geological events (to date) can be attributed with a high degree of confidence to rising global mean temperatures, although the rising rate at which polar sea ice is melting may prove to be an exception.[91]

In addition to the absence of available effects that are incontrovertibly *caused* by climate change, many individuals also have a difficult time comprehending why it should matter to them that global mean temperatures are expected to rise by perhaps a few degrees over the next 100 to 200 years. Spending public funds today solely to protect future generations is a difficult argument to sell, especially when most economists assure us that those future generations, on every continent, will be materially better off than current generations. However, low-probability, high-magnitude climate change 'catastrophes' could reduce the rate of growth in consumption or even result in negative growth rates.[92]

Already, climate change seems to be having some effects that might serve as catalysts for near-term action. Recently, for example, the media have been reporting on the plight of polar bears – an example of 'charismatic mega-fauna' if ever there was one – which are threatened with possible extinction as their habitat literally melts away.[93] According to the National Snow

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[90] *See, e.g.*, Sunstein, n 6 above, at 59 (noting that 'evidence linking Hurricane Katrina with climate change is contested and disputable'); Daniel Sarewitz and Roger A. Pielke, Jr., 'Rising Tide: The Tsunami's Real Cause' (17 Jan 2005) *New Republic* 10, available at <http://www.cspo.org/ourlibrary/articles/RisingTide.htm> (denying any connection between the tsunami that wreaked havoc in the Pacific in December 2004 and climate change);

[91] *See* 'Special Online Collection: Climate Change − Breaking the Ice' (24 Mar 2006) *Sci,* available at <http://www.sciencemag.org/sciext/ice/>.

[92] *See, e.g.,* Martin Weitzman, 'A Review of the Stern Review on the Economics of Climate Change' (2007) 45 *J Econ Lit* 703, 710; Martin Weitzman, 'On Modeling and Interpreting the Economics of Catastrophic Climate Change' (14 Jan 2008) working paper available at <http://www.economics.harvard.edu/faculty/weitzman/files/modeling.pdf>.

[93] *See, e.g.*, Eric V. Regehr *et al*., 'Polar Bears in the Southern Beaufort Sea I: Survival and Breeding in Relation to Sea Ice Conditions, 2001-2006' (2007) Administrative Report, U.S. Department

and Ice Data Center at the University of Colorado, 'if current rates of decline in sea ice continue, the summertime Arctic could be completely ice-free well before the end of this century.'[94] By 2050, two-thirds of the global polar bear population "would" (not could) be lost.[95] The possible extinction of polar bears from large segments of their natural range is certainly a prospect that could catalyze popular support for stronger action to stabilize the global climate. The problem, however, is that catalytic events usually occur *before* the public demands action to deal with the underlying problem. As we saw earlier, the Montreal Protocol was signed only after the discovery of the ominous ozone hole over Antarctica. It remains to be seen whether observations of more rapid melting of polar sea ice (which has happened in cycles in the past), along with the mere prospect of potentially dramatic consequences for polar bear populations, can focus popular opinion and lead to stronger international action to reduce GHG emissions.

2. Focusing Due Attention on Potential Climate Catastrophes (Without 'Doomsaying')

Environmentalists are prone to overplaying the catastrophe card, making dire predictions of doom and gloom that cannot withstand analytical scrutiny or the test of history. Among the most infamous of 'doomsayers' is Paul Ehrlich, an ecologist from Stanford University, who has variously predicted the starvation of hundreds of millions of people in the 1970s and 1980s because of over-population,[96] a decline in the US life expectancy to 42 years by 1999 because of

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of the Interior, U.S. Geological Survey, available at <http://www.usgs.gov/newsroom/special/polar_bears/docs/regehr.pdf>.

[94] University of Colorado, National Snow and Ice Data Center, 'Sea Ice Decline Intensifies' (28 Sept. 2005), available at <http://nsidc.org/about/contacts/directions.html>. The extent of summer sea ice is subject to frequent significant and natural fluctuations, so future trends are difficult to predict with accuracy. However, recent trends substantially exceed other observed fluctuations. *See* Marika Holland *et al*., 'Future abrupt reductions in the summer Arctic sea ice' (2006), 33 *Geophys Res Letters* L23503.

[95] Steven C. Amstrup, Bruce G. Marcot, and David C. Douglas, 'Forecasting the Range-Wide Status of Polar Bears at Selected Times in the 21st Century' (2007) Administrative Report, US Department of the Interior, US Geological Survey, p 9.

[96] Paul R. Ehrlich, *The Population Bomb* 5 (Binghampton, NY: Sierra Club, 1969).

pesticide poisoning,[97] and 'food riots' in the US, which might lead the President to dissolve Congress.[98] Ehrlich is best known for his bet with the economist Julian Simon that the prices of five commodities hand-picked by Ehrlich – copper, chrome, nickel, tin, and tungsten – would rise between 1980 and 1990. In fact, the prices of all five commodities dropped and Simon won the bet.[99] Ehrlich's persistent mistake has been to underestimate the combination of scarcity pricing, intellectual property rights, and hard budget constraints in free markets, which together create continual incentives to improve dynamic efficiency in production, including of food.

When environmental 'doomsayers' like Ehrlich make wild and theoretically implausible predictions of doom and gloom, they do substantially more harm than good for the causes they advocate.[100] To be fair, wildly over-optimistic predictions about the end of scarcity – 'cornucopian' predictions – have been almost equally common. For example, John von Neumann – arguably one of the most intelligent humans ever to have lived – suggested in 1955 that, thanks to nuclear power, in 'a few decades hence energy may be free – just like the unmetered air – with coal and oil used mainly as raw materials for organic chemical synthesis, to which, as experience has shown, their properties are best suited.' Moreover, as some prominent politicians are found of saying about terrorists,[101] the environmental doomsayers 'only have to be right once.'[102]

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[97] Paul R. Ehrlich, 'Eco-Catastrophe'(1969) 8 *Ramparts* 24-28.

[98] Paul R. Ehrlich and Anne H. Ehrlich, *The End of Affluence* 147 (New York: Ballantine Books, 1974).

[99] *See* John Tierney, 'Betting the planet' (2 Dec 1990) *New York Times,* available at <http://query.nytimes.com/gst/fullpage.html?res=9C0CE1DA163CF931A35751C1A966958260>.

[100] John von Neumann, 'Can We Survive Technology?' (June 1955) *Fortune* 12*, reprinted in* John von Neumann 'John von Neumann on Technological Prospects and Global Limits' (March 1986) 12(1) *Pop & Dev Rev* 117, 120.

[101] *See, e.g.,* White House Office of the Press Secretary 'President Bush Delivers Commencement Address at United States Coast Guard Academy' (23 May 2007), available at <http://www.whitehouse.gov/news/releases/2007/05/20070523-4.html> ('To strike our country, the terrorists only have to be right once; to protect our country, we have to be right 100 percent of the time'); Embassy of the United States, Bagdad, Iraq, 2007 Press Releases, 'Secretary of State Condoleezza Rice to U.S. Mission Personnel in

The problem of climate change certainly has its share of 'doomsayers,' including some who would willingly accept (and impose on others) huge social costs in order to avoid even a marginal human impact on 'natural' climatic conditions.[103] But there is a line to be drawn between 'doomsaying' and due attention to admittedly improbable climate change catastrophes. This is not the place for an extensive discussion of where to draw that line. But as a first approximation, we might distinguish between 'doomsaying' and the legitimate consideration of potential catastrophes in policy analysis according to whether the predictions (1) are based on the best scientific and social-scientific information available and (2) honestly portray relevant probabilities, magnitudes of harm, and unresolved uncertainties. On these measures, Al Gore's film and book, *An Inconvenient Truth*, arguably constitutes 'doomsaying' because it focuses so heavily on worst-case scenarios, without clearly explaining their relative improbabilities – that is,

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Iraq' (17 Feb 2007), available at <http://iraq.usembassy.gov/iraq/200770217_rice_bagdad.html> ('the terrorists only have to be right once and we have to be right 100 percent of the time').

[102] For an interesting comparison of the highly divergent American responses to the respective threats of terrorism and climate change, *see* Cass R. Sunstein, 'On the Divergent American Reactions to Terrorism and Climate Change' (May 2006) AEI-Brookings Joint Center Working Paper No. 06-13, available at <http://aei-brookings.org/admin/authorpdfs/redirect-safely.php?fname=../pdffiles/phpb6.pdf>.

[103] *See, e.g.*, Robert Newman, 'It's Capitalism or a Habitable Planet: You Can't Have Both' (2 Feb 2006), *The Guardian* 33, available at <http://www.guardian.co.uk/renewable/Story/0,, 1700302,00.html> ('Tinker at the edges as we may, we cannot sustain earth's life-support systems within the present economic system'); www.climatecamp.org.uk, 'Climate Change, Capitalism, & the Camp for Climate Action,' available at <http://www. networkforclimateaction.org.uk/toolkit/outreach_ideas/materials_for_talks_and_workshops/handout_for_climatecamp_workshop.doc> ('Solving climate change requires changing society and changing our whole way of looking at the world. We need to massively cut down our energy use and to 'relocalise' our world'); George Monbiot, *Heat: How to Stop the Planet Burning* (London: Allen Lane, 2006) (arguing for a 90% reduction in GHG emissions by 2030); James Lovelock, 'The Earth is About to Catch a Morbid Fever that May Last as Long as 100,000 Years' (16 Jan 2006) *The Independent* 31, available at <http://comment.independent.co.uk/commentators/ article338830.ece> (predicting unconditionally that 'before this century is over billions of us will die and the few breeding pairs of people that survive will be in the Arctic where the climate remains tolerable')

the extent to which they deviate from mean expected damages from climate change, given the best available science underlying the IPCC's assessment reports. On the other hand, the popular success of the Gore book and film, culminating in several awards including the 2007 Nobel Peace Prize, suggest that 'doomsaying' can sometimes be an effective, if risky, strategy – some might call it propoganda – for moving policy.[104]

Some prominent economists, including Sir Nicholas Stern and Martin Weitzman – neither of whom could plausibly be labeled a 'doomsayer' – believe that most economic analyses of climate change substantially underestimate the potential for climate 'catastrophes' that could adversely effect social welfare in the future.[105] Attacking the problem in different ways – Stern by adjusting the discount rate,[106] Weitzman by improving the way integrated assessment models

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[104] Al Gore, *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (NY: Rodale Books, 2006). One court has ruled, in effect, that *An Inconvenient Truth* is as much a political film as a scientific one. In *Dimmock v Secretary of State for Education and Skills* [2007] EWHC 2288 (Admin), the Royal Courts of Justice dismissed a complaint seeking to prevent state schools in the UK from showing Gore's film for educational purposes on grounds that the schools are legally required to provide a balanced presentation of political issues. Mr. Justice Burton ruled against the plaintiff, finding that *An Inconvenient Truth* "is substantially based on scientific research and fact, albeit that the science is used, in the hands of a talented politician and communicator, to make a political statement and to support a political programme." The court acknowledged, however, that aspects of the film were "erroneous" and/or "alarmist." Importantly, Mr. Justice Burton indicated that his ruling was based in substantial part on the decision of state educational authorities to send an amended Guidance Note for teachers using the film. That amended Guidance Note stressed the political nature of the film and called on teachers to "help pupils examine the scientific evidence critically (rather than simply what is said at face value) and to point out where Gore's views may be inaccurate or departs from that of mainstream scientific opinion."

[105] Nicholas Stern, *The Economics of Climate Change* (Cambridge: Cambridge University Press, 2007) (hereinafter "*Stern Review*"); Weitzman, 'On Modeling and Interpreting the Economics of Catastrophic Climate Change,' n 92 above.

[106] The *Stern Review*, n 105 above, adopts a social discount rate of 1.4 percent, based in part on a pure rate of time preference on 0.1 percent. For a detailed assessment of the *Stern Review*'s parameter

treat the 'fat tails' of probability density functions[107] – both economists reach a similar conclusion: analysts should not ignore low-probability, high-magnitude climate events, but should incorporate them into their models. Likewise, policy makers should not ignore potential climate catastrophes but should adjust their policies to *insure* against extreme climate events, *e.g.*, by taking cost-effective steps to minimize the expected harm of risks for which probabilities are known and by intensive research efforts to reduce overall uncertainty.[108] As Weitzman points out, reasonably risk averse individuals typically respond to even low-probability risks of financial doom or death by investing some amount of resources in further information, prevention, and/or insurance.[109]

The improved treatment of potential climate change catastrophes in economic analyses creates a political opportunity for reducing the obstacles to collective action on climate change by better aligning the incentives of the parties. While climate change is generally expected to create winners and losers, the prospect of low-probability, high-magnitude climate events levels the playing field to some extent. Should such a catastrophe occur, it might affect any or every country in the world. The combination of uncertainty about the precise location and the scale of extreme events should create *some* incentive for all countries to agree on action to minimize the uncertainties, probabilities, and magnitudes of harm resulting from such events. At the very least, it should raise the lowest common denominator in climate change negotiations.[110]

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values, *see* Daniel H. Cole, 'The *Stern Review* and Its Critics: Implications for the Theory and Practice of Benefit-Cost Analysis' (forthcoming 2008) 48(1) *Nat Resources J* __.

[107] Weitzman, 'On Modeling and Interpreting the Economics of Catastrophic Climate Change,' n 92 above.

[108] Weitzman remains, however, more reluctant than Stern to recommend rapid and steep reductions in GHG emissions.

[109] Weitzman, 'On Modeling and Interpreting the Economics of Catastrophic Climate Change,' n 92 above, 23, cites to Aumann and Kurz's 'fear of ruin' coefficient, which characterizes an individual's 'attitude toward risking his fortune' in binaries lotteries. Robert J. Aumann and Mordecai Kurz, 'Power and Taxes' (1977) 199 *Econometrica* 1137.

[110] There is some possibility that greater attention to potential climate change catastrophes, even with due attention to the (im)probabilities, could freeze negotiations by generating a widespread and

C. Accounting for the Indirect or Secondary Costs of Climate Change

Even if policy makers unwisely ignored potential climate change catastrophes, the notion that climate change will create winners and losers could prove mistaken or at least exaggerated once the secondary or indirect effects/costs of climate change are considered. For example, changes in environmental conditions, including of course the climate, have always driven human and animal migration patterns.[111] If, for example, climate change causes sea levels to rise enough to inundate low-lying coastal areas and flood plains, the displaced human and animal residents of those areas will seek new homes on higher ground, where existing residents might not greet them with open arms, especially if political or ethnic boundaries are crossed.[112] In regions hardest hit by climate change, individuals and groups who are materially affected may become politically disaffected. In the absence of sufficient humanitarian assistance and economic opportunities, they could turn increasingly to crime, violence, and insurrection.

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paralyzing fear of doom. As William Ruckelshaus, former administrator of the US Environmental Protection Agency, has noted, "[t]he very act of quantifying risk tends to reify dreaded outcomes in the public mind and may make it more difficult to gain public acceptance for policy decision or push those decisions in unwise directions." Willam D. Ruckelshaus, 'Risk, Science, and Democracy' (1985), 1 *Issues in Sci. & Tech.* 19, in Theodore S. Glickman and Michael Gough, eds., *Readings in Risk* (Washington, D.C.: Resources for the Future, 1990), p. 105, 110. However, this prospect does not cause Ruckelshaus to recommend against the use of risk assessment in policy making. It simply places a premium on clear communication of the probabilities as well as magnitudes of possible harm.

[111] *See* Intergovernment Panel on Climate Change, *Climate 2001: Impacts, Adaptation, & Vulnerability Technical Summary* (2001), pp 33-4 (observing an increase in northern migration of plants, insect, and animals species as the Northern Hemisphere growing season has extended by 1-4 days because of rising global mean temperatures during the preceding 40 years); R. McLeman and B. Smit, 'Migration as an Adaptation to Climate Change' (May 2006) 76(1-2) *Climatic Change* 31; Philip E. Graves, 'Migration and Climate' (May 1980) 20(2) *J Regional Sci* 227; Louis F. Pitelka, 'Plant migration and climate change' (Sept/Oct 1997) 85(5) *Amer. Scientist* 464.

[112] *See, e.g.*, Jon Barnett and W. Neil Adger, 'Climate change, human security, and violent conflict' (Aug 2007) 26(6) *Political Geo* 639; John Podesta and Peter Ogden, 'The Security Implications of Climate Change' (Winter 2007-2008) 31(1) *Wash Q* 115.

These are issues that policy makers have only recently begun considering. In 2007 the military advisory board of the CNA Corporation[113] issued a report on threats to US national security posed by climate change.[114] Among its findings, the board noted that '[c]limate change acts as a threat multiplier for instability in some of the most volatile regions of the world, and it presents significant national security challenges for the United States. Projected climate change will seriously exacerbate already marginal living standards in many Asian, African, and Middle Eastern nations, causing widespread political instability and the likelihood of failed states.'[115] Moreover, 'climate change will add to tensions even in stable regions of the world. The U.S. and Europe may experience mounting pressure to accept large numbers of immigrant and refugee populations as drought increases and food production declines in Latin America and Africa.'[116] For these reasons, the report recommends that '[t]he US should commit to a stronger national and international role to help stabilize climate change at levels that will avoid significant disruption to global security and stability.'[117] In addition, the US should enter into 'global partnerships that help less developed nations build the capacity and resiliency to better manage climate impacts.'[118] These recommendations are all based on the expected *indirect* effects on the US of climate change impacts in other countries. By focusing due attention on such indirect effects, the report reinforces the notion that even countries that are relatively immune to direct

[113] The CNA Corporation is a nonprofit organization, which includes the Center for Naval Analysis and the Institute for Public Research, providing research and analysis to the US Department of Defense and other public sector agencies. CNA's military advisory board is comprised of retired generals and admirals from all four branches of the US military.

[114] CNA Corporation, 'National Security and the Threat of Climate Change' (2007), available at <http://securityandclimate.cna.org/report/National%20Security% 20and%20the%20Threat%20of% 20Climate%20Change.pdf>.

[115] *Ibid* at 1.

[116] *Ibid* at 7.

[117] *Ibid.*

[118] *Ibid.*

climate change impacts should have a significant incentive to promote effective GHG mitigation and climate change adaptation regimes.[119]

Conclusion

It is easy to poke holes in the Kyoto Protocol (it is full of holes already), and not much harder to offer recommendations on how it might be improved or even optimized. But even the best policy recommendations in the world are useless if they cannot be enacted, implemented, and enforced. The true challenge in climate change negotiations is to offer policy recommendations that avoid or minimize climate change impacts while aligning the interests of the international community sufficiently to gain unanimous approval and minimize incentives for noncompliance. Policy recommendations that do not attend to the collective action problems confronting climate change negotiators are, like Kyoto's allocation of emissions allowances to Russia, simply 'hot air.'

This article has offered two recommendations, not for climate-change policy *per se* but for a negotiating *strategy* that might lead to better policies: the UNFCCC's Conference of the Parties and domestic policy-makers should focus due attention on (1) small-probability, high magnitude climate events and (2) the secondary and indirect consequences of climate change. Such a strategy would better align the interests of the parties and ameliorate the sizeable collective action problems that resulted in a weak Kyoto Protocol. With their interests better aligned, the parties should be able to negotiate a substantially stronger and more effective international climate change treaty.

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[119] *Also see* Kurt M. Campbell *et al.*, The Age of Consequences: The Foreign Policy and National Security Implications of Global Climate Change (Wash. D.C.: Center for Strategic and International Studies, Nov. 2007) p. 10 (concluding that climate change, if not successfully addressed, may represent "as great or greater foreign policy and national security challenge" than "reversing the decline in America's global standing, rebuilding the nation's armed forces, finding a responsible way out from Iraq, while maintaining American influence in the wider region, persevering in Afghanistan, working toward greater energy security, re-conceptualizing the struggle against violent extremists, … and quelling the fear that threatens to cripple our foreign policy").

Climate change remains, however, an extraordinarily difficult problem, which will not be quickly or easily resolved. In particular, the combined problem of ensuring adequate energy supplies for both developed and developing countries, while mitigating GHG gas emissions will require difficult and contentious trade-offs. Only unrealistic policy theorists believe in institutional panaceas that will lead to 'optimal' outcomes. Perhaps some technological miracle will occur in the next two or three decades that would allow the global community to rapidly and cost-effectively switch from fossil fuels. But it would be foolish indeed for the international community to rely on a miracle. The best for which we can reasonably hope, given the collective action problems associated with climate change, are incremental but valuable improvements to existing institutions.