CLIMATE CHANGE: THE NEXT DIMENSION

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I. INTRODUCTION

What we do know about the facts surrounding global warming, or — more accurately — climate change, is as significant as what we do not know. The scientific evidence about climate change is mottled, and the actions taken to address the phenomenon are as notable as those not taken. Moreover, even the apparently scientific issues have become subsumed within the political milieu of

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sustainable development (SD). Consequently, the next dimension in the evolving saga of climate change must confront the question of how to respond to climate change while engaged in SD. The challenge of devising policies, laws, and institutions that begin to address this question is a daunting one. The instant essay attempts to explore this next dimension.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol),[1] signed in 1997, though not yet in force,[2] constitutes the most important attempt of the international community to give concrete expression to the umbrella undertakings embodied in the 1992 United Nations Framework Convention on Climate Change (UNFCCC).[3] Although the Kyoto Protocol begins in Article 2 by paying ritual respect to SD,[4] the rest of the Protocol effectively ignores its meaning or application to climate change. This essay argues that the Kyoto Protocol is a deeply flawed agreement that negates SD for a number of reasons. First, it excludes developing countries that will be emitting more carbon dioxide than

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1. *See* Kyoto Protocol to the United Nations Framework Convention on Climate Change, 3d Sess., U.N. Doc. FCCC/CP/1997/L.7/Add.1 (1997), *reprinted in* 37 I.L.M. 32 (1998) [hereinafter Kyoto Protocol].

2. Article 24 of the Kyoto Protocol provides that the Protocol will enter into force the ninetieth day after at least 55 Parties aggregating at least 55% of the total carbon dioxide emissions for 1990 of the Parties in Annex I, have deposited their instrument of ratification. *See id*. art. 24, *reprinted in* 37 I.L.M. at 41.

3. *See* U.N. Conference on Environment and Development, Framework Convention on Climate Change, *opened for signature* June 4, 1992, U.N. Doc. A/CONF.151/26 (1992), *reprinted in* 31 I.L.M. 849 (1992) (entered into force Mar. 21, 1994) [hereinafter UNFCCC]. The UNFCCC defines climate change in article 1(2) as a "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." *Id*. art. 1(2), *reprinted in* 31 I.L.M. at 853.

4. Article 2(1) provides in part: "Each Party included in Annex I in achieving its quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall . . . .", Kyoto Protocol, supra note 1, art. 2(1), reprinted in 37 I.L.M. at 32. The phrase "sustainable development" is also used in Articles 10 and 12(2). Article 10 provides in part:

> All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, without introducing any new commitments for Parties not included in Annex I, but reaffirming existing commitments in Article 4, paragraph 1, of the Convention, and continuing to advance the implementation of these commitments in order to achieve sustainable development, taking into account Article 4, paragraphs 3, 5 and 7, of the Convention, shall . . . .

Id. art. 10, *reprinted in* 37 I.L.M. at 36-37. Article 12(2) reads:

> The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

Id. art. 12(2), *reprinted in* 37 I.L.M. at 38.

the developed countries after the next thirty years.[5] The total exemption of developing countries from even voluntary reductions of carbon dioxide invalidates the environmental dimension of SD. A removal of any form of environmental self-restraint is tantamount to an unfettered freedom or liberty to cause global pollution and damage and effectively disembowels SD.

In this context, I further argue that the United States committed a major diplomatic and policy blunder by signing both the misconceived Berlin Mandate[6] at the First Conference of the Parties (COP-1)[7] in 1995 and the 1996 Geneva Declaration[8] at COP-2, instructing negotiators to seek short-term, legally-binding emission control targets and timetables confined to participating (developed) countries at COP-3, which was scheduled to be held in Kyoto in 1997. The U.S. Senate responded to both resolutions of the COP by unequivocally declaring that the United States should not be a party to any mandatory reductions of greenhouse gases (GHGs) unless the developing countries were also parties to such an agreement.[9] This

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5. *See* Mark A. Drumbl, *Does Sharing Know Its Limits? Thoughts on Implementing International Environmental Agreements: A Review of National Environmental Policies, A Comparative Study of Capacity-Building*, 18 Va. ENVTL. L.J. 281, 286 (1999).

6. *See Report of the Conference of the Parties on Its First Session, Held at Berlin from 28 March to 7 April 1995, Addendum, Part Two: Action Taken by the Conference of the Parties at Its First Session*, UNFCCC, 1st Sess., U.N. Doc. FCCC/CP/1995/7/Add.1 (1995) (visited May 22, 2000) <http://www.unfccc.de/resource/docs/cop1/07a01.pdf> [hereinafter Berlin Mandate]. In signing the Berlin Mandate, developed countries agreed to act first in reducing greenhouse gas (GHG) emissions before requiring developing countries to do so. *See id*. art. I(1)(d).

7. The Conference of the Parties is an institution developed by the UNFCCC as a policymaking body authorized to review periodically the implementation of the UNFCCC. *See* UNFCCC, *supra* note 3 art. 7, *reprinted in* 31 I.L.M. at 860-62.

8. *See Report of the Conference of the Parties on Its Second Session, Held at Geneva from 8 to 19 July 1996, Addendum, Part Two: Action Taken by the Conference of the Parties at Its Second Session*, UNFCCC, 2d Sess., U.N. Doc. FCCC/CP/1996/15/Add.1 (1996) (visited May 22, 2000) <http://www.unfccc.de/resource/docs/cop2/15a01.pdf> [hereinafter Geneva Declaration].

9. *See* S. Res. 98, 105th Cong. (1997), 143 CONG. REC. S8113-05 (daily ed. July 25, 1997) (enacted) [hereinafter Senate Resolution Regarding UNFCCC]. The Senate Resolution provides in pertinent part:

> Resolved, That . . .
> (1) the United States should not be a signatory to any protocol to, or other agreement regarding, the United Nations Framework Convention on Climate Change of 1992, at negotiations in Kyoto in December 1997, or thereafter, which would —
> (A) mandate new commitments to limit or reduce greenhouse gas emissions for the Annex I Parties, unless the protocol or other agreement also mandates new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period, or
> (B) would result in serious harm to the economy of the United States; and
> (2) any such protocol or other agreement which would require the advice and consent of the Senate to ratification should be accompanied by a detailed explanation of any legislation or regulatory actions that may be required to implement the protocol or other agreement and should also be accompanied by an analysis of the detailed financial costs and other impacts on the economy of the

rebuff left the Clinton Administration scrambling to preserve its international image, while domestically committing to the idea that costly carbon dioxide reductions were necessary in order to save the world. The selling of this domestic objective necessitated international success, and reaching some kind of accord became the dominant focus of the negotiations.[10] The result was the unfortunate Kyoto Protocol.

The second major flaw in the Kyoto Protocol is that it repudiates SD by virtually ignoring the importance of research and development (R&D) in finding alternatives to fossil fuels. There is hardly any mention in the Kyoto Protocol of the need for serious long-term R&D into alternative fuels without which attempts to cut down fossil fuel use would be almost futile.[11] Costly cuts in carbon dioxide emissions can only succeed if they also strike a balance between economic development and environmental protection. It is not possible to strike this balance, required by SD, without developing other sources of readily accessible and cheap energy such as nuclear, solar, hydroelectric, geothermal, and hydrogen energy.[12] The Kyoto Protocol failed to address this question.

Third, the Kyoto Protocol indulges in short-term gain at the cost of long-term benefits. The Kyoto Protocol may have allowed political leaders to spin an international success story, but did little to address the more important, long-term climate issues at stake. Consequently, the next decade may be spent quibbling over these demanding short-term commitments while ignoring more important century-scale solutions.[13]

> United States which would be incurred by the implementation of the protocol or other agreement.

Id. at S8138-39.

10. *See* David M. Driesen, *Free Lunch or Cheap Fix?: The Emissions Trading Idea and the Climate Change Convention*, 26 B.C. ENVTL. AFF. L. REV. 1, 19-20 (1998).

11. The only mention of the role of research and development is in Article 2(1)(a)(iv) of the Kyoto Protocol, wherein the developed countries of Annex I are urged to "[i]mplement and/or further elaborate policies and measures" for the "[p]romotion, research, development and increased use of new and renewable forms of energy." *See* Kyoto Protocol, *supra* note 1, arts. 2(1)(a), 2(1)(a)(iv), *reprinted in* 37 I.L.M. at 32.

12. *See* Henry D. Jacoby et al., *Kyoto's Unfinished Business*, 77 FOREIGN AFF. July/Aug. 1998, at 54, 66; *See also* Laura H. Kosloff, *Linking Climate Change Mitigation with Sustainable Economic Development: A Status Report*, 3 WIDENER L. SYMP. J. 351, 364 (1998) (discussing effect of Kyoto Protocol as only a first step in changing future patterns of energy use and development).

13. Proof of the lack of agreement on implementation of the Kyoto Protocol is readily seen in subsequent efforts of the COP after Kyoto in COP-4 and COP-5, held in Buenos Aires and Bonn, respectively. The Fourth COP met from Nov. 2-13, 1998 in Buenos Aires with the objective of ironing out details of the Kyoto Protocol, but ended up setting a further two year schedule for future negotiations in the so-called "Buenos Aires Plan of Action." *See* Anita Margrethe Halvorssen, *Climate Change Treaties—New Developments at the Buenos Aires Conference*, 1998 Y.B. COLO. J. INT'L ENVTL. L. &

The Kyoto Protocol is also fraught with significant other perils. It is very likely that countries might fail to meet even their immediate goals, and that the Kyoto Protocol will not be ratified in the United States.[14] The failure to meet deadlines coupled with inaction by the United States might have the effect of discrediting the entire international response to climate change, and will obstruct collective action in the future — no matter how serious the problem turns out to be.[15] The result is a treaty that does not make environmental, economic, or political sense. In this essay, I argue that we should ignore the Kyoto Protocol and concentrate instead on negotiating a long-range protocol on GHG emissions.

POL'Y 1, 1-2 (1998); *See also* Comment, *As the Globe Warms*, ARIZ. DAILY STAR, Dec. 29, 1998, at 10A, *available in* 1998 WL 22300739 (discussing significant remaining conflicts after COP-4). The Fifth COP met at Bonn from 25 October to 5 November 1999, but recognized that work remained to be done on developing a framework of elements of procedures and mechanisms related to the Kyoto compliance system. *See Report of the Conference of the Parties on Its Fifth Session, Held at Bonn from 25 October to 5 November 1999, Part Two: Action Taken by the Conference of the Parties at Its Fourth Session*, at 35 (preliminary, unedited version) (visited May 24, 2000) <http://cop5.unfccc.de/resource/docs/cop5/cop5decis.pdf>.

14. The Clinton Administration signed the Kyoto Protocol in Buenos Aires at COP-4 in November of 1998, but in order for the agreement to bind the United States domestically, the approval of two-thirds of the Senate is constitutionally required. *See* Peter N. Spotts, *Scientists Call for Action on Global Warming*, CHRISTIAN SCI. MONITOR, Jan. 29, 1999, at 4. Even if the Kyoto Protocol is not approved by the Senate, it may be possible that the President could adopt it as a policy framework. *See* Mitchell F. Crusto, *All That Glitters Is Not Gold: A Congressionally-Driven Global Environmental Policy,* 11 GEO. INT'L ENVTL. L. REV. 499, 511 (1999); *See also* James P. Lucier, *Globally Warm, Economically Cool*, INSIGHT MAG., Dec. 28, 1998, at 18, *available in* 1998 WL 21496730 (discussing methods of implementing the Kyoto Protocol without Senate ratification). In the meantime, the Clinton Administration has continued to advocate domestic budgetary allowances for purposes of curbing GHG emissions, and the President's fiscal year 2001 budget seeks $4 billion for climate change initiatives and research. *See Budget Asks $4 BN on Climate Change; Gives Tax Breaks to Clean Cars*, OCTANE WEEK, Feb. 28, 2000, *available in* 2000 WL 4312205.

15. *See* Jacoby et al., *supra* note 12, at 55-56.

II. FACTS AND COMPETING EXPLANATIONS

A. Agreed Facts

GHGs[16] enable the earth to trap infrared radiation which warms surface temperature while at the same time permitting excess heat to escape.[17] The earth must radiate energy away in an amount equal to that absorbed from the sun, if surface temperature is to remain in balance.[18] GHGs, at their natural level, maintain such a heat balance.[19] In the right quantities, GHGs help support life and eco-systems on earth by maintaining a relatively constant surface temperature that averages nearly 60°F or about 15°C.[20] The functioning of the greenhouse effect on earth may be supported by comparing the atmosphere and average temperature of Venus and

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16. Major GHGs contributing to global warming are carbon dioxide, chlorofluorocarbons, methane, nitrous oxide, and ozone. *See* WILLIAM R. CLINE, THE ECONOMICS OF GLOBAL WARMING 15 (1992). The Kyoto Protocol includes three naturally occurring gases—carbon dioxide, methane, and nitrous oxide—as well as three synthetic compounds—hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. *See* Anastasia Telesetsky, *The Kyoto Protocol*, 26 ECOLOGY L.Q. 797, 801 (1999); Kyoto Protocol, *supra* note 1, Annex A, *reprinted in* 37 I.L.M. at 42.

17. This is commonly known as the "greenhouse effect." The theory posits that certain gases and particles in an atmosphere preferentially allow the penetration of sunlight to the surface of a planet relative to the amount of radiant infrared energy that is allowed to escape back to space. *See* Stephen H. Schneider, *The Greenhouse Effect: Science and Policy*, 243 SCI. 771, 771 (1989).

18. The equilibrium in the earth's natural radiative budget, measured by watts per square meter (wm-2), is theorized by analyzing the following description of earth's radiation balance: Solar radiation into the earth's atmosphere is about 340 wm-2. Some 100 wm-2 is reflected back to space by snow, ice, clouds and aerosols. The 240 wm-2 which is left warms the earth's atmosphere and surface to about -18oC. On the other end, the earth's surface emits infrared radiation of about 420 wm-2 into the atmosphere. The greenhouse effect redirects 180 wm-2 back to the earth, increasing the atmosphere and surface warming by about 33oC to approximately 15oC. What is left of the emitted infrared radiation escapes and balances the net incoming solar radiation. See Cline, supra note 16, at 15-16.

19. Because of the earth's radiative budget, an increase in atmospheric concentrations of GHGs from anthropogenic emissions would mean that the greenhouse effect would redirect more of the earth's emitted infrared radiation back to the surface, increasing global temperature. In order to balance the budget, then, the earth would emit more infrared emissions. *See id*. at 16. However, it should be noted that modifications in the climate do not respond instantly to the change in atmospheric concentrations of GHGs. There is a "lag" period before equilibrium is achieved. Hence, the increase in global average temperature corresponding to increased GHG concentrations may not be cognizable for several decades. *See* PANEL ON POLICY IMPLICATIONS OF GREENHOUSE WARMING, NATIONAL ACADEMY OF SCIENCES, POLICY IMPLICATIONS OF GREENHOUSE WARMING: MITIGATION, ADAPTATION, AND THE SCIENCE BASE 19 (1992) [hereinafter POLICY IMPLICATIONS OF GREENHOUSE WARMING].

20. *SEE* ROBERT C. BALLING, JR., THE HEATED DEBATE: GREENHOUSE PREDICTIONS VERSUS CLIMATE REALITY 8 (1992).

Mars. The dense carbon dioxide concentration in the atmosphere of Venus contributes to a very hot surface temperature (477°C), while the low concentration of carbon dioxide in the atmosphere on Mars contributes to a much colder surface temperature (-47°C).[21]

Water vapor and clouds, which usually remain in the atmosphere for a week or so, are responsible for radiating upward-flowing infrared light back to the surface of the earth.[22] Long-lasting GHGs, most notably carbon dioxide, however, are the central actors in the climate change debate.[23] Atmospheric concentrations of carbon dioxide and other long-lived GHGs have increased substantially over the past century.[24] The increase in atmospheric concentrations of GHGs has corresponded to a decrease in the flow of infrared energy to space, "so that, all else being equal, the earth receives slightly more energy than it radiates to space."[25] This imbalance contributes to a rise in temperature at the earth's surface.[26]

Enormous quantities of trace GHGs are emitted into the atmosphere today through anthropogenic emissions. For example, each year the burning of fossil fuels discharges six billion tons of carbon dioxide into the atmosphere.[27] Many scientists fear such anthropogenic emissions may be upsetting the environmental balance hitherto maintained by atmospheric gases that blanket the

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21. *See* Cline, *supra* note 16, at 26.

22. One viewpoint is that approximately 75% of the natural greenhouse effect is due to water vapor in the atmosphere. *See* William C. Burns, *Global Warming—The United Nations Framework Convention on Climate Change and the Future of Small Island States*, 6 DICK. J. ENVTL. L. & POL'Y 147 n.17 (1997) (citing AUSTRALIAN STEERING COMMITTEE OF THE CLIMATE CHANGE STUDY, CLIMATE CHANGE SCIENCE 13 (1995)).

23. *See* Jacoby et al., *supra* note 12, at 56. Measurements show that about 40% of carbon dioxide released into the atmosphere stays there for decades at least, while 15% is incorporated into the top layers of the ocean. It is unknown what happens to the remaining 45%. *See* POLICY IMPLICATIONS OF GREENHOUSE WARMING, *supra* note 19, at 12. In addition to carbon dioxide, other long lived GHGs are nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. *See* WORKING GROUP I, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE 3 (J.T. Houghton et al., eds., 1996) [hereinafter IPCC CLIMATE CHANGE 1995].

24. The Intergovernmental Panel on Climate Change (IPCC) concluded in 1990 that emissions of GHGs from human activities were contributing to substantial increases in atmospheric concentrations of carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT xi (J.T. Houghton et al., eds., 1990).

25. Jacoby et al., *supra* note 12, at 56-57.

26. *See* Claire Breidenich et al*., The Kyoto Protocol to the United Nations Framework Convention on Climate Change*, 92 AM. J. INT'L L. 315, 316 (1998).

27. *See* D. Abrahamson*, Global Warming: The Issue, Impacts, Responses, in The Challenge of Global Warming* 7 (D. Abrahamson ed., 1989). Further emissions in carbon dioxide, methane, and nitrous oxide into the atmosphere can be attributed to other human activities like land-use change and agriculture. *See* IPCC CLIMATE CHANGE 1995, *supra* note 23, at 3.

earth.[28] They believe that if GHGs are allowed to build, this energy balance will be upset, and trapped infrared radiation will cause a rise in surface temperature.[29]

Debate is seriously joined with respect to both the extent and impact of global warming and how complex systems that determine our climate will respond to changes in the concentrations of GHGs in the atmosphere.[30] Moreover, global warming is integrally connected to the warming of the oceans, but it is not known just how rapidly heat is carried into the ocean depths or whether oceanic organisms can serve as carbon dioxide sinks.[31] It is also not known to what extent forests and vegetation on the terrestrial environment can act as sinks.[32]

In predicting climate, scientists use mathematical models with complexities taxing the capabilities of even the world's largest computers. To date, such models have not been able to include complete "knowledge about the key factors that influence climate, including clouds, ocean circulation, the natural cycles of greenhouse gases, natural aerosols like those produced by volcanic gases, and man-made aerosols like smog."[33] According to the Intergovernmental Panel on Climate Change (IPCC), in summary, the main uncertainties in model simulations arise from the difficulties in adequately representing clouds and their radiative properties along with those of the atmosphere, the ocean, and the land surface.[34] Moreover, atmospheric general circulation models still exhibit inconsistencies when their results are matched with climatic data of

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28. Although anthropogenic emissions of carbon dioxide are small relative to the total stock of carbon contained in the atmosphere, it is feared that even a small variation in natural flows and stocks may upset the natural energy balance. *See* Cline, *supra* note 16, at 16-17. *See also* JOHN FIROR, THE CHANGING ATMOSPHERE: A GLOBAL CHALLENGE 51 (1990).

29. *See* JOSEPH CONSTANTIN DRAGÀN & STEFAN AIRINEI, GEOCLIMATE AND HISTORY 142 (2d ed. 1989).

30. For an illuminating overview of the range of arguments in the climate change debate, *see* BALLING, JR., *supra* note 20.

31. *See* Leslie Roberts, *Report Nixes "Geritol" Fix for Global Warming*, 253 SCI. 1490, 1490 (1991). The UNFCCC defines a "sink" as "any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere." *See* UNFCCC, *supra* note 3, art. 1(8), *reprinted in* 31 I.L.M. at 854.

32. The common view is that forests take up about as much carbon dioxide while photosynthesizing as they give off when respiring. A newer picture of forest dynamics suggest that more carbon is stored in soils and peat than previously thought. Coupled with the expansion of forests in certain parts of the world, improved use of forests worldwide could help mitigate increased anthropogenic emissions of carbon dioxide. *See* Anne Simon Moffat, *Resurgent Forests Can Be Greenhouse Gas Sponges*, 277 Sci. 315, 315 (1997).

33. *See* Jacoby et al., *supra* note 12, at 57.

34. *See* IPCC CLIMATE CHANGE 1995, *supra* note 23, at 31; *See* also Burns, *supra* note 22, at 156 n.47.

past centuries.[35] "In addition, climate models are driven by forecasts of greenhouse gas emissions, which in turn rest on highly uncertain long-term predictions of population trends, economic growth, and technological advances."[36]

Despite the fact that the awesome complexity of atmospheric mechanisms cannot fully be replicated by mathematical models,[37] a majority of the scientific community agree that the greenhouse effect will be enhanced by the increased atmospheric concentrations of GHGs.[38] Indeed, there is a strong general consensus among the international scientific community that some action should be taken now to limit or reduce atmospheric GHGs on a global basis, because corrective actions will be ineffective after climate change has gained momentum.[39]

Further, a scientific consensus holds that atmospheric carbon dioxide levels will increase between 100 and 200% by the year 2100 if no changes are made to current policy and practice.[40] This could correspond to a mean global temperature increase of between 0.9 and 3.5°C, with a best estimate placing the increase near 2.5°C.[41] Over the past century, data reveals approximately a 0.5°C increase in average global temperature.[42] This rise has not yet made a discernible difference to the earth's environment. Larger temperature increases such as those now predicted to occur over the next century, however, may cause a different result.

B. The Yea-Sayers

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35. In studies of climate change of the past 18,000 years, general circulation model results have not been able to match the paleoclimatic data. *See* P.M. Anderson et al., *Climatic Changes of the Last 18,000 Years: Observations and Model Simulations*, 241 SCI. 1043, 1051 (1988).

36. *See* Jacoby et al., *supra* note 12, at 57.

37. *See* IPCC CLIMATE CHANGE 1995, *supra* note 23, at 14 box 1; *See* also DRAGÀN & AIRINEI, *supra* note 29, at 27.

38. *See* Daniel Bodansky, *The United Nations Framework Convention on Climate Change: A Commentary*, 18 YALE J. INT'L L. 451, 456 (1993).

39. *See* IPCC CLIMATE CHANGE 1995, *supra* note 23; WORKING GROUP II, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1995: IMPACTS, ADAPTATIONS AND MITIGATION OF CLIMATE CHANGE: SCIENTIFIC-TECHNICAL ANALYSES (Robert T. Watson et al., eds., 1996); WORKING GROUP III, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1995: ECONOMIC AND SOCIAL DIMENSIONS OF CLIMATE CHANGE (James P. Bruce et al., eds., 1996).

40. "If carbon dioxide emissions were maintained at near current (1994) levels, they would lead to a nearly constant rate of increase in atmospheric concentrations for at least two centuries, reaching about 500 ppmv (approaching twice the pre-industrial concentration of 280 ppmv) by the end of the 21st century." IPCC CLIMATE CHANGE 1995, *supra* note 23, at 3.

41. *See id*. at 39.

42. *See* J.D. Mahlman, *Uncertainties in Projections of Human-Caused Climate* Warming, 278 SCI. 1416, 1416 (1997). IPCC CLIMATE CHANGE 1995, *supra* note 23, at 61 (estimating the mean global warming over the past century to be between 0.3 and 0.6°C).

In 1988, the IPCC, currently composed of more than 2000 climate change scientists,[43] was formed jointly by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to evaluate the scientific phenomenon of global warming and its effects on earth's community.[44] These scientists and climate change experts participate in three working groups and a Task Force.[45] The first assessment report of the working groups was published in 1990. Updates followed in 1992 and 1994, along with the second assessment report in 1995.[46]

The IPCC concluded in its original report that global climate change might have its greatest impact in the polar regions, melting polar ice caps and causing a rise in sea-level of about one meter by the year 2100 and a rise in temperature of the surface ocean layer of between 0.2 and 2.5°C.[47] They predicted that climate changes will affect agriculture, forestry, natural terrestrial ecosystems, hydrology, water resources, human settlements, oceans and coastal zones, seasonal snow cover, permafrost, and ice.[48] Specific predictions were difficult on a regional scale since climate varies regionally. The IPCC supplements confirmed the original findings and provided additional supporting data and a refinement of specific predictions.[49] According to the IPCC second assessment report in 1995, the most pronounced impacts will be related to water resources.[50] Rising

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43. *See* Deborah E. Cooper, *The Kyoto Protocol and China: Global Warming's Sleeping Giant*, 11 GEO. INT'L ENVTL. L. REV. 401, 402 (1999).

44. A 1988 United Nations General Assembly Resolution endorsed the joint activities of the WMO and UNEP. *See* G.A. Res. 43/53, U.N. GAOR, 2d Comm., 43d Sess., Supp. No. 49, at 133, U.N. Doc. A/43/49 (1989), *reprinted in* 28 I.L.M. 1326 (1989).

45. *See* IPCC, *About IPCC* (visited May 22, 2000) <http://www.ipcc.ch/about/about.htm>. Working Group I focuses on the scientific aspects of climate change. *See id*. Working Group II concentrates on the socio-economic impact and positive and negative consequences of climate change. *See id*. Working Group III addresses the options for limiting GHG emissions and mitigating climate change. *See id*. The Task Force supervises the National Greenhouse Gas Inventories Programme. *See id*.

46. The IPCC published its first assessment report in 1990, followed by a supplementary report in 1992, a special report on radiative forcing in 1994, and in 1995, a second assessment report. *See* U.S. Global Change Research Program, *The Intergovernmental Panel on Climate Change* (visited May 24, 2000) <http://www.usgcrp.gov/usgcrp/IPCCINFO.html>.

47. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC IMPACTS ASSESSMENT 1 (W.J. McG. Tegart et al., eds., 1990).

48. *See id*.

49. *See generally* WORKING GROUP I, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1992: THE SUPPLEMENTARY REPORT TO THE IPCC SCIENTIFIC ASSESSMENT (J.T. HOUGHTON ET AL., EDS., 1992); WORKING GROUPS I & III, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1994: RADIATIVE FORCING OF CLIMATE CHANGE AND AN EVALUATION OF THE IPCC IS92 EMISSION SCENARIOS (J.T. Houghton et al., eds., 1995).

50. *See* WORKING GROUP II, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *Summary for Policymakers: Scientific-Technical Analyses of Impacts, Adaptations and Mitigation of Climate*

global temperatures will change existing patterns of precipitation, which in turn will cause meteorological shifts affecting seasonal snow patterns.[51] Additionally, melting polar ice caps are expected to cause a rise in sea level which will directly impact commercial marine industries like shipping and fishing.[52] Sea level rises will also severely challenge coastal land use.[53] Agriculture will follow precipitation and temperature, and entire species will either adapt to the new habitats, shift locations, or face localized and potentially widespread extinction.[54]

Human settlements will also change as world population and trading centers are typically located on coasts.[55] Developing countries and areas with significant lowlands may be unable to survive the health impacts of changing water and food supplies.[56] Finally, human migration may disrupt settlement patterns and cause social instability.[57] In light of the fact, however, that global warming may lead to winners as well as losers, diplomatic progress has been inhibited by geographical differences in the impact of global warming effects and the remote manifestation of actual changes to the ecosystem.

C. The Nay-Sayers

The predictions of the IPCC have been challenged by a large group of scientists. Since the UNFCCC was signed in 1992, dissenting scientists have expressed themselves through four petitions culminating in the Oregon Petition signed by over 17,000 U.S. scientists.[58] To begin, some scientists contend that despite the volume emitted by human activities, the accumulation of anthropogenic carbon dioxide is really a tiny constituent of our atmosphere,

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Change—IPCC Working Group II (visited May 22, 2000) <http://www.ipcc.ch/pub/sarsum2.htm>, at § 3.2.

51. *See id*.

52. *See id*. § 3.1.

53. *See id*.

54. *See id*.

55. *See* WORKING GROUP III, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1995: ECONOMIC AND SOCIAL DIMENSIONS OF CLIMATE CHANGE 199 (James P. Bruce et al., eds., 1996).

56. See *id*. at 189.

57. See *id*. at 199.

58. The petitions are: the 1992 "Statement by Atmospheric Scientists on Greenhouse Warming" (more than 100 signatures); the 1992 "Heidelberg Appeal," (over 4000 signatures); the 1996 "Leipzig Declaration" (signed by 130 U.S. climate scientists, including several who participated in the IPCC); and the "Oregon Petition," which has been signed so far by 17,000 U.S. scientists. *See* Candace Crandall, Letter, *The Number of Scientists Refuting Global Warming Is Growing*, WASH. TIMES, Nov. 20, 1998, at A22. *See* also S. Fred Singer, *Warming Orthodoxy Ambush,* WASH. TIMES, Oct. 4, 1999, at A15.

comprising about 4/100 of 1% of all gases present.[59] A number of factors related to climate change remain uncertain, they say, including the effects of clouds,[60] and there are a number of non-greenhouse-related factors that may augment global temperature.[61] They further argue that carbon dioxide has been steadily increasing for the last 11,000 years, coinciding with an interruption in the ice age and the onset of global warming.[62]

One of the other issues on which they disagree with the IPCC is whether the global warming the earth has experienced over the last century is due to human intervention. It is admitted by the naysayers that a 0.45°C warming has taken place during this last century.[63] What many of these scientists contend, however, is that the temperature rise took place before 1940, prior to the huge increase in carbon dioxide emissions, and that there has not been much change since 1940.[64] They point out that National Oceanic and Atmospheric Administration (NOAA) satellites have been measuring the temperature at a height of a few kilometers in the atmosphere essentially over the entire earth since 1979.[65] These records, based on

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59. *See* Andrew R. Solow, *Is There a Global Warming Problem?*, in GLOBAL WARMING: ECONOMIC POLICY RESPONSES 7, 8 (Rudiger Dornbusch & James M. Poterba eds., 1991).

60. Although clouds trap some heat, they reflect heat from the sun, in net, producing a cooling effect on the planet. *See* Richard A. Kerr, *Greenhouse Forecasting Still Cloudy*, 276 SCI. 1040, 1040 (1997). The precise impact of clouds is not clear, however, and it is debatable whether global warming will contribute to a change in this balance. *See id*. at 1041.

61. It is claimed, for example, that the IPCC has not paid sufficient attention to the astronomical causes of global warming caused by the earth's orbital eccentricities as well as variations in solar output. To illustrate the former, there are at least two competing orbital mechanism theories that explain the occurrence of Ice Ages in the earth's past. The first theory posits that cyclical changes in the earth's elliptical orbit shift the pattern of solar heating, affecting the buildup of ice sheets. This has been termed the Milankovitch mechanism. *See* Richard A. Kerr, *Upstart Ice Age Theory Gets Attentive But Chilly Hearing*, 277 SCI. 183, 183 (1997). The second, newer, theory proposes that ice ages were stimulated by changes in the inclination of the earth's orbit relative to the plane of the solar system, causing the planet to be enveloped in clouds of cosmic dust. *See id*. As for the latter theory, See Richard A. Kerr, *A New Dawn for Sun-Climate Links*, 271 SCI. 1360, 1360 (1996) (discussing apparent sun-climate connection resulting from the sun's eleven and twenty-two year sunspot cycles).

62. *See* S. FRED SINGER, HOT TALK, COLD SCIENCE: GLOBAL WARMING'S UNFINISHED BUSINESS 5-6 (1997). However, some recent studies question the solidity of evidence showing a constant buildup in carbon dioxide levels from the beginning of the Holocene epoch (about 11,000 years ago) to the present. *See* Curt Suplee, *Studies May Alter Insights into Global Warming*, WASH. POST, Mar. 15, 1999, at A7.

63. *See* BALLING, JR., *supra* note 20, at 68-69.

64. *See* S. Fred Singer, *An Assessment of the Kyoto Protocol, Transcript from Panel Discussion, April 15, 1999*, 11 GEO. INT'L ENVTL. L. REV. 767, 771 (1999). Of the 0.46°C amount of warming occurring from 1891 to 1990, it is contended that the amount of warming from 1891 to 1940 was 0.33°C. *See* Robert C. Balling, Jr., *The Global Temperature Data*, 9 RES. & EXPLORATION 201, 202 (1993).

65. *See* George C. Marshall Institute, *Uncertainties in Climate Modeling: Solar Variability and Other Factors* (testimony of Sallie Baliunas, Ph.D., Senior Scientist of the George C. Marshall Institute, before the Senate Committee on Energy and Natural Resources) (Sept. 17, 1996) <http://www.marshall.org/baliunastestimony.htm> [hereinafter Uncertainties in Climate Modeling]. The NOAA also has in place a Geostationary Operational Environmental Satellite System providing

microwave sounding units (MSUs),[66] have smaller systematic errors than the surface records, which, unlike the satellite records, come from a variety of instruments, techniques, and measurement histories, and whose coverage is sparse over large areas like the southern ocean.[67] The very precise satellite record shows no net warming over the last seventeen years, contrary to the forecasts calculating the effect of the recent rapid increase in human-made GHGs.[68] The results based on satellite data using MSUs are supported by researchers whose observations are based on radiosonde data (weather balloons).[69]

An expert panel of the U.S. National Research Council (NRC)[70] that attempted to reconcile the contradictory figures between surface and atmospheric measurements has offered only a partial explanation. In light of the panel's inability to explain the differentials, they recommended the implementation of a worldwide monitoring system. Until more light is shed on this issue, the discrepancies still remain largely unexplained.[71]

The nay-sayers further point out that temperatures have fluctuated over the centuries and while the last 600 years have been cold, it was warmer 1000 years ago, and even warmer 3000 years ago.[72] According to them, it is untrue that the warming from rising GHGs is going to be unprecedented in both magnitude and rapidity.[73] Ocean sediment data of the past 3000 years discloses temperature

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climatological observation of the United States. *See* Charles Davies et al., *Moving Pictures: How Satellites, the Internet, and International Environmental Law Can Help Promote Sustainable Development*, 28 STETSON L. REV. 1091, 1116 (1999). In addition, a worldwide system of satellites to provide information on global climate is currently being implemented through coordination by NOAA, NASA, and public and private operations in several countries. *See id*. at 1116-17.

66. The radiometers aboard the NOAA satellites are MSUs designed to measure thermal emission of radiation by atmospheric O2 at four frequencies near 60 GHz. *See* Roy W. Spencer & John R. Christy, *Precise Monitoring of Global Temperature Trends from Satellites*, 247 SCI. 1558, 1558 (1990). This can be accomplished because atmospheric O2 is constant in space and time and ensures a stable temperature tracer. *See id*.

67. *See id*.

68. *See Uncertainties in Climate Modeling*, *supra* note 65.

69. *See* Dian J. Gaffen et al., *Multidecadal Changes in the Vertical Temperature Structure of the Tropical Troposphere*, 287 SCI. 1242, 1242 (2000).

70. *See* PANEL ON RECONCILING TEMPERATURE OBSERVATIONS, NATIONAL RESEARCH COUNCIL, RECONCILING OBSERVATIONS OF GLOBAL TEMPERATURE CHANGE (2000).

71. *See* B.D. Santer et al., *Interpreting Differential Temperature Trends at the Surface and in the Lower Troposphere*, 287 SCI. 1227, 1231 (2000). Three explanations have been forwarded to explain the difference: first, there could be data problems in either the surface thermometers, or the radiosonde and satellite data; second, the effects of natural internal variability and/or external forcing may account for the difference; third, the difference could be related to coverage differences between satellite and surface temperature data. *See id*. at 1227.

72. *See* Singer, *supra* note 64, at 772.

73. *See id*.

changes of 3°C (about 5°F) taking place in a matter of a decade or two.[74] Such rapid temperature changes, they state, have happened throughout recorded human history.[75]

Another method of measuring temperatures from the past is drilling ice cores from the ice in the Arctic and Antarctic and taking the samples to a laboratory where temperatures can be measured.[76] These measurements reveal low temperatures during the last ice age followed by a warming that began about 20,000 years ago and continuing to the present time.[77] Prior to that time, it was considerably colder, and a thick overlay of ice covered most of the northern United States.[78] The last 8000 to 4000 years, however, witnessed a period of significant warmth called the "Climate Optimum."[79] It was followed in turn by a cooling period and another warming 1000 years ago, called the "Medieval Climate Optimum."[80] This warming enabled the Vikings to settle Greenland and cultivate crops, but was followed, from about 1250 to 1850 A.D., by a period called the "Little Ice Age," during which crop failures caused starvation.[81] A sharp recovery with warming then commenced at about 1850, reaching a maximum temperature in 1940. According to the nay-sayers, then, global warming theories cannot explain the temperature peaking in the 1940s.[82]

III. LEGAL RESPONSE

A. 1992 United Nations Framework Convention on Climate Change

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74. *See id*.

75. *See id*.

76. *See* Singer, *supra* note 64, at 772. The temperature at the time the ice froze can be calculated by measuring isotopes of hydrogen and oxygen in the water molecules in the ice. Air bubbles that are trapped in the ice record the amount of GHGs in the atmosphere. *See* Richard L. Stroup & Jane S. Shaw, *Global Issues: Policies And Dilemmas*, 3 TOURO J. TRANSNAT'L L. 111, 117 n.17 (1992) (citing Eric T. Sundquist, *The Greenhouse Effect and Global Warming: Critical Questions and Essential Facts*, in INFORMATION ON SELECTED CLIMATE AND CLIMATE-CHANGE ISSUES (U.S. Geological Survey Open File Report No. 888-718) 11, 15 (1988); S.H. Schneider, *The Changing Climate*, SCI. AM., Sept. 1989, at 72; C. Lorius, *A 150,000-Year Climatic Record from Antarctic Ice*, 316 NATURE 591, 591-96 (1985)).

77. *See* Singer, *supra* note 64, at 772; *See* also D. Dahl-Jensen, *Past Temperatures Directly From the Greenland Ice Sheet*, 282 SCI. 268, 270 (1998).

78. *See* Singer, *supra* note 64, at 772.

79. *See id*.

80. *See id*.

81. *See id*.

82. *See id*.

The international law response to the threat of global warming was first expressed in the 1992 UNFCCC.[83] Though there was a substantial political base which desired long-term quantitative emission limits, eventually a "go-slow" approach prevailed. The short negotiating period, combined both with the enormous economic stakes and a substantial amount of scientific uncertainty, resulted in the adoption of only cautious controls in the final version of the treaty.[84]

The UNFCCC, however, is not an empty framework treaty whose substantive details entirely await further elaboration; instead, it is a framework convention with a number of built-in requirements. Most significantly, developed countries must strive to reduce their overall emissions of GHGs to 1990 levels by the year 2000.[85] In addition, developed countries have a general commitment to make financial and technological transfers to developing countries.[86] Furthermore all parties, both developed and developing countries, must develop inventories of GHGs, as well as national mitigation and adaptation programs.[87] The UNFCCC, however, provides different timetables and requirements for both categories of parties with regard to inventories and other programs,[88] and the COP has established different guidelines for the national reports communicating such programs to the COP.[89]

In mandating different requirements for developed and developing countries, as well as making further delineations within those groups, the UNFCCC embraces the concept of "common but differentiated responsibility" (CBDR).[90] This principle recognizes that only international cooperation will help to resolve a problem of the magnitude of global warming, but that in responding to the problem, different states have different social and economic conditions that affect their response capabilities.[91] CBDR also incor-

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83. For an overview of the issues surrounding the global response to climate change, *See* Bodansky, *supra* note 38, at 455-57, 471-77.

84. *See* Ved P. Nanda, *The Kyoto Protocol On Climate Change and the Challenges to Its Implementation: A Commentary*, 10 COLO. J. INT'L ENVTL. L. & POL'Y 319, 321 (1999).

85. *See* UNFCCC, *supra* note 3, art. 4(2)(b), *reprinted in* 31 I.L.M. at 857.

86. *See id*. art. 4(3), *reprinted in* 31 I.L.M. at 858.

87. *See id*. arts. 4(1)(a) and 4(2)(a), *reprinted in* 31 I.L.M. at 855, 856.

88. *See id*. art. 12, *reprinted in* 31 I.L.M. at 865-66.

89. *See id*. art. 12(5), *reprinted in* 31 I.L.M. at 866.

90. The concept of common but differentiated responsibility is explicitly referred to in the Preamble and Articles 3 (dealing with principles) and 4 (dealing with commitments) of the UNFCCC. *See id*. pmbl. and arts. 3-4, *reprinted i*n 31 I.L.M. at 851-53, 854-56.

91. *See* Paul G. Harris, *Common But Differentiated Responsibility: The Kyoto Protocol and United States Policy*, 7 N.Y.U. ENVTL. L.J. 27, 29 (1999) (tracing the evolution of the concept of "common but differentiated responsibility" from the notion of the "common heritage of mankind").

porates the equitable notion that developed countries, which have the largest share of historical and current emissions of GHGs, should take the first painful actions to ameliorate the problem.[92] As we shall see, however, the exact application of CBDR remains in controversy concerning a number of issues.

B. 1997 Kyoto Protocol

The First COP (COP-1) assembled on March 28, 1995, in Berlin to address additional commitments, financial mechanisms, technical support to developing countries, and administrative and procedural issues involving climate change.[93] A pressing issue was whether Annex I Parties would be able to achieve the general emissions reduction goal heralded by the UNFCCC.[94] As a result, the Berlin Mandate was passed, under which developed countries agreed to future negotiation of a protocol containing express targets and timetables for emissions reductions.[95] The Berlin Mandate created an Ad-Hoc Group on the Berlin Mandate (AGBM) to meet periodically with the function of determining how to strengthen the commitments of Annex I Parties past the year 2000.[96] This was to be concluded ultimately in the form of a protocol, to be adopted at COP-3. The AGBM met eight times between COP-1 in 1995 and the Kyoto Protocol conference in December 1997.

Further stimulus for negotiation of a protocol at COP-3 occurred when, in April 1996, the IPCC published its 1995 second assessment report finding that "the balance of evidence suggests a discernible human influence on global climate."[97] Subsequently, COP-2 convened in July 1996, producing several important developments.[98] First, the Parties published the Geneva Declaration, calling for "legally-binding targets and timetables to ensure significant reductions in GHG emissions," similar to the Berlin Mandate.[99] Second, the U.S. shifted its position toward a legally-binding agreement to accomplish the objectives of the Berlin Mandate and UNFCCC, a stance that the European Union had been advocating for

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92. *See id*. at 28.
93. *See* Cooper, *supra* note 43, at 411.
94. *See* UNFCCC, *supra* note 3, art. 4(2)(b), *reprinted in* 31 I.L.M. at 857.
95. *See* Nanda, *supra* note 84, at 326.
96. *See* Cooper, *supra* note 43, at 411.
97. IPCC CLIMATE CHANGE 1995, *supra* note 23, at 4.
98. *See* Cooper, *supra* note 43, at 412.
99. *Id*.

years.[100] The remaining issue left for the COP-3 negotiations in Kyoto was the establishment of legally-binding targets.[101]

In direct response to these developments, a unanimous Senate Resolution in July 1997,[102] passed during the run-up to Kyoto in 1997, clearly and unequivocally declared that the United States should not be a party to any mandatory reductions of greenhouse gases unless the developing countries were also parties to such an agreement. Despite their full knowledge that any agreement required by the Berlin mandate would not be approved by the Senate, the Clinton Administration felt obligated by the Berlin undertaking, and publicly committed itself to an emission reduction agreement restricted to developed countries alone, while taking its case to the public over the heads of the Senate.[103]

Significant steps in the global response to climate change were then taken at COP-3 in Kyoto in 1997 and at COP-4 in Buenos Aires in 1998. After intense negotiation at Kyoto, the developed countries agreed to reduce GHG emissions to five percent below their 1990 levels between the years 2008 and 2112.[104] The Kyoto Protocol, embodying this agreement, also provided a basis for emissions trading, primarily between developed countries.[105] The Kyoto Protocol, however, has not been ratified in the United States. Additionally, a number of the industrialized (Annex I) countries have failed to carry out the emission reductions to which they had aspirationally agreed under the UNFCCC.[106] The faltering attempts made at COP-4 in Buenos Aries in 1998 did little to remedy this problem. Consequently, the Kyoto Protocol's objectives of reducing GHGs, primarily carbon dioxide, to a level that is five percent below 1990 discharges by 2112, are receding into the distance and appear effectively

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100. *See id*.

101. *See id*.

102. *See* Senate Resolution Regarding UNFCCC, *supra* note 9.

103. For an overview of the Administration's stance after the results of COP-2, *See* Administration Statement, *Global Climate Change Negotiations*, Congressional Testimony by Federal Document Clearing House, Sept. 26, 1996, *available* in 1996 WL 13104202.

104. *See* Kyoto Protocol, *supra* note 1, art. 3(1), *reprinted in* 37 I.L.M. at 33. The United States agreed to a reduction of emissions of 7%, the Europeans to a reduction of 8%, and the Japanese to a reduction of 6%. *See id*. Annex B, *reprinted in* 37 I.L.M. at 43.

105. The Kyoto Protocol allowed for two types of implementation based upon: (1) joint implementation between Annex I (developed) countries, including the creation of mechanisms such as the creation of a "bubble" for the European Union and the clean development mechanism (between developed and developing countries), and (2) emissions trading between industrialized countries. *See* Nanda, *supra* note 84, at 328-29.

106. An estimate for the United States is that it will miss the hortatory year 2000 target of the UNFCCC by 13%. *See* Paul E. Hagen et al., *International Environmental Law*, 32 INT'L LAW, 515, 517 (1997).

unattainable. But what is even more disturbing is that even if the Kyoto Protocol were fully and faithfully implemented, GHGs will double to their pre-industrial levels by the year 2100, and quadruple within another 50 years.[107]

IV. WHY THE KYOTO PROTOCOL IS IRREPARABLY FLAWED

A. The Meaning of Sustainable Development

In 1983, the World Commission on Environment and Development (WCED or Brundtland Commission) was constituted by the General Assembly of the U.N., and charged with proposing long-term environmental strategies for SD.[108] That elusive term was not defined by the U.N., and despite the efforts of the Brundtland Commission and the Earth Summit of 1992 in Rio de Janeiro (Earth Summit),[109] still eludes satisfactory definition. After four years of deliberation, worldwide consultation and study, the Brundtland Report, titled *Our Common Future*, articulated the paradigm on which the Earth Summit, and indeed international environmental law, has since been based.[110] In essence, it rejected the despairing thesis that environmental problems were past repair, spiraling out of control, and could only be averted by *no growth* that arrested development and economic growth.[111] Instead, it argued that economic growth was both desirable and possible within a context of SD.[112]

SD has come to be accepted as a foundational norm of environmental law and policy by the international community. Though proclaimed the *grundnorm* of international environmental law since the Earth Summit, the concept admittedly still bears a chimerical character and calls to be honed, refined and more clearly defined.[113] While this process of development has been progressing,

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107. *See* IPCC CLIMATE CHANGE 1995, *supra* note 23, at 25.

108. *See Process of Preparation of the Environmental Perspective to the Year 2000 and Beyond,* U.N. GAOR, 38th Sess., Supp. No. 47, 102d plen. mtg., at 131, U.N. Doc. A/38/47 (1983).

109. The Earth Summit culminated in the creation of five primary documents: the Rio Declaration on Environment and Development; Agenda 21; the Framework Convention on Climate Change (FCCC); the Convention on Biological Diversity; and the Statement of Principles for a Global Consensus of the Management, Conservation, and Sustainable Development of All Types of Forests.

110. *See generally* WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, OUR COMMON FUTURE (1987) [hereinafter OUR COMMON FUTURE].

111. *See id*. at 1.

112. *See id*. at 49-54.

113. *See* Ben Boer, *Institutionalizing Ecologically Sustainable Development: The Roles of National, State, and Local Governments in Translating Grand Strategy into Action*, 31 WILLAMETTE L. REV. 307, 317 (1995) (asserting that the concept is growing into an "environmental mandate for the world"); *See also* Catherine Giraud-Kinley, *The Effectiveness of International Law: Sustainable*

a recent re-statement of SD, conceptualized by a group that includes a significant number of Nobel Laureates, is worthy of particular attention.[114] The re-statement defines SD as the wise use of resources through social, economic, technological, and ecological policies governing natural and human-engineered capital.[115] Such policies should promote innovations that assure a higher degree of life support for human needs fulfillment, across all regions of the world, while ensuring intergenerational equity.

SD marks a departure from our thinking of the sixties and seventies by recognizing that humans are part of the environment and ought no longer to be treated as predators within the natural systems of the world. Although SD was not clearly defined by the Brundtland Report, some of its key attributes are identifiable. First, it calls for developmental policies and for economic growth that can relieve the great poverty of the least developed countries, while protecting the environment.[116] Second, development and growth should be based on policies that sustain and expand the environmental resource base in a manner that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.[117] Consequently, SD was seen as environmentally sensitive development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.[118] From this standpoint, SD gives parity of status to economic growth and environmental protection. It rejects economic development and growth that is not environmentally sensitive or destroys the resource base. Thus it embraces both development and environmental protection.[119]

The iteration of SD that emerged at the Earth Summit was somewhat different. To begin, the intended "Earth Charter" was replaced by the "Rio Declaration on Environment and Development" (Rio

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Development in the South Pacific Region, 12 GEO. INT'L ENVTL. L. REV. 125, 130-31 n.19 (1999) (summarizing the current competing conceptions concerning SD's rise to a mandate of international environmental law).

114. *See Conceptual Framework*, in ENCYCLOPEDIA OF LIFE SUPPORT SYSTEMS (visited June 22, 2000) <http://www.eolss.co.uk/CF.pdf > [hereinafter *Conceptual Framework*].

115. *See id*.

116. *See* OUR COMMON FUTURE, *supra* note 110, at 49.

117. *See id*. at 44; cf. Giraud-Kinley, *supra* note 113, at 130 (describing two basic elements derived from the concept of sustainable development: a temporal element calling for maintaining natural resources at a renewable level for use by future generations; and a spatial element "integrating economic and ecological factors in decision-making").

118. *See* OUR COMMON FUTURE, *supra* note 110, at 8.

119. *See* John C. Dernbach, *Sustainable Development as a Framework for National Governance*, 49 CASE W. RES. L. REV. 1, 19 (1998).

Declaration),[120] a title that diminished the environmental resonance and status of that document.[121] Second, the principles of the Rio Declaration, when compared to those of the Stockholm Declaration,[122] stressed development at the expense of conservation.[123] For example, the nascent right to a wholesome environment embodied in the Stockholm Declaration was abandoned in favor of a right to development (Principle 2) in the Rio Declaration.[124] The obligation not to cause trans-frontier damage contained in Principle 21 of the Stockholm Declaration[125] was weakened in Principle 2 of the Rio Declaration by the addition of crucial language authorizing states "to exploit their own resources pursuant to their own environmental and *developmental* policies."[126]

The obligation to *conserve* implied by the duty to protect the environment for the benefit of future generations found in the Stockholm Declaration is replaced in the Rio Declaration by a right to *consume* or develop. The Rio formulation refers to "developmental and environmental needs of present and future generations" (Principle 3).[127] This re-formulation impliedly negates or weakens the obligation to conserve expressed in the Stockholm Declaration. Finally, the Rio Declaration frowns upon action such as that taken by the United States under the Marine Mammal Protection Act of 1972[128] to prevent the killing of dolphins by prohibiting imports of tuna caught in dolphin killing nets. Principle 12 of the Rio Declaration states that "[u]nilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided."[129]

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120. *Report of the United Nations Conference on Environment and Development: Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26/Rev. 1 (vol. I) (1992), *reprinted in* 31 I.L.M. 874 (1992) [hereinafter Rio Declaration].

121. *See* Marc Pallemaerts, *International Environmental Law in the Age of Sustainable Development: A Critical Assessment of the UNCED Process*, 15 J.L. & COM 623, 628-29 (1996).

122. The Stockholm Declaration was produced by the 1972 United Nations Conference on the Human Environment, a conference that was prompted by concerns of environmental destruction around the world. The Stockholm Declaration articulated 26 principles grounded in the objective of "inspir[ing] and guid[ing] the peoples of the world in the preservation and enhancement of the human environment." *Report of the United Nations Conference on the Human Environment, Declaration of the United Nations Conference on the Human Environment*, U.N. Doc. A/CONF.48/14/Rev.1 (pmbl.) (1972), *reprinted in* 11 I.L.M. 1416 (1972) [hereinafter Stockholm Declaration].

123. *See* Pallemaerts, *supra* note 121, at 630-36 (analyzing the Principles of the Rio declaration as affirming the right of developmental imperatives over ecological requirements).

124. *See* Rio Declaration, *supra* note 120, princ. 2, *reprinted in* 31 I.L.M. at 876.

125. *See* Stockholm Declaration, *supra* note 122, princ. 21, *reprinted in* 11 I.L.M. at 1420.

126. Rio Declaration, *supra* note 120, princ. 2, *reprinted in* 31 I.L.M. at 876 (emphasis added).

127. *Id*. princ. 3, *reprinted in* 31 I.L.M. at 877.

128. 16 U.S.C. §§ 1361-1421 (1994).

129. Rio Declaration, *supra* note 120, princ. 12, *reprinted in* 31 I.L.M. at 878

Not surprisingly, some commentators, including the present author, have argued that the Rio Declaration institutionalized a preeminent right to economic development that enfeebled and attenuated the ecological imperative of SD.[130] Such a claim is confirmed by language of the Convention on Biological Diversity (CBD).[131] SD functions as a prevailing force and the ultimate objective of the CBD.[132]

Despite these misgivings about what SD ought to mean, the hard fact remains, however, that SD is about economic growth. Consequently, the *Encyclopedia of Life Support Systems Conceptual Framework* defines sustainable development as development that wisely uses human and natural resources so as to "assure a higher degree of human needs fulfillment, or life support."[133] The life support systems referred to are both natural and social systems that promote human welfare. Thus "life support systems" are defined as "natural environmental systems as well as ancillary social systems required to foster societal harmony, safety, nutrition, medical care, economic standards, and the development of new technology . . . that . . . operate in partnership with the conservation of global natural resources."[134] These definitions give primacy to the pursuit of human welfare and the betterment of human quality of life through the prudential conservation of natural resources. The emphasis is clearly on the advancement of human welfare and not the protection of the environment or the preservation of natural resources for its own sake. In sum, it would be fair to conclude that the balance in SD on the international level is weighed in favor of development, not conservation.

The manner in which SD is being defined can have profound implications for law, policy and institutions. As presently envisioned, the promotion of human needs fulfillment is not countervailed by environmental or conservationist constraints, except where environmental abuse might imperil human needs fulfillment. This per-

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130. *See* Pallemaerts, *supra* note 121, at 656; David A. Wirth, *The Rio Declaration on Environment and Development: Two Steps Forward and One Back, or Vice Versa?*, 29 GA. L. REV. 599, 640-42 (1995).

131. *See Convention on Biological Diversity*, United Nations Conference on Environment and Development, June 5, 1992, *reprinted in* 31 I.L.M. 818 (1992).

132. The Preamble to the Convention on Biological Diversity declares that "States are responsible for conserving their biological diversity and for using their biological resources in a sustainable manner," and that signatories are "[d]etermined to conserve and sustainably use biological diversity for the benefit of present and future generations." *Id.* pmbl., *reprinted in* 31 I.L.M. at 822, 823.

133. *Conceptual Framework*, *supra* note 114.

134. *Id.* at 1.

spective may be contrasted with the existing paradigm of U.S. environmental laws and policies as found in the National Environmental Policy Act of 1969 (NEPA),[135] Endangered Species Act of 1973 (ESA),[136] the Wilderness Act,[137] the Clean Air Act (CAA)[138] and Clean Water Act (CWA).[139] These U.S. laws institutionalize environmental protection as a value in its own right, whether or not human needs are fulfilled or promoted.[140] They embody a concept different to sustainable development as presently defined, based at least in part on a view of the environment and ecology that is not scientifically supported.

Despite this paradigm shift, this essay maintains that the Kyoto Protocol repudiated SD. The reason is that environmental protection still remains an integral, albeit weakened, component of SD. The prominence given to development in SD does not nullify the need to preserve or support the life support systems on which human fulfillment is based. To do otherwise would be to destroy the primary source of human welfare. Moreover, when facing a global peril of the magnitude of climate change, it is difficult to argue that a common threat to global security does not call for common action. Surely, there is no moral or ethical justification for allowing a deprived member of the family to fuel a deadly fire that is being put out by the others.

B. Exemption of Developing Countries

The Kyoto Protocol remains an irreparably flawed instrument because it exempts developing countries from even voluntary reductions of carbon dioxide. By exempting developing countries from any form of self-restraint, they have been freed and authorized to pollute by relying on as much fossil fuel energy as they may choose. The case of China illustrates how SD has been negated by the Kyoto Protocol.[141] China emits 14% of the world's GHGs in comparison to the 22% emitted by the United States today. China's modest contribution to GHG emissions in the past, however, stands

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135. 42 U.S.C. §§ 4321-70d (1994).
136. 16 U.S.C. §§ 1531-43 (1994).
137. 16 U.S.C. §§ 1131-36 (1994).
138. 42 U.S.C. §§ 7401-7671q (1994).
139. 33 U.S.C. §§ 1251-1387 (1994).
140. *See* infra notes 242-247 and accompanying text.
141. The following discussion of China incorporates substantially the research findings of Deborah Cooper in her article examining the vast impact China is predicted to have on the emissions of GHGs. *See* Cooper, *supra* note 43, at 404-07, 416-17.

in bleak contrast to the future. China's energy consumption is expected to rise with future economic development and rising standards of living, causing carbon dioxide emissions to increase dramatically. It is predicted that China's annual carbon dioxide emissions could rise to 2380 metric tons of carbon by the year 2020, if the expected energy consumption is met. In addition, because it is anticipated that China will rely upon coal-fired power production for the next 100 years, its emissions from energy use could expand from "today's 0.7 billion tons to 3.2 billion tons by the year 2025."[142] In that event, China's contributions alone would constitute 40% of global emissions and would likely undercut whatever progress is made by the emission reductions by those developed countries implementing the Kyoto Protocol.

China's reliance upon coal-fired power production is aggravated by the use of high-sulfur coal and the inefficient power plants.[143] High-sulfur coal is used because of abundance and ease of mining, but vast amounts of energy go by the wayside when it is burned.[144] This is because a typical Chinese power plant's efficiency rate is only 6%, as compared to a typical American power plant efficiency rating of 36%.[145] Accordingly, the Chinese have to use six times more coal to produce an equivalent amount of U.S.-produced energy.[146] Moreover, reliance on this type of coal has caused severe air pollution throughout China. Seventy percent of smoke or dust and ninety percent of sulfur dioxide emissions stem from the burning of coal.[147] This severe level of air pollution causes nausea, dizziness, lung cancer, bronchitis, pneumonia, and asthma.[148] In fact, the Ministry of Public Health reported the poor air quality was a contributing factor in 26% of all deaths in China in 1988.[149] This figure has been corroborated by the World Bank, according to which respiratory disease associated with air pollution is the leading cause of death in China.[150] Air pollution of this magnitude has also caused

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142. *Id*. at 404. However, a 1999 Energy Information Administration report stated that coal production had started to drop in China. *See* Ken Ward Jr., *2000 and Beyond: The Future of Coal*, CHARLESTON GAZETTE & DAILY MAIL, Feb. 13, 2000, at 1A, *available in* 2000 WL 2592532.

143. *See* Cooper, *supra* note 43, at 404.

144. *See id*.

145. *See id*.

146. *See id*.

147. *See* Chenggang Wang, *China's Environment in the Balance*, WORLD & I, Oct. 1, 1999, at 176, available in 1999 WL 11151439.

148. *See* Cooper, *supra* note 43, at 405.

149. *See id*. at 405-06.

150. *See id*. at 406.

diminishing crop yields, and a shortage on the level of 100 million tons of grain could occur by the year 2030.[151]

China's carbon dioxide emissions will be exacerbated by its economic progress that leads to increases in the use of vehicles and personal energy.[152] Previously, more than one in three Chinese exclusively used bicycles for transportation, but cars are increasingly becoming status symbols.[153] The car industry has been embraced by China as a foundation of its growing economy. By the year 2000, China aims to produce three million cars per year for domestic use.[154] If vehicle use in China ends up paralleling the United States, this would account for over 19% of the world's GHG emissions.[155] China's philosophy also opposes limits on personal energy consumption because such limits are viewed as a barrier to prosperity.[156]

The picture thus is clear that China is not engaging in SD because SD encapsulates economic development with due care for the environment.[157] It embraces the idea that development can prevail over simple preservationism but not that the environment ought to be sacrificed for economic growth. Rather, development can coincide with environmental consciousness, and must be sensitive to environmental protection. SD is not a form of "ecocolonialism." China's purported objective of avoiding "ecocolonialism," therefore may be seen as an ill-disguised subterfuge for advancing its own economic advantage at the expense of the global environment.

This becomes clear from China's negotiating position at Kyoto which demonstrated that its desire to pursue economic development trumps environmental goals. The position of China and other countries like India and Brazil was that economic development is a necessity, while environmental protection is a luxury that developing countries cannot afford.[158] In the words of Chinese Foreign Ministry spokesman, Tang Guoqiang, China would "shoot

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151. *See id*.
152. *See id*.
153. *See id*.
154. *See id*. at 407.
155. *See id*.
156. *See id*.
157. See Sir Shridath Ramphal, *Sustainable Development*, in THE ENCYCLOPEDIA OF THE ENVIRONMENT 680 (1994).
158. It appears, however, that the collective developing country consensus is becoming fractious. *See* Cheryl Hogue, *Climate Change: Once Solid Developing Country Bloc Dividing Into Five or More Factions*, 21 INT'L ENV'T REP. (BNA) 1201 (Nov. 25, 1998).

down any treaty that would hamper developing countries' hopes of prosperity."[159]

There is no doubt that, in poor developing countries, problems of poverty, famine, natural disaster and social unrest appear far more real than any long term effects of global warming. It is also incontrovertible that developing countries have a right to development, recognized by the UNFCCC in Article 3(4) as "a right to . . . sustainable development" requiring each Party to "tak[e] into account that economic development is essential for adopting measures to address climate change."[160] In addition, Article 3(5) states that the Parties should cooperate to achieve "sustainable economic growth and development in all Parties."[161] This premise is incontestable, but as we have observed, environmental protection is an integral, if diminished, component of SD and SD cannot just be equated to development *simplicitur.*

The restriction of emissions reductions to developed countries alone adversely affects SD in other ways. Carbon dioxide emission controls will raise the cost in participating countries of manufacturing those goods whose production requires substantial energy. For these products, industries in developing countries such as China, India and Brazil will gain an advantage over industries in countries that adhere to emission controls. Hence, once developing countries have invested in production facilities as part of their economic development, they will be more reluctant to take emission control measures that threaten these activities.[162]

C. Environmental and Economic Nonsense

The Kyoto Protocol does not make environmental sense. The core of the Protocol calls for the reductions of GHGs by at least 5% below 1990 levels between 2008 and 2012.[163] What happens if these targets are perfectly met? The IPCC climate models dealing with central scenarios predict 1.4°C warming by the year 2050.[164] If the same models are run, computing for the Kyoto Protocol mandated emission levels, there appears, under one viewpoint, only to be an

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159. *Greenhouse Treaty Fight*, S. CHINA MORNING POST, Nov. 30, 1997, at 6, *available in* 1997 WL 13272657.

160. UNFCCC, *supra* note 3, art. 3(4), *reprinted in* 31 I.L.M. at 855.

161. *Id*. art. 3(5), *reprinted in* 31 I.L.M. at 855.

162. *See* Jacoby et al., *supra* note 12, at 60.

163. *See* Kyoto Protocol, *supra* note 1, art. 3, *reprinted in* 37 I.L.M. at 33.

164. *See* Russell Jones, *An Assessment of the Kyoto Protocol, Transcript from Panel Discussion, April 15, 1999*, 11 GEO. INT'L ENVTL. L. REV. 767, 777 (1999).

avoidance of one-twentieth of one degree of the predicted 1.4°C warming.[165] Another view is that the Kyoto Protocol helps only to the extent of a 16% reduction of global warming if that reduction is held stable for the whole of the century.[166] But, of course, as previously stated, reductions by developed countries alone cannot hold reductions stable because the increasing emissions of developing countries will more than compensate for reductions by developed countries.

Historically, contributions to atmospheric GHGs have been made by the industrialized countries, led in volume by the United States. Unfortunately, forecasts for the next century show significant increases in emissions from developing nations, and emissions from such nations are projected to equal or exceed the amount emitted by developed nations by the year 2030.[167] In contrast to the positions by developing countries, the U.S. Senate, as we have seen, resolved that any responsibility for reducing carbon dioxide cannot be borne by the developed countries alone. By 2010, developing countries are expected to account for 45% of worldwide GHG emissions, and China and India will have greater growth in emissions than all twenty-four member countries of the Organization of Economic Cooperation and Development combined.[168]

The refusal of the developing countries to control their emissions as part of the global effort to stabilize concentrations of GHGs presents a major diplomatic challenge.[169] Current efforts to include developing countries within the emission reducing framework of the Kyoto Protocol have proven unsuccessful.[170] By any analysis, portentous implications arise from the present diplomatic deadlock with regard to the cooperation of developing countries and the rising concentrations of GHGs.

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165. *See id*.

166. *See* Jacoby et al., *supra* note 12, at 63-64

167. *See* Drumbl, *supra* note 5, at 286.

168. *See* Richard N. Cooper, *Toward a Real Global Warming Treaty*, 77 FOREIGN AFF. 66, 68-69 (Mar./Apr. 1998).

169. *See id*.

170. The issue of binding emission controls on developing countries did not even make it to the agenda at the fourth conference of the parties (COP-4) at Buenos Aires in Nov. 1998. The efforts of the United States to include developed countries in the effort to stabilize GHGs were successfully thwarted by China and the "Group of 77." *See Climate Change: Proposal to Require Developing Countries to Reduce Emissions Rebuffed by China*, 29 ENV'T REP. (BNA) 1337-38 (Nov. 6, 1998). While Argentina agreed to voluntary emissions limitations, they are exceptions to the overwhelming opposition of developing countries to submit to any GHG limitations. *See* William K. Stevens, *Argentina Takes a Lead in Setting Goals on Greenhouse Gasses*, N.Y. TIMES, Nov. 12, 1998, at A7.

Those advocating unilateral developed country emission reductions emphasize the symbolic value of cuts by developed countries which, according to them, will motivate and encourage developing countries to follow suit.[171] This is an unfounded premise. Kyoto proponents mystifyingly claim that even though defiant developing nations have obdurately refused to undertake any reductions of carbon dioxide emissions, the United States nevertheless must set a moral example by accepting the costs of the Kyoto Protocol. By such selfless action the United States will shame other misguided nations into becoming responsible members of the community of nations by accepting carbon dioxide reductions.[172]

While this might be a good script for a morality play, the international community of nations functions within a hard world of Realpolitik. All nations are fully aware of their statuses as co-equal sovereign entities and behave as rational entities who pursue their own national interests, expecting others to do the same. And that, as we have seen, is precisely what nations have done. It makes no sense to require one segment of the community of nations to forebear or desist from conduct which other members are free to carry out. Even more poignantly, it is nonsense to allow one section of the community of nations to flood mine shafts that are simultaneously being drained by others.

Second, the argument for unilateral developing country reductions assumes that developed countries will meet the unrealistic short-term obligations of the Kyoto Protocol. Such an assumption flies in the face of the available evidence.[173] While the Kyoto Protocol demands at least a 5% reduction from 1990 levels in carbon dioxide emissions, according to the most recent Organization for Economic Cooperation and Development (OECD) evidence from twenty-nine industrialized (developed) countries, carbon dioxide emissions by energy use have increased 9% since 1990, now

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171. *See* Alex G. Hanafi, Note, *Joint Implementation: Legal and Institutional Issues for an Effective International Program to Combat Climate Change*, 22 HARV. ENVTL. L. REV. 441, 459 (1998).

172. Another problem with this strategy is that it is unclear when a country would be considered at the proper stage of economic development for moving to "developed" status, particularly if doing so leads to loss of eligibility in favorable economic development programs. *See* Cooper, *supra* note 168, at 78.

173. Even if industrialized countries complied with the Kyoto Protocol, the Department of Energy's Energy Information Administration projected that carbon emissions would be 32% greater than 1990 levels by 2001, rather than 44% greater without the Kyoto Protocol's limitations. *See Energy: Carbon Emissions Predicted to Increase Substantially by 2020, DOE Report Says*, 21 INT'L ENV'T REP. (BNA) 439 (Apr. 29, 1998).

accounting for 54% of global carbon dioxide emissions.[174] Among the signatories to the Kyoto Protocol, the increases were 10% in Japan, 12% in North America, and 16% in Australia.[175] According to other estimates, U.S. emissions are likely to be 20 to 25% above 1990 levels by the year 2007.[176]

Moreover, the U.S. has a 7% reduction target under the Kyoto Protocol 1990 figure, the European Union has an 8% reduction target and Japan has a 6% reduction target.[177] But U.S. population growth over the twenty-year period to 2010 is forecast as 20%, whereas in Western Europe and Japan growth is projected at 2 to 3%.[178] The U.S. has a much harder target to achieve, given the projected increase in its population. To achieve the 7% cuts below 1990 levels required by the Kyoto Protocol, the U.S. would need to reduce its carbon dioxide emissions by at least 30% in the space of four years and this according to some commentators is "simply laughable."[179]

As to the increasing volume of carbon dioxide emissions, some commentators suggest that developed countries could comfortably adapt to or mitigate the consequences of a doubling of GHGs.[180] They argue that GHG reductions, in the long term, would occur naturally with the advance of technology, following investment cycles based on demand. According to one commentator, future carbon dioxide reductions should be left to the development of new reduced carbon technologies and better sources of energy driven by markets that demanded cleaner and cheaper energy.[181]

The Kyoto Protocol, however, requires dramatic carbon dioxide emission cuts by 2010, without regard to investment and technology cycles.[182] A fundamental question, then, is whether it is economically efficient and environmentally effective to demand that a manufacturer or utility incur significant costs in retrofitting to meet a short-term deadline, as opposed to phasing in more efficient equip-

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174. *See Climate Change: Greenhouse Gas Emissions Rising Across Industrialized World, OECD Says*, 23 INT'L ENV'T REP. (BNA) 3 (Feb. 2, 2000).

175. *See id*.

176. *See* Jacoby et al., *supra* note 12, at 64.

177. *See* Kyoto Protocol, *supra* note 1, art. 3 and Annex B, *reprinted in* 37 I.L.M. at 33, 43.

178. *See* Jones, *supra* note 164, at 780-81.

179. *See* Jacoby et al., *supra* note 12, at 64.

180. *See* Rob Coppock, *Implementing the Kyoto Protocol*, 14 ISSUES IN SCI. & TECH. 66, 68 (1998). *See also* Alex G. Hanafi, *Note, Joint Implementation: Legal and Institutional Issues for an Effective International Program to Combat Climate Change*, 22 HARV. ENVTL. L. REV. 441, 448 (1998) (citing estimates of damage from doubling of carbon dioxide pre-industrial levels using 1988 GNP as ranging from 1.4% in the United States and 1.6% in the EC to 5.3% for China).

181. *See* Coppock, *supra* note 180, at 74.

182. *See id*. at 66.

ment and technology as old machinery and processes become obsolete. The clear answer emerging from an examination of a number of industries is that it is not. A few examples offered by Coppock are illuminating.[183]

Coppock first refers to the pulp and paper industry, an energy intensive and polluting industry.[184] If the Kyoto Protocol were implemented, the industry would have to undertake costly action to reduce emissions of carbon dioxide. This immediate costly action could not fully incorporate the benefits of a new energy reducing bleaching process being developed which has yet to be perfected and widely deployed. The industry would end up spending money now that could have been invested in the new bleaching process, delaying a natural reduction in energy use and carbon dioxide emissions.

Likewise, in the metal casting industry, new technology is being developed that would increase the yield of the casting process from 55 to 65%.[185] A higher yield means that less raw material and power will be needed for processing, leading to less carbon dioxide emissions. As with the pulp and paper industry, spending money to bring the new process online, rather than on controls, benefits both global warming and the manufacturer's costs.

Another example offered by Coppock comes from the commercial building sector.[186] The replacement of static insulation (put in walls and roofs to increase thermal resistance) with "dynamic systems" like "computer-controlled windows" and "sensor-controlled ventilation systems" could decrease a building's heating and cooling energy load by as much as 35 to 45%.[187] New buildings with such characteristics thus would use very little space heat.[188] Unfortunately, new buildings comprise only 2 to 3% of the existing building stock in any given year.[189] Also, almost 80% of commercial buildings in existence in 1997 will still be in use in 2010.[190] Coppock suggests that retrofitting existing buildings with dynamic insulation systems would be less cost effective than waiting for the natural

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183. The following seven paragraphs incorporate substantially the findings and suggestions of Coppock's discussion of the difficulties in implementing the Kyoto Protocol. See Coppock, *supra* note 180, at 69-71.

184. *See id*. at 70.

185. *See id*.

186. *See id* at 71.

187. *Id*.

188. *See* POLICY IMPLICATIONS OF GREENHOUSE WARMING, *supra* note 19, at 223. Building efficiency may also be improved by passive solar techniques. *See id*. at 220.

189. *See* Coppock, *supra* note 180, at 71.

190. *See id*.

turnover to improve the energy consumption, i.e. carbon emissions.[191]

Similarly, electric utilities would have to add costly equipment that would be used for only a few years beyond 2010.[192] The equipment would then be obsolete as more efficient generation equipment became available. Because retrofitting is the only mechanism to meet the deadline of the Kyoto Protocol, electric utilities' finances would be compromised with the destruction of costly equipment before the expiration of their useful lives. Forcing utilities to incur short-term expenses will deprive them of funds that could be used to purchase more expensive, but more efficient, equipment when the time comes to replace current generators. Rates may be increased and the utility's ability to bring online more efficient equipment would be jeopardized. A much bigger return would be achieved by the "wider use of combined systems such as cogeneration, where waste heat from electricity generation is used to power industrial processes or heat buildings."[193]

These examples make clear that a rush to adhere to the Kyoto deadline of 2010 will raise short-term costs considerably and siphon off money that could be used for smarter, long-term investments that would both reduce carbon dioxide by the same levels and result in lower costs and emissions of supplemental pollutants.

Coppock continues his analysis by pointing out that the U.S. Department of Energy's Energy Information Administration estimates that carbon dioxide emissions will increase 30% by 2010 if no actions are taken, requiring annual emissions to be reduced by about 400 million tons to achieve 1990 levels.[194] The Environmental Energy Technologies Division at the Lawrence Berkeley National Laboratory calculates that U.S. emissions could be lowered about half the distance to 1990 levels through efficiency approaches costing about $50 per ton of avoided carbon emissions.[195] If the burden for this reduction were equally spread across all sources of emissions and all consumers bore the costs, this would result in an increase in the price

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191. *See id*.

192. *See id*.

193. *See id*. Another helpful technology currently viable is the potential for coal-fired plants to utilize combined-cycle natural gas facilities to cut down on GHG emissions. It seems, though, that regulatory hurdles destroy the incentive to utilize the newer technology, because higher profits can be gleaned from grandfathered power facilities. *See* David Mallery, Comment, *Clean Energy and the Kyoto Protocol: Applying Environmental Controls to Grandfathered Power Facilities*, 10 COLO. J. INT'L ENVTL. L. & POL'Y 469, 473 (1999).

194. *See* Coppock, supra note 180, at 69.

195. *See id*.

of gasoline of 12 cents per gallon.[196] An estimate garnered by the American Petroleum Institute is that "it would cost about $200 per ton to get all the way down to the 1990 level."[197] These estimates show considerable costs, yet the United States' commitment under the Kyoto Protocol (7% below 1990 emissions) is greater; achieving the additional reduction would be even more expensive.

The U.S. commitment to reduce emissions more than 30% below what they otherwise would be in 2010 will therefore entail enormous changes in industry and consumer practices.[198] Under this time scale of the Kyoto Protocol, the question is whether such huge efforts will be made. The answer given by the Clinton administration is that tax incentives, research subsidies, and trading will allow the United States to meet its goal with price hikes of only 4 to 6 cents per gallon of gasoline.[199] But this can be accomplished only if abatement costs are cut in half through emissions trading with other industrial countries, as well as by another quarter from trading with developing countries.[200] Robert Stavens, a distinguished economist advising the Administration, said the following of the Administration's claims: "It is true that the impact can be relatively small—if this is done in the smartest possible way. But if we don't do it that way it will cost 10 times what the administration is saying."[201]

V. THE WAY FORWARD

A. Future Scenarios

The IPCC has developed a range of six scenarios based on anthropogenic increases in GHGs[202] and the Massachusetts Institute of Technology has developed seven forecasts of climate change.[203] Between them, these sets of forecasts deal with temperature increases of between 1 to 5°C (2 to 9°F).[204] Most analysts agree that the most

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196. *See id*.

197. Id.

198. *See id*. at 70

199. See id.

200. *See id*.

201. *Id*. at 70 (quoting Robert Stavens, an economist and professor of public policy at Harvard's John F. Kennedy School of Government).

202. *See* IPCC CLIMATE CHANGE 1995, *supra* note 23, at 5. The range of scenarios, IS92a-f, is based on assumptions of population and economic growth, land-use, technological changes, energy availability, and fuel mix from 1990 to 2100. *See id*.

203. *See* Jacoby et al., *supra* note 12, at 57.

204. Under the Massachusetts Institute of Technology model, future climate change could be in the range from 2 to 9°F if nothing is done to curb GHG emissions. *See* Nanda, *supra* note 84, at 320.

extreme of these scenarios implies significant risk to the earth's life support systems, including ocean circulation, polar glaciers, unmanaged ecosystems, agriculture and human health.[205] It is accepted that concentrations of carbon dioxide were fairly constant in the atmosphere at 280 parts per million (ppm) and that this figure has increased to 350 ppm today.[206] While the life support systems of the world could live with a doubling of this figure, a quadrupling could lead to dangerous even catastrophic consequences.[207] It does seem, therefore, that we do need to take some preventive action against possible calamitous circumstances. What is certain is that at present rates of discharge, carbon dioxide concentrations will double within the next 50 to 100 years and quadruple by the year 2150.[208]

A doubling of the pre-industrial concentration of carbon dioxide poses only modest environmental and economic problems and little, if any, economic problems if counteracted with good planning.[209] If the pre-industrial concentration is quadrupled, the consequences might be disastrous. In this respect, some educated guesses can be made as to the relationship between temperature rise and the confrontation of serious thresholds. For example, various models indicate U.S. agriculture would have to shift to a different set of cultivars if the 5°C threshold is crossed, because of changed weather patterns and soil moisture. The alteration of rainfall patterns, along with the reconfiguration of ecosystems, would likely change the nutrient flows of Midwest soils, posing a serious threat to that region's agricultural productivity. Similarly, bottomland hardwood forests of Texas might not be able to rebound from fires or storms, affecting viability of preserved and commercial forests there.

The fear is that at some point, continued temperature rise will trigger global changes of a magnitude that does not allow for adaptation. They would, in the language of the UNFCCC, amount to a "dangerous anthropogenic interference with the climate system."[210] Illustrative of such change, were it to occur, is ocean circulation. Salinity and temperature differentials in the oceans are significant contributing factors in driving what is called the deep ocean conveyer, a huge flow that sinks in the North Atlantic, runs

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205. *See* Jacoby et al., *supra* note 12, at 58.

206. *See* Cline, *supra* note 16, at 26.

207. *See* Coppock, *supra* note 180, at 67.

208. *See id*.

209. This paragraph relies upon Coppock's research of the impact of increases in carbon dioxide concentration in the atmosphere on agriculture. *See id*. at 68-69.

210. UNFCCC, supra note 3, art. 2, *reprinted in* 31 I.L.M. at 854.

around the African cape, and empties into the Pacific Ocean.[211] Upwelling currents from this conveyer carry nutrients to the major fishing areas of the world.

Some commentators argue that sufficient warming could increase precipitation in the North Atlantic Basin enough to change salinity and alter ocean temperatures, perhaps even stopping the ocean conveyer.[212] This might cause drastic weather consequences around the world, surpassing the effects of the El Niño Southern Oscillation. In particular, it is thought the cessation of the deep ocean conveyer would cool Europe significantly.[213] It is thus critical that any attempt to control GHGs comprehend the long range nature of the problem and take practicable steps to deal with the situation.

B. An Inclusive Treaty

The first step in moving toward a long-term solution to climate change is to include both developing and developed nations in this earth saving enterprise. The inclusion of the developing countries must be on the basis of the concept of "common but differentiated responsibility" (CBDR) articulated in the UNFCCC. Any obligations to protect the climate need not fall disproportionately on the poor and the deprived. Given the enormous disparities of wealth amongst nations, equity, fairness,[214] and efficiency require that discharging the burden of protection should fall differentially and more heavily on the richer nations. Climatic stability is a public good that is of critical importance to all humanity, and ought to be protected by the entire international community. In the absence of a system of international government that can act to protect public goods for collective benefit, other mechanisms should be found.

It may be necessary to work out a scheme that pays at least the poorest of the poor countries to reduce their emissions. There is much to commend the suggestion of one commentator that depending upon the circumstances, global environmental governance and

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211. The ocean's conveyor belt works in the following fashion: the upper loop carries warm waters from the North Pacific across the Indian Ocean, down around Africa, and up the Atlantic Ocean. *See* Richard A. Kerr, *Warming's Unpleasant Surprise: Shivering in the Greenhouse?*, 281 SCI. 156, 156 (1998). North of Iceland, winds absorb the heat and carry it toward Europe, contributing to temperature differentials of as much as 10°C. See id. The flow of the winds also increases saltiness by evaporating freshwater, making the denser surface water sink. The colder, saltier deep water then flows to the south, completing the loop. See id.; *See* also Wallace S. Broecker, *Thermohaline Circulation, the Achilles Heel of Our Climate System: Will Man-Made CO2 Upset the Current Balance?*, 278 SCI. 1582, 1582-83 (1997).

212. *See* Kerr, *supra* note 211, at 156.

213. *See* id.

214. *See* JOHN RAWLS, A THEORY OF JUSTICE 103 (1971).

international environmental law should move from a "Polluter Pay Principle" to a "Beneficiaries Pay Principle."[215] But this should go hand in hand with other more flexible credits to developing countries for reducing GHGs. For example, commitment by developing countries to increased amounts of reforestation, population control measures, energy efficiency, more technology transfers, and more investment in R&D should be brought into any carbon dioxide reduction calculus.

This essay accepts the premise that the world can adapt to a doubling of carbon dioxide from pre-industrial levels. While developed countries can do so quite comfortably, some developing countries face a bleaker prospect. In such cases, there can be no doubt that the principle of CBDR embodied in the UNFCCC demands that the "specific needs and special circumstances" of developing countries, "especially those that are particularly vulnerable to the adverse effects of climate change"[216] should be met by developed countries.[217] These countries, already sorely stressed by socioeconomic and environmental problems that cause considerable human suffering, cannot cope with the added threats posed by climate change. These nations may not have the money to alter farming that might adapt[218] to changing soil moisture or higher temperatures, or to implement widespread control and eradication programs to battle the greater spread of disease by insects or other means.[219]

Developed industrialized nations are obligated to help meet these new demands under the UNFCCC, and it is just and fair that they should do so. Developing nations face so many other socioeconomic and environmental problems that the added challenges imposed by global warming may pose an insufferable burden. For example, even modest sea level rises may pose an

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215. Jonathan Baert Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L.J. 677, 751-752 (1999). The "Beneficiaries Pay Principle" is desirable for regulatory instruments under a Voluntary Assent voting rule, where international agreements bind only those who consent to be bound. *See id*. at 737, 752. This means that those who benefit from global environmental protection must attract non-beneficiaries to participate in global international agreements like the Kyoto Protocol. *See id*. at 752.

216. UNFCCC, *supra* note 3, art. 3(2), *reprinted* in 31 I.L.M. at 854.

217. Id. art. 4(4), *reprinted in* 31 I.L.M. at 858.

218. *See generally* Paul E. Waggoner, *Now Think Adaptation*, 9 ARIZ. J. INT'L & COMP. L. 137 (1992).

219. *See* Jim Dawson, *Scientists Say Global Warming Will Spur Disease Outbreaks*, STAR TRIBUNE (Minneapolis-St. Paul), Feb. 19, 2000, at 7A, *available in* 2000 WL 6960904 (discussing research linking climate change with outbreaks of cholera and the hanta virus).

ominous, even deadly prospect for island nations that are members of the Association of Small Island States.[220]

Some commentators have argued that any additional suffering by developing countries will be real but pales in comparison to the suffering brought about by much larger forces in these countries such as war, oppression, and poverty.[221] While this may be generally true, there are numerous exceptions. Consequently, the UNFCCC places special obligations on developed countries to help developing countries suffering from disadvantageous geographical, natural resource, or environmental circumstances such as those faced by small island countries and those with low-lying coastal areas.[222] In any event, it would be ethically intolerable and morally offensive to permit nations to be swept over by rising seas that have been caused. in major part. due to the activities of developed countries. There surely must be a new international effort to save them from such a plight.

The approach to an inclusive treaty must proceed on many fronts, and no one formula can be applied to all developing nations. One way forward might be to model the treatment of some, though not all, developing nations on the Montreal Protocol on Substances that Deplete the Ozone Layer.[223] China and India held out on signing that Protocol until an agreement about compensatory financing

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220. *See* Burns, *supra* note 22, at 149.

221. *See* Coppock, *supra* note 180, at 68.

222. *See* UNFCCC, *supra* note 3, art. 4(8), *reprinted in* 31 I.L.M. at 858-59, placing a specific obligation on developed countries to help developing countries suffering from the effects of climate change such as:

> (a) Small island countries;
> (b) Countries with low-lying coastal areas;
> (c) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay;
> (d) Countries with areas prone to natural disasters;
> (e) Countries with areas liable to drought and desertification;
> (f) Countries with areas of high urban atmospheric pollution;
> (g) Countries with areas with fragile ecosystems, including mountainous ecosystems;
> (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; and
> (i) Land-locked and transit countries.

In particular, the United States has engaged in a multitude of tasks in 44 countries around the world in meeting its commitment under the UNFCCC. See Jim Fuller, *U.S. Programs Help Developed Countries Cope with Climate Change*, WASHINGTON FILE (visited May 22, 2000) <http://www.usembassy.de/cop5/jf1101a.htm>.

223. *See Montreal Protocol on Substances that Deplete the Ozone Layer*, United Nations, Sept. 16, 1987, *reprinted in* 26 I.L.M. 1541 (1987) (as amended 32 I.L.M. 874 (1993)) [hereinafter *Montreal Protocol*].

had been reached.[224] Quite clearly, the investment and effort necessary to control chlorofluorocarbons (CFCs) does not compare with the colossal problems of controlling GHGs. Nonetheless it may, for example, be possible to induce China, India and Brazil to join an inclusive treaty in exchange for consideration that is deemed fair and equitable. Such consideration should, however, avoid being seen as perverse incentives to these countries to emit more carbon dioxide to obtain greater compensation.

Recognizing the wisdom of using carrots and sticks, the Montreal Protocol also provides for trade sanctions restricting parties from trading in CFCs and CFC-related products with non-parties.[225] A number of commentators feel that trade restrictions play a major role in preserving the integrity of the Protocol,[226] while others argue that trade sanctions are preferable to incentives because they avoid perverse incentive efforts.[227] While trade sanctions might not work on their own, it should be possible to devise an astute mix of sticks and carrots that will induce developed and developing countries to become parties to an inclusive global warming treaty.[228]

C. Research and Development

Dealing seriously with climate change also requires a substantial R&D program to produce new technologies that could bring about deep global emissions reductions and still allow robust economic growth.[229] Such an effort should involve several wealthy

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224. Harold K. Jacobson & Edith Brown Weiss, *Compliance with International Environmental Accords: Achievement and Strategies*, in INTERNATIONAL GOVERNANCE IN ENVIRONMENTAL ISSUES 75, 95 (Mats Roden et al., eds. 1997).

225. *See Montreal Protocol*, supra 223, art. 4, *reprinted in* 32 I.L.M. at 881-82. The Protocol regulated trade with non parties, subject to stipulated procedures, in three ways. First, it banned the import and export of controlled substances from non-parties. Second, it banned imports of products containing controlled substances. Third, after a feasibility study, it banned imports from non-parties of substances made with, but not containing, controlled substances.

226. *See*, e.g., Robert Housman & Durwood Zaelke, *Trade, Environment, and Sustainable Development: A Primer*, 15 HASTINGS INT'L & COMP. L. REV. 535, 580 (1992). The impressionistic view, certainly in the United States, is that trade sanctions are the single most effective way of forcing foreign nations to adopt stricter environmental standards. There appears to be evidence either way. The literature is reviewed in Richard J. McLaughlin, *UNCLOS and the Demise of the United States' Use of Trade Sanctions to Protect Dolphins, Sea Turtles, Whales, and Other International Marine Living Resources*, 21 ECOLOGY L.Q. 1, 25-29 (1994).

227. *See* Sean T. Fox, Note, *Responding to Climate Change: The Case for Unilateral Trade Measures to Protect the Global Atmosphere*, 84 GEO. L.J. 2499 (1996); *see also* Howard F. Chang, *An Economic Analysis of Trade Measures to Protect the Global Environmen*t, 83 GEO. L.J. 2131, 2154-60 (1995). For a contrary view, see Wiener, supra note 215, at 757-760.

228. *See* Wiener, *supra* note 215, at 755-768 (discussing the participation efficiency of regulatory instruments).

229. Technological options for GHG substitution include replacement technologies, involving a 100% reduction in carbon dioxide emissions, and reduction technologies, which involve a reduction in

participating nations. Candidate energy technologies include nuclear, solar, hydroelectric, geothermal, and hydrogen from fossil fuel.[230] Methods for safe and economical long-term storage of carbon in subterranean reservoirs, the deep ocean, and forests are also important research areas, as are technologies that enhance energy efficiency.[231] In contrast, the U.S. "technology initiative" concentrates on subsidizing the adoption of existing technologies but would spend little in the search for long-term breakthroughs. Efforts elsewhere are similarly dwarfed by the challenge. These concrete steps could be treated as part of an overall planetary plan to deal with climate change.

Far more attention must be paid to the development of new technologies for reducing GHG emissions. It will be nearly impossible to slow warming appreciably without condemning much of the world to poverty unless energy sources that emit little or no carbon dioxide become competitive with conventional fossil fuels. Only a large R&D effort can have any hope of bringing this about, although it would be cheap relative to the cost of dramatic reductions in carbon dioxide emissions using current technologies. The range of technological options is wide; from using solar power to produce electricity to converting fossil fuels to hydrogen fuel and storing (underground or deep in the ocean) the carbon dioxide produced as a byproduct.[232] Few of the alternatives currently under discussion, however, can be widely used at reasonable costs without fundamental improvements.

Investment in R&D on new long-term technical options was barely discussed at the Kyoto Protocol. One phrase advocating "cooperat[ion] in scientific and technical research" was tucked away in the text,[233] but that was all; no nation was obliged to devote any resources to R&D. Politicians love to call for more research instead of more regulation, but there is little commitment to the long-term

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emissions of carbon dioxide. *See* Edward B. Barbier et al., *Technological Substitution Options for Controlling Greenhouse Gas Emissions*, *in* GLOBAL WARMING: ECONOMIC POLICY RESPONSES 109 (Rudiger Dornbusch & James M. Poterba eds., 1991).

230. *See id*. at 112-21, 139.

231. Carbon storage through afforestation remains effective, however, only for as long as the forest is expanding, otherwise carbon released by dying trees offsets that stored by new trees. *See* Cline, *supra* note 16, at 216-17. Nonetheless, Cline considers afforestation as a viable option for three reasons: (1) reducing existing deforestation in developing countries is a low cost alternative for reducing carbon emissions; (2) afforestation can provide a temporary window of several decades, allowing time for technological advancement and development; and (3) a strategy of afforestation and use of the resulting biomass for energy can provide for a closed cycle of zero net emissions. *See id*. at 217.

232. *See* Jacoby et al., *supra* note 12, at 66.

233. *See* Kyoto Protocol, *supra* note 1, art. 10(d), *reprinted in* 37 I.L.M. at 37.

development of greenhouse-friendly technology by those countries most capable of producing it.

D. Realistic Long-Term Implementation Strategies

As previously mentioned, it is suggested that the economies of industrialized nations could easily adapt to the climatic consequences of a doubling of pre-industrial atmospheric carbon dioxide.[234] This is because the rate of change will be slow. The trend this century has been about 0.05°C to 0.1°C per decade. Investment cycles for most industrial sectors are rapid enough that suitable adjustments can be made along the way. Even agriculture ought to be able to cope. It takes about eight years to bring a new cereal hybrid into production, which would be needed to adjust to differences in soil moisture, and recent experience breeding disease-resistant rice suggests that genetic engineering can reduce this time. It also will not be long before agricultural implements are able to make "on-the-fly" soil-moisture measurement and precision delivery of fertilizer to offset changes measured.

Clearly, a permanent rise in temperature will give rise to a number of problems. Rising warmth and moisture would also broaden the breeding grounds for insects, most notably mosquitoes, increasing their spread of diseases like malaria, dengue, and yellow fever.[235] However, lifestyle and public health measures such as mosquito control, eradication programs, and piped water systems, which have wiped out these epidemics in the United States, will far outweigh the effects of future climate change.

Even the effort to counter a possible sea level rise of 6 to 37 inches by the end of the next century is not likely to be catastrophic.[236] In urban and industrial locations, the cost of protective sea walls, such as those used in Holland, will be cost effective.[237] Elsewhere the coastline can be left to find its new level. The previously valuable property on the water's edge will be replaced by formerly inland property that becomes newly valuable because it is now next to water. Obviously there will be winners and losers, but then there

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234. *See* Coppock, *supra* note 180, at 68.

235. *See* POLICY IMPLICATIONS OF GREENHOUSE WARMING, supra note 19, at 41.

236. *See* U.S. Department of State, *Meeting the Challenge of Global Climate Change* (visited May 22, 2000) <http://www.state.gov/www/global/global_issues/climate/fs-wh9904_climate_990526.html>.

237. *See* Kathryn S. Brown, *Taking Global Warming to the People*, 283 SCI. 1440 (1999) (discussing worldwide efforts examining the impact of rising sea level and possible countering actions).

always have been. Urban expansion has created more winners and losers than moderate climate change will do.

A doubling would definitely change particular ecosystems, and the most important question may be whether significant disruption will result.[238] Plant and animal life in bodies of fresh water and in wetlands will face new conditions due to higher temperatures and altered precipitation, and may have difficulty producing sufficient organic sediment and root material to adjust. Other so-called "loosely managed ecosystems" have more capacity to adjust. Ecosystems in general will be forced to reconfigure into new communities more rapidly than they have since the end of the last ice age. But research indicates they should be capable of adjusting quickly enough to maintain the grand mineral and nutrient cycles upon which life on earth depends.

We now know that ecological systems do not possess fixed equilibria, or static stability, and are characterized by changes not by constancy.[239] Such a view sees nature in a constant state of change and flux, and stands in marked contrast to the earlier belief that ecological systems existed in perfect balance or stability.[240] Many environmental lawyers and policy makers have been weaned on the view prevailing in the sixties and seventies that law and policy should strive to restore, and not tamper with, the primordial balance of nature.[241] Thus, much bedrock U.S. legislation such as the National Environmental Policy Act,[242] Endangered Species Act,[243] the Wilderness Act,[244] section 404 of the Clean Water Act[245] protecting wetlands, and the broader non-degradation provisions of the Clean Air Act[246] and the Clean Water Act[247] are based on the premise that nature should be preserved or left untouched. According to this equilibrium paradigm, the absence of human intervention would

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238. *See* POLICY IMPLICATIONS OF GREENHOUSE WARMING, *supra* note 19, at 39-40.

239. *See* Daniel B. Botkin, *Ecological Stability*, in ENCYCLOPEDIA OF THE ENVIRONMENT, 164, 166 (Ruth A. Eblen & William R. Eblen eds., 1994).

240. *See id*. at 165.

241. *See* Fred P. Bosselman & A. Dan Tarlock, *The Influence of Ecological Science on American Law: An Introduction*, 69 CHI.-KENT L. REV. 847, 864-69 (analyzing the confluence of the ecological idea of general equilibrium with federal legislation of the 1960s).

242. 42 U.S.C. §§ 4321-70d (1994).

243. 16 U.S.C. §§ 1531-43 (1994).

244. 16 U.S.C. §§ 1131-36 (1994)

245. 33 U.S.C. § 1344 (1994).

246. 42 U.S.C. §§ 7401-7671q (1994).

247. 33 U.S.C. §§ 1251-1387 (1994).

restore the balance of nature, and enable it to achieve a natural permanence of form and structure that persists indefinitely.[248]

By contrast, the nonequilibrium paradigm considers living things and the external world not as separate static entities, but as interacting components of complex dynamic systems.[249] Today's ecologists point out that humans and their environments are not "separate, static entities," but are "interacting components of complex dynamic systems," and that practically all inhabited environments are artificial in the sense that they have been profoundly altered by human cultures.[250] Human life implies interventions into nature, which if properly managed, according to the knowledge available to us, can be ecologically sound, and create new environmental values.[251] According to an important exponent of this viewpoint, it is not always true that nature knows what is best for other creatures, humans, and the environment.[252] Nature often creates ecosystems that are inefficient, wasteful, and destructive. By using reason, knowledge, imagination and toil, people can shape ecosystems that have qualities not found in wilderness.[253]

What we see, therefore, is a historic confluence of politics and science: SD and the non-equilibrium paradigm; creating conceptions of resource use once eschewed by equilibrium ecologists; lawmakers and policymakers. The convergence of these two streams of thinking have heightened the need for a re-evaluation and re-defining of the rationales underlying environmental protection and integration in the United States as well as globally.

Finally, a well-designed, durable institutional structure for reduction of global GHG emissions can significantly reduce the cost of limits on global emissions. Here the key piece of unfinished business from Kyoto is implementing a system for trading the rights to emit greenhouse gases among participating nations.[254] In negotiating the

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248. *See* A. Dan Tarlock, *Environmental Law: Ethics or Science?*, 7 DUKE ENVTL. L. & POL'Y F. 193, 197-98 (1996).

249. *See* Tarlock, *supra* note 248, at 202.

250. ENCYCLOPEDIA OF THE ENVIRONMENT xv (Ruth Eblan & William Eblan eds., 1994).

251. *Id*. at xv-xvi.

252. *See* Daniel B. Botkin, *Beyond the Balance of Nature: Environmental Law Faces the New Ecology: Adjusting Law to Nature's Discordant Harmonies*, 7 DUKE ENVTL. L. & POL'Y F. 25, 26 (1996) (arguing that the revolution in environmental sciences has shown that the balance of nature myth is not true).

253. *See* Rene Dubos, *Humanized Environments*, in ENCYCLOPEDIA OF THE ENVIRONMENT 344 (Ruth Eblan & William Eblan eds., 1994).

254. When COP-6 convenes in November of 2000, a key issue will be implementation of measures on buying and selling the right to emit GHGs, known as carbon trading. *See Environment: Commission to Moot Carbon Trading Plan*, EUR. REP., Mar. 8, 2000, *available in* 2000 WL 8840773.

details of this system, a focus on clear definitions, vigilant monitoring, and strict enforcement is essential. The market should be left unfettered. Many nations oppose trading in any form; others want to restrict its use in meeting emissions commitments. If they make it impossible to implement a plausible framework for international trading of emission rights, the Kyoto Protocol is headed for a dead end, obviating the point of ratifying it.

VI. CONCLUSION

Two articles published after the conclusion of this essay, reinforce key arguments advanced herein. First, the next dimension in the evolving saga of climate change must recognize the endemic uncertainties besetting scientific findings and conclusions about global warming. In a recent offering of remarkable cogency, two accomplished scientists — Daniel Sarewitz and Roger Pielke — demonstrate the extent to which the alleged scientific certainty surrounding the anthropogenic causes and consequences of global warming is a mirage. According to them, "predicting the impact on climate of reducing carbon dioxide emissions is so uncertain as to be meaningless."[255]

Second, the long-term nature of climate change calls for solutions that are both environmentally sensitive and economically realistic within the framework of SD. Strategies for doing so must embrace the developmental priorities of both developing and developed countries and plot a course that acknowledges the risks of climate change as well as the costs of mitigation and adaptation. In a balanced and persuasive political essay, Senator Murkowski argues for just such a bi-partisan approach.[256] Such global strategies must accept both the fragility of our life support systems, as well as the potential for human ingenuity to forge solutions to new challenges.

The task of developing a framework for international decision-making that can work for several decades is a formidable one. It is clear, however, that it should be based upon a tripod that includes the developing world, the importance of R&D, and the use of flexible provisions for emissions reductions. No serious response to climate

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255. Daniel Sarewitz & Roger Pielke, Jr., *Breaking the Global-Warming Gridlock*, July 2000, ATLANTIC MONTHLY, 55, 61 (2000), *also* available at http://www.theatlantic.com/issues/2000/07/sarewitz3.htm.

256. *See* Senator Frank H. Murkowsky, *The Kyoto Protocol is Not the Answer to Climate Change*, 37 HARV. J. ON LEGIS., 345 (2000).

change is possible without these three vital elements and it is time to by-pass Kyoto and begin that challenging journey.

THE ANTARCTIC ICE SHEET: RISE AND DEMISE?

SHERWOOD WILLING WISE, JR.*

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I. INTRODUCTION**

Since 1995, the popular press has widely reported major break-outs of shelf ice along the Antarctic Peninsula as a harbinger of the deleterious effects of global warming.[1] Sections of the floating Larsen Ice Shelf the size of Rhode Island have detached and floated

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**Abbreviations for time in this article will be SI (International System of Units): ky = thousands of years; m.y. = millions of years; Ka = thousands of years before the Present; Ma = millions of years before the Present. Other abbreviations used in this article include: m = meters; ft = feet; *ca.* = circa; ~ = approximately; ‰ = parts per mil; $\delta^{18}O$ = oxygen isotope ratio; Gt/yr = gigatons per year; ODP = Ocean Drilling Program; CRP = Cape Roberts Project; CIROS = Cenozoic Investigations of West Ross Sea; IRD = ice-rafted debris; ANTOSTRAT = Antarctic Offshore Stratigraphy Program; DSDP = Deep Sea Drilling Program; SCAR = Scientific Committee on Antarctic Research.

1. *See generally* Charles W. Petit, *Polar Meltdown*, U.S. NEWS & WORLD REPORT, Feb. 28, 2000, at 64.

out to sea in a matter of days.[2] Indeed, since the mid-1940's the average annual temperature along the Antarctic peninsula has risen ~ 2° C (3-4° F) and in midwinter has risen 4-5° C (7-9° F).[3] This phenomenon has been accompanied by major dislocations of marine fauna which are sensitive to changes in temperature and ice conditions. For example, colonies of southern elephant seals and fur seals as well as gentoo and chinstrap penguins are moving south from the latitudes of the Falkland Islands to the vicinity of the U.S. scientific base at Palmer Station (Fig. 1).[4] On the other hand, the dominant Adélie penguins which reside there and feed on krill, are perishing.[5] On land, the normal low grasses, tiny shrubs and mosses of the tundra are thickening rapidly, glaciers are retreating, and major ice shelves are thinning.[6]

Although the annual temperatures farther south over the continent are not rising significantly, scientists are nonetheless concerned because Antarctica is considered to be the primary engine that drives ocean and atmospheric circulation in the Southern Hemisphere.[7] Any change in the condition or volume of its ice sheet could have profound effects not only on climate but on sea level as well. In a worst case scenario, if all of the water stored in the ice caps of the world were to melt, it would raise eustatic sea level 72 m (236 feet).[8]

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2. *See* Helmut Rott et al., *Rapid Collapse of Northern Larsen Ice Shelf, Antarctica*, 271 SCIENCE 788, 788-89 (1996). Other breakouts of shelf ice further south have also been reported within the last five years, including along the Ronne-Filchner Ice Shelf (*see* The Antarctic Meterological Research Center Photo Gallery [visited July 7, 2000] <http://uwamrc.ssec.wisc.edu/amrc/amrcgallery.html>) and the Ross Ice Shelf. In March 2000, the Ross Ice Shelf produced an elongate iceberg that measured 183 miles by 22 miles, about twice the size of the State of Delaware. The iceberg is believed to be "among the largest ever observed" and it will take approximately a century to replace. *See Huge Chunk of Ice Breaks Off From Antarctica Ice Sheet*, TALL. DEM., Mar. 24, 2000, at 4B (available from AP Wire Archives, Mar. 23, 2000 [visited Aug. 10, 2000] <http://llwire.ap.org>; *see* also Iceberg Images at Anarctic Meteorological Research Center (visited July 7, 2000) <http://uwamrc.ssec.wisc.edu/amrc/iceberg.html>.

3. *See* Jocelyn Kaiser, *Is Warming Trend Harming Penguins?*, 276 SCIENCE 1790, 1790 (1997).

4. *See id.*

5. *See id.* Krill are shrimp-like swimming organisms that must shelter under solid sea during their first month.

6. *See e.g.*, J. R. Potter & J. G. Paren, *Interaction Between Ice Shelf and Ocean in George VI Sound, Antarctica*, 43 ANTARCTIC RES. SERIES 35, 35-36 (1985). The base of the largest ice shelf in the western Antarctic Peninsula region, the George VI Ice Shelf, is melting at an average rate of 2 m/yr and is retreating at 1 km/yr. The Wordie Ice Shelf was historically a source of ice flowing into Marguerite Bay but has disappeared within the last two decades. *See generally* C. S. M. Doake & D. G. Vaughan, *Rapid Disintegration of the Wordie Ice Shelf in Response to Atmospheric Warming*, 350 NATURE 328, 328-29 (1991).

7. *See generally* A. B. Mullan & J. S. Hickman, *Meteorology*, 51 ELSEVIER OCEANOGRAPHY SERIES 21, 51 (1990).

8. *See* B.P. Flower, *Cenozoic Deep-Sea Temperatures and Polar Glaciation: The Oxygen Isotope Record*, 3 TERRA ANTARCTICA REPORTS 27, 29 (1999).

This rise would be enough to flood San Francisco's Golden Gate Bridge.[9] Lesser melt downs would be disastrous for most coastal cities and island nations of the world,[10] not to mention the southern halves of the states of Florida and Louisiana.[11]

The culprit, in the eyes of many, is global warming, perhaps induced by man's activities including the anthropogenic release of "greenhouse" gases.[12] These gases raise temperatures by trapping within the atmosphere long-wave (heat) radiation emitted by the sun-warmed Earth.[13] Records of the steady increase in these atmospheric gases have been kept only for the past three decades at the Mauna Loa Observatory in Hawaii.[14] Over the past two centuries, however, sharp increases in carbon dioxide of 30% and methane of 145% have been detected in gas bubbles trapped in cores from the Greenland Ice Sheet.[15] These values have never been experienced in the last 420,000 years for which ice-core records from ice sheets exist.[16] When combined, these curves paint a startling picture for the years after the beginning of the Industrial Revolution (Fig. 2) and peak at present day. In North America, the winters from 1997 to 2000 have been the warmest since the government began record keeping 105 years ago. This is apparently an El Nino-induced phenomenon,[17] although continued record temperatures and droughts around the world during the summer of 2000 led noted climatologist James Hansen of the Goddard Institute to observe "in

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9. *See Golden Gate Bridge*, WORLD BOOK ENCYCLOPEDIA 255 (2000) (stating that the floor of the bridge is 67 m (220 ft) above sea level).

10. *See* Nicholas D. Kristof, *For Pacific Islanders, Global Warming is No Idle Threat*, TALL. DEM., Mar. 2, 1997, at 16A (pointing out that "Kiribati, the Marshall Islands, and Tuvalu in the Pacific Ocean and the Maldives in the Indian Ocean" are mostly coral atolls only a few feet above sea level. In addition to inundating these nations, "a 1 m (3.3 ft) rise in sea level would force the evacuation of [some] 70 million Chinese and 32 million Bangladeshis. One-fifth of Bangladesh would disappear").

11. *See* Rick Callahan, *Greenland's Glaciers May be Biggest Threat*, TALL. DEM., April 9, 2000, at 14A; William K. Stevens, *Catastrophic Melting of Ice Sheet is Possible, Studies Hint*, N.Y. TIMES, July 7, 1998, at F4.

12. "Greenhouse" gases include carbon dioxide [CO_2], methane [CH_4], nitrogen oxide [N_2O], and the man-made chlorofluocarbons [CFCs].

13. *See* GRAHAM R. THOMPSON & JONATHAN TURK, MODERN PHYSICAL GEOLOGY 453-469 (2d ed. 1997).

14. *See Mauna Loa Observatory* (visited June 6, 2000) <http://mloserv.mlo.hawaii.gov/>.

15. *See* G. Orombelli, *Climate Record from Ice Cores*, 3 TERRA ANTARCTICA REPORTS 3, 9 (1999) (citing J. R. Petit et al., *Climate and Atmospheric History of the Past 420,000 Years from the Vostok Ice Core, Antarctica*, 399 NATURE 429 (1999); see Fig. 1 for the location of the Vostok core).

16. *See id.*

17. *See* Brigitte Greenberg, *La Nina Culprit Behind History's Warmest Winter*, TALL. DEM., Mar. 12, 2000, at 1A.; *see also U.S. Has Its Warmest January-April on Record, NOAA Reports* (last modified May 24, 2000) <http://www.noaanews.noaa.gov/stories/s432.htm>.

my opinion, we can say that global warming is contributing to the increased frequency of extreme events."[18]

Temperature increases are also being noted in the oceans where the average heat content to ~275 m (900 ft) has increased 0.56% from 1948 to 1996. Waters as deep as ~3050 m (10,000 ft) have gained an average of 0.06° C (0.11° F).[19] The United Nations-sponsored Intergovernmental Panel on Climate Change (IPCC) has stated that "the balance of evidence suggests that there is a discernible human influence on global" warming.[20] It further declared that a doubling of greenhouse gases could raise average global temperatures by approximately 1° to 3.5 ° C (2° to 6° F) over the next century.[21] This in turn would raise average sea level approximately 15 to 94 cm (6 to 37 in) by melting of polar glacial ice.[22]

Nevertheless, the extent that man's activities are influencing global climate is a matter of strong debate. Some believe that the underlying strength and magnitude of Earth's natural climate cycles are far greater than man's ability to alter them. They believe, therefore, the warming over the past century and a half since the end of the "Little Ice Age"[23] may have little to do with human activities. The Ad Hoc Committee on Global Climate Issues of the American Association of Petroleum Geologists states frankly that "there is no discernible human influence on global climate at this time."[24]

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18. Shanon Begley, *If you can't take the heat…*, NEWSWEEK, Aug. 7, 2000 at 64.

19. *See* H. Josef Hebert, *Researchers Find Even Deepest of Oceans Warning,* TALL. DEM., Mar. 24, 2000, at 1B.

20 *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE IN 1995: THE SCIENCE OF CLIMATE CHANGE, at 5 (J. T. Houghton et al. eds., 1996).

21 *See id.* at 6.

22 *See* R.A. WARRICK ET AL., *Changes in Sea Level*, *in* CLIMATE CHANGE IN 1995: THE SCIENCE OF CLIMATE CHANGE 364 (J. T. Houghton et al. Eds., 1996).

23 The "Little Ice Age" was a global cooling episode between about 1400 and 1850 AD during which mountain glaciers all over the world advanced well beyond their present limits. *See* J. MURRAY MITCHELL, JR., ENERGY AND CLIMATE 53 (1977); *see also* H. H. Lamb, *Climatic Fluctuations,* 2 WORLD SURVEY OF CLIMATOLOGY 173, 177-178 (1969). *See generally* George H. Denton & Wibjorn Karlén, *Holocene Climatic Variations-Their Pattern and Possible Cause*, 3 QUATERNARY RESEARCH 155, 155, 201 (1973) (pointing out that the Little Ice Age was the last of five such Holocene events which seem to be part of a smaller scale cycle superimposed on larger-scale climate trends).

24 See Lee C. Gerhard & Bernold M. "Bruno" Hanson, *Ad Hoc Committee on Global Climate Issues: Annual Report*, 84 AAPG BULL. 466, 466 (2000). This report has resulted in a policy statement on climate change approved by the AAPG Executive Committee on behalf of the U.S. members of the association which argues that "[D]etailed examination of current climate data strongly suggests that current observations do not correlate with the assumptions or supportable projections of human-induced greenhouse effects." *Climate change* 20 AAPG EXPLORER at 6, at 8 (1999). *But see* R.C.L. (Chris) Wilson, *Wait on Proof (in "Readers' Forum")*, 21 AAPG EXPLORER 82, 82-83 (2000); Andrew H. Warrington, *Tactical Move*?, *id.* at 83 (both letter writers are international members of the AAPG pointing out omissions and deficiencies in the

Undeterred, the IPCC has issued a draft of their next five-year report (due out this year) stating unequivocally with even more confidence "that there has been a discernible human influence on global climate."[25] They base their opinion in part on the magnitude and abruptness of the 20th-century warming when scaled against temperature data for the past millennium recorded in tree rings, other sources, and the more recent instrumental record (Fig. 3).

Given the concern over anthropogenic climate effect, it is ironic that just twenty-five years ago leading geoscientists and climatologists were predicting that the Northern Hemisphere was not only poised to enter another glacial cycle, but that the cooling trend from the 1940s to the mid-1960s might even be leading up to that event.[26] Their prediction was based primarily on the fact that we are living in an interglacial period that is thought to be nearing its end.[27] For the past *ca.* 700,000 years, glacial-interglacial cycles have been paced by variations in the earth's orbital parameters.[28] Combined, these render a ~100,000 year period in which the interglacials span about 1/10 of each cycle, or about 10,000 years.[29] Our present-day interglacial interval (formally called the Holocene Epoch) has already endured almost that long. Assuming that "nature [is] left to her own devices with [no] interference from man", predictions by paleoclimatologists

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Committee's report while also expressing some degree of dismay if not trepidation. "AAPG's … opposing the Kyoto Protocol [*see infra* note 25 below] points to an organization failing to face the challenges of the 21st century" [Warrington, *supra* at 83] and "If this [global greenhouse gas] experiment triggers a rapid reorganization of the climate system, proof might come too late for preventative action" [Wilson, *supra* at 83]).

25. Richard A. Kerr, *Draft Report Affirms Human Influence,* 288 SCIENCE 589, 590 (2000) (noting that this report should be available in time for consideration during final negotiations on the "implementation of the Kyoto Protocol for the reduction of [anthropogenic greenhouse] gas emissions"). For more on the Kyoto Protocol, see Hoong N. Young, *An Analysis of a Global CO_2 Emissions Trading Program*, 14 J. LAND USE & ENVTL. L. 125 (1998).

26. *See* MITCHELL, *supra* note 23, at 55; *see also* J. Murray Mitchell, Jr., *Carbon Dioxide and Future Climate*, ENVIRONMENTAL DATA SERVICE, March 1977, at 3, 4 (stating that global climate had been cooling since 1940, and that if continued, many places would reach ice-age levels only 700 years from now); [*Weather Experts Believe Ice Age Is On Way*, TALL. DEM., June 4, 1975, at 12A.]

27. *See* MITCHELL, *supra* note 23, at 53; Mitchell, *supra* note 26, at 4.

28. These orbital variations are frequently referred to as Milankovitch cycles and are detected by time-series analysis of variations in the sedimentary record (such as the spacing of laminations [varves], contrasting rock types, or changes in geochemical or magnetic properties). For an excellent historical summary and explanation of Milankovitch theory written in layman's language, *see generally* JOHN IMBRIE & KATHERINE PALMER IMBRIE, ICE AGES, SOLVING THE MYSTERY (1998).

29. *See generally* MITCHELL, *supra* note 23, at 53.

as to the onset of the next glacial cycle vary, but could exist within the range of a few thousand years.[30]

Interestingly, marine sediment records show that climate stability on millennial time scales during interglacials is generally high. This is true for the relatively mild interglacial in which now we live.[31] Hence, despite relatively minor variations such as the Little Ice Age, human civilization has developed within a period of remarkably stable climatic conditions. On the other hand, both the marine sediment and continental ice-core records show that over the past 110,000 years some changes in climate have been large, abrupt, and global.[32] Even as recently as 8,000 years ago, a brief intense cold event occurred after temperatures had risen close to current levels.[33] These abrupt switches in global climate seem to reflect drastic reorganizations (or even collapses) of the current thermohaline oceanic circulation system. The triggers for these are not well understood, although the Antarctic ice sheet is an important influence on that system. Professor Wallace B. Broecker concludes that:

> [t]here is surely a possibility that the ongoing buildup of greenhouse gases might trigger yet another of these ocean reorganizations and thereby the associated large atmospheric changes. Should this occur when 11 to 16 billion people occupy our planet [as has been pro-

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30. *See* Mitchell, *supra* note 26, at 4. Cooling could begin as soon as 700 years from now (*see* MITCHELL, *supra* note 23) with a substantial expansion of Northern Hemisphere ice during the next 5,000 years. S*ee* DR. JAMES D. HAYS, OUR CHANGING CLIMATE 84 (1979).

31. Not all interglacial periods are created equal, however. Marine isotope stages have been systematically numbered with even numbers for glacial and odd numbers for interglacial intervals. Marine isotope stage 11, which began at about 400 Ka, was a particularly mild interglacial and produced ice-free conditions in the North Atlantic for about 30-40 ky. *See* Jerry F. McManus et al., *A 0.5-Million-Year Record of Millennial-Scale Climate Variability in the North Atlantic*, 283 SCIENCE 971, 973 (1999).

32. *See generally* Wallace S. Broecker, *Thermohaline Circulation, The Achilles Heel of Our Climate System: Will Man-Made CO_2 Upset the Current Balance?*, 278 SCIENCE 1582, 1582 (1997) (citing Wallace S. Broecker & George H. Denton, *The Role of Ocean-Atmosphere Reorganizations in Glacial Cycles*, 53 GEOCHIMICA ET COSMOCHIMICA ACTA 2465 (1989); W. Dansgaard et al., *A New Greenland Deep Ice Core,* 218 SCIENCE 1273 (1982); W. Dansgaard et al., *Evidence for General Instability of Past Climate from a 250-kyr Ice Core Record,* 364 NATURE 218 (1993); P.M. Grootes et al., *Comparison of Oxygen Isotope Records from the GISP2 and GRIP Greenland Ice Core,* 366 NATURE 552 (1993); W. Dansgaard et al., *The Abrupt Termination of the Younger Dryas Climate Event,* 339 NATURE 532 (1989); K. C. Taylor et al., *The 'Flickering Switch' of Late Pleistocene Climate Change,* 361 NATURE 432 (1993)).

33. *See* Broecker, *supra* note 32, at 1586 (citing Richard B. Alley et al., *Holocene Climatic Instability: A Prominent, Widespread Event 8200 Yrs. Ago,* 25 GEOLOGY 483 (1997)).

> jected for the next century], it could lead to widespread starvation.[34]

To determine what man's influence has or has not been on global climate and to make predictions for the future, scientists must first understand both the causes and effects of secular climate cycles. Knowledge of the glacial history of Antarctica is the key to such an understanding, since the Antarctic ice sheet accounts for about 90% of current global ice volume. This paper will review the glacial history and current efforts to decipher it, dwelling on what is known, unknown, and disputed in our knowledge base, as well as implications for the future. This paper will also consider promising lines of attack to extend that knowledge base by further exploration in Antarctica, the most remote and inhospitable environment on Earth.

Part II will serve as a description of the present ice sheet on Antarctica. Part III will provide a brief history of that ice sheet as currently understood based on detailed and exhaustive technical accounts. Part IV will discuss the stability of the ice sheet on West Antarctica and its implications for global warming, and Part V will present the conclusions.

II. THE PRESENT DAY ICE SHEET

The Antarctic Ice Sheet covers some 13.6 million square kilometers or about 98% of the continent[35](Fig. 4). Hence, it is most difficult to study its history directly from geological deposits on land. Up to 4,776 m thick, the ice sheet averages over 2 kilometers in thickness and attains a maximum elevation of over 4,000 m.[36] It is divided by the Transantarctic Mountains, which project above the ice at many points and separate a relatively stable East Antarctic Ice Sheet that rests mostly on continental crust located above sea level[37] from an inherently less stable West Antarctic Ice Sheet. The West Antarctic Ice Sheet is relatively unstable because it is grounded in many places well below sea level in a series of marine basins.[38] It

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34. Broecker, *supra* note 32, at 1588.

35. *See* P. Barrett, *Antarctic Climate History Over the Last 100 Million Years*, 3 TERRA ANTARCTICA REPORTS 53, 53 (International School of Earth and Planetary Science) (citing David J. Drewry, *The Surface of the Antarctic Ice Sheet*, ANTARCTICA: GLACIOLOGICAL AND GEOPHYSICAL FOLIO (1983)).

36. *See id*.

37. *See id*.

38. *See id*.; *see also* J.R. Keys, *Ice*, 51 ELSEVIER OCEANOGRAPHY SERIES 95, 96 (1990).

also projects north of 65° South into warmer climes along the Antarctic Peninsula (Fig. 4).

The ice sheet moves plastically under its own weight towards the sea where it thins to give rise to floating ice shelves that extend beyond the grounding line.[39] These ice shelves (Fig. 1) are particularly extensive over the inland Ross and Weddell Seas as well as along the eastern margin of the Antarctic Peninsula (the Larsen Ice Shelf). Beyond that, conditions are still sufficiently cold during the winter months to cause sea water around the continent to freeze. This creates an ephemeral sea ice that may extend over 1000 km beyond the continental margin,[40] but which breaks up and melts during the summer months. The freezing seawater, which also undercoats the bottoms of the ice shelves, rejects salt back into the water column to form dense cold brines that sink to the bottom of the ocean. This contributes to the Antarctic Bottom Water, which is a current that moves northward to help drive global ocean circulation.[41]

The conveyer-belt-like movement of the Antarctic Ice Sheet seaward and renewal at its source by precipitation of snow accounts for its relatively young age of just over 400,000 years. Thus, the Antarctic Ice Sheet is a dynamic system, subject to variations in supply and wastage. Were its components to melt, the West Antarctic Ice Sheet would cause sea level to rise 6 m, whereas the East Antarctic Ice Sheet would raise sea level by ten times that amount.[42]

III. ICE SHEET HISTORY

Our direct knowledge of the history of the Antarctic Ice Sheet is skeletal at best because the ice sheet either obscures or erodes away the geological deposits and features needed to decipher that history. For these reasons, geoscientists have come to rely on various "proxy" or indirect records of global climate and Antarctic ice behavior based on their analysis of marine sediments deposited beyond the continent itself. These proxies include: 1) the character of sediments deposited in the Southern Ocean surrounding the continent, including the deposition of ice-rafted debris (i.e., sediment detritus deposited

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39. *See* Keys, *supra* note 38, at 95.

40. *See* Leanne K. Armand, *An Ocean of Ice – Advances in the Estimation of Past Sea Ice in the Southern Ocean*, 10 GSA TODAY, March, 2000, at 5, Fig. 3 (2000).

41. *See* Stanley S. Jacobs et al., *Origin and Evolution of Water Masses Near the Antarctic Continental Margin: Evidence from $H_2{}^{18}O/H_2{}^{16}O$ Ratios in Seawater*, 43 ANTARCTIC RES. SERIES 59, 75-77 (1985).

42. *See* Barrett, *supra* note 35, at 53.

by melting ice bergs); 2) changes in sea level; and 3) variations in the oxygen isotope compositions of calcareous microfossil skeletons, particularly those of planktonic and benthic foraminifers[43] that accumulate in deep sea sediments of the world's oceans. Sea-level changes and variations in oxygen isotope ratios[44] provide estimates of ice volume (Fig. 5). Oxygen isotope ratios can also be used to help estimate paleotemperatures. The application of these proxies is by necessity based on a number of assumptions and variables,[45] not all of which can be well constrained. However, they do provide a reflection of major events in the history of the Antarctic Ice Sheet. Confirmation of these events, though, can be provided best by direct physical evidence in the way of sedimentary deposits left by the ice sheet itself. However, as stated above, direct evidence is difficult to obtain and hence is largely a task for the new century.

North American and European geologists have long recognized a series of Northern Hemisphere continental glacial-interglacial cycles, now dated as beginning about 2.5 Ma (million years before present). These comprise the so-called "ice age" in which we live. The antiquity of Cenozoic[46] Antarctic glaciations, however, was not brought home until the scientific drill ship, *Glomar Challenger*, explored the Ross Sea in 1973. Through this effort, ice-rafted debris was recovered and cored dating back to 25 Ma.[47] Shortly thereafter a detailed paleotemperature curve revealed an overall global cooling of about 7° C during the Cenozoic.[48] This curve was based on oxygen isotope measurements of planktonic and benthic foraminifers in *Glomar Challenger* cores from the Subantarctic region.[49]

Major steps along the benthic foraminiferal curve (which are similar to that depicted in Fig. 5) were interpreted as thresholds that

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43. Planktonic and benthic foraminifers are unicellular ameboid-like protists that live at the surface or bottoms of the oceans, respectively.

44. Oxygen isotope ratios are measured against a standard and expressed through a formula by the term $\delta^{18}O$.

45. For a discussion of these variables vis a vis oxygen isotopes, see Sherwood W. Wise, Jr. et al., *Paleogene Glacial History of Antarctica*, *in* CONTROVERSIES IN MODERN GEOLOGY 136-137 (1991).

46. The Cenozoic Era comprises the last 65 m.y. of geologic time, beginning with the extinction of the dinosaurs which reigned during the preceding Mesozoic Era. See Figure 5 for the sequence of `epochs' or subdivisions of the Cenozoic time interval (Paleocene, Eocene, etc.).

47. *See generally* Dennis E. Hayes & Lawrence A. Frakes, *General Synthesis, Deep Sea Drilling Project Leg 28*, 28 INITIAL REP. DEEP SEA DRILLING PROJECT 927-928, 938 (1975).

48. *See* Nicholas J. Shackleton & James P. Kennett, *Paleotemperature History of the Cenozoic and the Initiation of Antarctic Glaciation: Oxygen and Carbon Isotope Analyses in DSDP Sites 277, 279, and 281*, 29 INITIAL REP. DEEP SEA DRILLING PROJECT 743, 751, 754 (1975); *see also* Barrett, *supra* note 35, at 54, 61.

49. *See* Shackleton & Kennett, *supra* note 48; *see also* Barrett, *supra* note 35, at 61.

signaled significant events in the formation of Southern or Northern Hemisphere ice.[50] Underlying this overall cooling trend were several factors including the position of Antarctica under the geographic South Pole, and the dispersal of the other southern continents away from Antarctica via plate tectonics (Fig. 6). Antarctica's position provided a base for the accumulation of a land-based ice cap. The dispersal of the other continents allowed for two things to happen - the opening of deep-water marine passageways ("gateways") to allow the establishment of the infinite Antarctic Circumpolar Current, and better access of the interior of the continent to sources of moisture for the precipitation of snow. The Antarctic Circumpolar Current thermally isolated the continent from warmer currents of the global ocean circulation. Its establishment occurred when Antarctica's final connections with Australia and South America were severed during the Eocene and Oligocene.[51]

A. Late Paleocene Thermal Maximum (~55.5 Ma)

The bottom-water temperature peak during the Late Paleocene Thermal Maximum (~11-13^{o} C; Fig. 5) is a logical place to begin our narrative of the Cenozoic history of the Antarctic Ice Sheet.[52] This is mainly because at that point, as most investigators would agree, there was virtually no continental ice sheet in existence.[53] This was a high-water mark, both literally and figuratively, of the "Greenhouse world" that had prevailed since the preceding Mesozoic Era.[54] Evaporation in the tropics produced warm, dense, oxygen-poor salty waters that swept through the oceans to Antarctica and upset the steady-state ecological balance normally enjoyed by the bottom dwelling benthic foraminifers. Their extinction at this point was the greatest for these organisms in the past ninety million years.[55] This upset was especially sudden as deep-sea waters rose *ca.* 8.7^{o} C in less than 6,000 years to about 18^{o} C at ODP Site 690 on Maud Rise off

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50. *See* James P. Kennett, *Cenozoic Evolution of Antarctic Glaciation, the Circum-Antarctic Ocean, and Their Impact on Global Paleoceanography*, 82 J. GEOPHYSICAL RES. 3843 (1977).

51. *See id.* at 3845; *see also* Peter F. Barker et al., *Weddell Sea Palaeoceanography: Preliminary Results of ODP Leg 113*, 67 PALAEOGEOGRAPHY, PALAEOCLIMATOLOGY, PALAEOECOLOGY 75-102 (1988).

52. *See* Flower, *supra* note 8, at 29 (citing K.G. Miller et al., *Tertiary Oxygen Isotope Synthesis, Sea Level History, and Continental Margin Erosion*, 2 PALEOCEANOGRAPHY 1 (1987)).

53. *See* Flower, *supra* note 8, at 29 (citing THOMAS J. CROWLEY & G. R. NORTH, PALEOCLIMATOLOGY (1991)).

54. *See* Flower, *supra* note 8, at 34.

55. *See* Flower, *supra* note 8, at 33 (citing Ellen E. Thomas, *Late Cretaceous - Early Eocene Mass Extinction in the Deep-Sea, in* GLOBAL CATASTROPHES 481-496 (1990)).

Antarctica (Fig. 1).[56] According to oxygen-isotope records, surface waters also warmed.[57]

Other such thermal events apparently continued into the early Eocene, while warm-water loving calcareous nannoplankton[58] continued to thrive in the surface waters around Antarctica.[59] No major boundaries based on temperature changes in surface water masses are evident within the region, which is an indication of relatively equable climates at this time. Where terrestrial sedimentary deposits of this age exist along the Antarctic Peninsula, it appears the land was well vegetated by southern temperate or more warmth-loving flora consisting of angiosperms (particularly the southern beech, *Nothofagus*), southern conifers, and ferns.[60] Parts of East Antarctica were apparently rather warm with seasonal rainfall which allowed winds to blow dust out to sea.[61]

A number of hypotheses have been advanced to account for the Late Paleocene Thermal Maximum. Major changes in the mode of ocean circulation must have occurred.[62] These changes were caused by a catastrophic emission of greenhouse gases connected with increases of volcanism[63] and the climate feedbacks associated with such releases.[64] This suggests the Late Paleocene Thermal Maximum

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56. *See* Flower, *supra* note 8, at 33 (citing James P. Kennett & Lowell D. Stott, *Abrupt Deep-Sea Warming, Paleoceanographic Changes and Benthic Extinctions at the End of the Palaeocene*, 353 Nature 225 (1991)). The paleo-water depth at this site was ~2,100 m. *See* Kennett & Stott, *supra* at 225.

57. *See* Flower, *supra* note 8, at 34.

58. Nannoplankton are golden-brown algae that produce calcareous nannofossils, the basic constituents of chalk.

59. *See generally* James J. Pospichal & Sherwood W. Wise, Jr., *Paleocene to Middle Eocene Calcareous Nannofossils of ODP Sites 689 and 690, Maud Rise, Weddell Sea,* 113 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS 613 (1990).

60. *See* J.E. Francis, *Evidence from Fossil Plants for Antarctic Palaeoclimates Over the Past 100 Million Years*, 3 TERRA ANTARCTICA REPORTS 43, 48 (1999) (citing R.A. Askin, *Late Cretaceous-Early Tertiary Antarctic Outcrop Evidence for Past Vegetation and Climates*, 56 ANTARCTIC RES. SERIES 61 (1992); H.M. LI, *Early Tertiary Palaeoclimate of King George Island, Antarctica – Evidence from the Fossil Hill Flora*, *in* RECENT PROGRESS IN ANTARCTIC EARTH SCIENCE 371 (1992)).

61. *See* Shipboard Scientific Party, *Site 690*, 113 PROC. OCEAN DRILLING PROGRAM, INITIAL REP. 183, 238-39 (1988).

62. *See* Flower, *supra* note 8, at 34 (citing Kennett & Stott, *supra* note 56; James P. Kennett & Lowell D. Stott, *Proteus and Proto-Oceanus: Ancestral Paleogene Oceans as Revealed from Antarctic Stable Isotopic Results, ODP Leg 113*, 113 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS 865 (1990)).

63. *See* Flower, *supra* note 8, at 34 (citing David Rea et al., *Global Change at the Paleocene/Eocene Boundary: Climate and Evolutionary Consequences of Tectonic Events*, 79 PALAEOGEOGRAPHY, PALEOCLIMATOLOGY, PALAEOECOLOGY 117 (1990); Timothy J. Bralower et al., *High-Resolution Records of the Late Paleocene Thermal Maximum and Circum-Caribbean Volcanism: Is There a Causal Link?*, 25 GEOLOGY 963 (1997)).

64. *See* Flower, *supra* note 8, at 34 (citing G. R. Dickens et al., *Dissociation of Oceanic Methane Hydrate as a Cause of the Carbon Isotope Excursion at the End of the Paleocene*, 10

may have witnessed a natural global experiment with an outcome similar in many respects to some of the worst-case scenarios now being postulated for man's new millennium.

B. Eocene (55-34 Ma)

As noted in Figure 5, the Eocene epoch witnessed a progressive decline in sea-bottom oxygen-isotopic paleotemperatures from the high-water mark of the Late Paleocene Thermal Maximum. The early Eocene was nearly as warm as the latest Paleocene. However, around the beginning of the middle Eocene (at approximately 49 Ma) a consistent increase of $\delta^{18}O$ is noted. This equates to a decrease in inferred paleotemperatures. Some investigators believe the first Cenozoic ice sheets appeared on Antarctica at this time.[65] Although sedimentologic evidence has been cited in a number of instances to suggest that ice rafting and/or deposition by glaciers punctuated the gradual decline in paleotemperatures during the middle to late Eocene, none of these have been accepted as conclusive evidence of ice deposition because of questions concerning the age dates or origins of the sediments.[66] Antarctica continued to support healthy temperate vegetation during this period although an increase in the predominance of *Nothofagus* in the Antarctic Peninsula (Seymour Island, Fig. 1) indicates "the onset either of cooler or more seasonal climates."[67]

C. Eocene/Oligocene Boundary Transition (~33.6 Ma)

Far more striking in the deep-sea oxygen isotope record is the *ca.* 1‰ $\delta^{18}O$ "shift" (i.e., a permanent deflection in the curve) at the

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PALEOCEANOGRAPHY 965 (1995); G. R. Dickens et al., *A Blast of Gas in the Latest Paleocene: Simulating First-Order Effects of Massive Dissociation of Oceanic Methane Hydrate*, 25 GEOLOGY 259 (1997)). *See also* Katz et al., *The Source and Fate of Massive Carbon Input During The Latest Palocene Thermal Maximum*, 286 SCIENCE 1531 (1999) (providing sedimentologic evidence for the massive release of biologic methane along the continental shelf off Florida (CODR site 1051) at ~5.5 Ma in response to a warming of deep waters).

65. *See* Elizabeth M. Kemp, *Tertiary Climatic Evolution and Vegetation History in the Southeast Indian Ocean Region,* 24 PALAEOGEOGRAPHY., PALAEOCLIMATOLOGY., PALAEOECOLOGY 169 (1978); Werner U. Ehrmann, *Implications of Sediment Composition on the Southern Kerguelen Plateau for Paleoclimate and Depositional Environment*, 119 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS 185, 195-98, 201 (1991).

66. For a review of questionable occurrences, see Sherwood W. Wise, Jr. et al., *Paleogene Glacial History of Antarctica in Light of Leg 120 Drilling Results,* 120 PROC. OF THE OCEAN DRILLING PROGRAM, SCI. RESULTS 1001 (1992)

67. *See* Francis, *supra* note 60, at 48 (citing Rosemary A. Askin, *Late Cretaceous-Early Tertiary Antarctic Outcrop Evidence for Past Vegetation and Climates,* 56 ANTARCTIC RES. SERIES 61 (1992); ROSEMARY A. ASKIN, *Eocene – Earliest Oligocene Terrestrial Palynology of Seymour Island, Antarctica*, *in* THE ANTARCTIC REGION: GEOLOGICAL EVOLUTION AND PROCESSES 993 (1997)).

Eocene/Oligocene boundary ("short term" curve, Fig. 5). This is the greatest such change in the entire Cenozoic record. Exactly what this dramatic shift signaled has been the subject of considerable debate and interpretation over the years, as is often found with proxy records no matter how detailed and informative they may be. Clearly delineated in the seminal study of subantarctic foraminifera by Nicholas J. Shackleton and James P. Kennett,[68] this break in the curve was interpreted as the initiation of the psychrosphere[69] and a pivotal event in the evolution of Cenozoic climates.[70] Initially, this $\delta^{18}O$ shift was thought to mark the formation of the first floating sea ice around Antarctica[71] and not the development of an actual ice sheet. Subsequent oxygen-isotope studies, however, suggested a major expansion of the Antarctic Ice Sheet.[72] The argument in favor of a major ice-sheet expansion revolved around the fact that if no ice sheet were present then the paleo-temperature equation for an "ice-free world" would result in deep-water paleotemperatures close to the freezing point of seawater (colder than is found in the deep sea today).[73] This is a circumstance not supported by other geological evidence. If temperatures had been close to freezing, one would expect to see evidence of a polar cryospheric (glacial-ice) regime similar to the present-day southern high latitudes. This was clearly not the case at the Falkland Plateau, the southernmost locality at which high oxygen-isotopic values had been measured in the lower Oligocene, but where the sediments contain none of the ice-rafted debris prevalent in modern-day deposits.[74] The assumption of a significant volume of ice on the continent, corrected for possible variations in salinity, produced more reasonable bottom-water temperatures.[75]

Confirmation of predictions of a major ice sheet on the continent by early Oligocene times came with a flurry of drilling activity that

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68. *See generally* Shackleton & Kennett, *supra* note 48.

69. The psychrosphere is the modern mode of thermo-haline ocean circulation, which is driven primarily by cold waters generated in the high latitudes. *See generally* Barrett, *supra* note 35, at 63 (citing James P. Kennett, *The Development of Planktonic Biogeography in the Southern Ocean During the Cenozoic*, 3 MARINE MICROPALEONTOLOGY 301 (1978)).

70. *But see* R. H. Benson et al., *Evidence from the Ostracoda of Major Events in the South Atlantic and World-Wide Over the Past 80 Million Years, in* SOUTH ATLANTIC PALEOCEANOGRAPHY 325, 333 (K. H. Hsu and M. J. Weissert, eds.) (1985) (arguing that the psychrosphere developed earlier, during the Eocene).

71. *See* Kennett, *supra* note 50, at 3853.

72. *See generally* Flower, *supra* note 8, at 29 (citing Miller et al., *supra* note 52).

73. *See id.*

74. *See* S. W. Wise et al., *Cenozoic Evolution of Polar Water Masses, Southwest Atlantic Ocean, in* SOUTH ATLANTIC PALEOCEANOGRAPHY 283, 294-304 (1985); *see also* Wise et al., *supra* note 45.

75. *See* Wise et al., *supra* note 45.

took place around the continent during the late 1980's (Fig. 1). This was accomplished by ice-based drilling in the Eastern Ross Sea (the CIROS project) and by the scientific drill ship *JOIDES Resolution* off East Antarctica in the Weddell Sea (Site 693), Prydz Bay (Sites 739 and 742), and on the outlying Kerguelen Plateau (Sites 738, 744 and 748; Fig. 7). The CIROS-1 hole was cored using a diamond-impregnated drill bit from a drilling rig set on the annual fast winter sea ice.[76] This was the first time this procedure had been attempted. Ice-rafted debris detected in lowermost Oligocene rocks was interpreted as coming from mountain outlet glaciers along the Transantarctic Mountains.[77] On the opposite side of the continent, drilling over the outlying Kerguelen Plateau also produced unmistakable evidence of ice-rafted debris[78] in conjunction with the lower Oligocene benthic-foraminiferal isotopic shift (Fig. 8). The shift at this site registered 1.2-1.3 ‰ $\delta^{18}O$.[79] Considering that large drop stones deposited by ice bergs had also been drilled in 33 Ma sediment along the Weddell Sea margin,[80] it was concluded that a major ice sheet had reached the margin of the continent at several widely separated points around Antarctica during the early Oligocene.[81] Although it may have been as extensive as the present-day ice sheet, it would not have been as cold. Instead, it was probably "temperate" and "wet-based" (i.e., warmer internal temperatures, more prone to rapid expansion and decay) in nature.[82] This is similar to the ice sheets of the Northern Hemisphere during the past two and one-half million years.[83] Being temperate in nature, it would not have been as stable as the present-day Antarctic Ice Sheet but rather subject to major advances, retreats, and decay. This ice sheet probably would have disappeared completely at some point during the Miocene.[84]

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76. Fast sea ice freezes in against the shoreline and remains attached to land until the summer breakup, thus it can provide an exceptionally stable drilling platform. *See generally* JOHN B. ANDERSON, ANTARCTIC MARINE GEOLOGY 19-20 (1999).

77. *See* P.J. Barrett et al., *Synthesis,* 245 DSIR BULL. N. Z. 241, 245-47 (1989).

78. *See generally* James Breza & Sherwood W. Wise, Jr., *Lower Oligocene Ice-Rafted Debris on the Kerguelen Plateau: Evidence for East Antarctic Continental Glaciation*, 120 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS 161 (1992).

79. *See* James C. Zachos et al., *Isotope and Trace Element Geochemistry of Eocene and Oligocene Foraminifers from Site 748, Kerguelen Plateau,*120 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS 839, 841 (table 1), 847 (figure 5) (1992).

80. *See* Wise et al., *supra* note 66, at 1009, 1012 (figure 12).

81. *See* Wise et al., *supra* note 45.

82. *See generally* Barrett, *supra* note 77, at 244; *see also* Keys, *supra* note 38.

83. *See generally* Barrett, *supra* note 77, at 244; *see also* Wise et al., *supra* note 66.

84. *See* Elizabeth M. Kemp & Peter J. Barrett, *Antarctic Glaciation and Early Tertiary Vegetation*, 258 NATURE 507, 508 (1975); Miller et al., *supra* note 52; David M. Harwood et al.,

Varying estimates have been formulated for the sea-bottom temperatures and ice volumes associated with the Oligocene ice sheet. As mentioned previously, these two variables of $\delta^{18}O$ readings are difficult to partition out as they both contribute to the signal provided by the benthic foraminiferal curve. Approximately 0.5 of the increase in isotopic values has been ascribed to ice volume increase (45-m eustatic sea level lowering). "The remaining 0.9 ‰ [was] attributed to deep-sea cooling of 3-4° C, about 30-40% of the total" cooling found in the Cenozoic.[85] Depending on what estimate of bottom-water temperatures and ice compositions are assumed, the ice volume could have been anywhere from half the size to greater than the size of the present-day sheet[86] (Fig. 8). A recent analysis employing an independent method to estimate paleotemperatures at a lower latitude drill site[87] suggested that the ~0.9 ‰ shift recorded there can be attributed almost entirely to the ice-volume effect.[88] This accords well with the absence of significant extinction among the benthic foraminiferal assemblages.[89] At the higher southern latitudes where the isotopic shift was greater, however, there were marked changes in the surface-water phytoplankton populations, which indicate cooling in the vicinity of the Antarctic continent.[90] Significant to the present discussion, the $\delta^{18}O$ increase is thought to have occurred quite rapidly in "less than 350,000 years, with the greatest change [in] the final 40-50 thousand years."[91]

Multiple Miocene Marine Productivity Events in West Antarctica as Recorded in Upper Miocene Sediments Beneath the Ross Ice Shelf (Site J-9), 15 MARINE MICROPALEONTOLOGY 91 (1989).

85. *See* Flower, *supra* note 8, at 34 (citing James C. Zachos et al., *Evolution of Early Cenozoic Marine Temperatures*, 9 PALEOCEANOGRAPHY 353 (1994); James C. Zachos et al., *High-Resolution (10^4 years) Deep-Sea Foraminiferal Stable Isotope Records of the Eocene-Oligocene Climate Transition,* 11 PALEOCEANOGRAPHY 251 (1996)).

86. *See generally* Flower, *supra* note 8, at 29 (citing Zachos et al. *Evolution of Early Cenozoic Marine Temperatures* (1994), *supra* note 85; Miller et al., *supra* note 52).

87. *See* Shipboard Scientific Party, *Site 522*, 73 INITIAL REP. DEEP SEA DRILLING PROGRAM 187, 187 (1984) (stating that Hole 522 was drilled at 26°6.843′ S, 5°7.784′ W in 4456.6 m of water).

88. *See* C. H. Lear et al., *Cenozoic Deep-Sea Temperatures and Global Ice Volumes from Mg/Ca in Benthic Foraminiferal Calcite*, 287 SCIENCE 269, 271 (2000).

89. *See generally* Ellen Thomas, *Middle Eocene-Late Oligocene Bathyal Benthic Foraminifera (Weddell Sea): Faunal Changes and Implications for Ocean Circulation, in* EOCENE-OLIGOCENE CLIMATIC AND BIOTIC EVOLUTION 245, 258-61 (Princeton University Press 1992).

90. *See* Wuchang Wei & Sherwood W. Wise, Jr., *Biogeographic Gradients of Middle Eocene-Oligocene Calcareous Nannoplankton in the South Atlantic Ocean*, 79 PALAEOGEOGRAPHY, PALAEOCLIMATOLOGY, PALAEOECOLOGY 29, 35, 46 (1990).

91. *See* Flower, *supra* note 8, at 34 (citing Zachos et al., *High-Resolution (10^4 years) Deep-Sea Foraminiferal Stable Isotope Records of the Eocene-Oligocene Climate Transition* (1996), *supra* note 85).

D. Oligocene-Early Miocene (34-15 Ma)

As previously mentioned, the early Oligocene isotopic shift is the "largest step in the transition from the 'greenhouse' to the 'icehouse' world" of the Cenozoic and has been numbered as the "Oi1" or first Oligocene benthic foraminiferal isotopic event (Fig. 5).[92] Following a change in the placement of the Eocene/Oligocene boundary and a recalibration of the geological time scale,[93] "Oi1" is now dated at 33.6 Ma.[94] Thereafter began a general warming trend of about sixteen million years punctuated by a number of intermittent glaciations on Antarctica as noted in ice-based drill cores[95] (CIROS-1, CRP; Fig. 1) and the deep-sea isotopic record.[96] Detailed studies are beginning to show that the intensity of some of these glaciations at least was modulated by variations in the Earth's orbital parameters, ie., Milankovitch cycles.[97]

By the late Oligocene, alpine (mountain valley) glaciation along the Transantarctic Mountains had given way to full-scale development of several ice sheets in East Antarctica that advanced repeatedly over the CIROS-1 locality. Upper Oligocene glacial deposits at CIROS-1 in the Eastern Ross Sea consist of a "number of thin (10's of m) till sheets [sediments deposited directly by glaciers] separated by thin mudstones that" represent interglacial intervals.[98] One of the latter contained a complete leaf impression of the southern beech, *Nothofagus*[99] along with contemporaneous pollen[100] that suggest a

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92. *See* Flower, *supra* note 8, at 31 (citing Kenneth G. Miller et al., *Cenozoic Global Sea Level, Sequences, and the New Jersey Transect: Results from Coastal Plain and Continental Slope Drilling*, 36 REVIEWS OF GEOPHYSICS 569 (1998)).

93. *See* William A. Berggren et al., *Towards a Revised Paleogene Geochronology, in* EOCENE-OLIGOCENE CLIMATE AND BIOTIC EVOLUTION 29 (1992); *see also* WILLIAM A. BERGGREN ET AL., *A Revised Cenozoic Geochronology and Chronostratigraphy,* GEOCHRONOLOGY, TIME SCALES AND GLOBAL STRATIGRAPHIC CORRELATION 129 (1995) (updating the time scale currently in use). For the previous widely used time scale, *see generally* William A. Berggren et al., *Cenozoic Geochronology*, 96 GEOLOGICAL SOC'Y AM. BULL. 1047 (1985).

94. *See* Flower, *supra* note 8, at 31, 36.

95. *See* Barrett et al., *supra* note 77. *See generally* Cape Roberts Science Team, *Initial Report on CRP-1, Cape Roberts Project, Antarctica,* 5 TERRA ANTARCTICA 1-187 (1998); Cape Roberts Science Team, *Initial Report on CRP-2, Cape Roberts Project, Antarctica,* 6 TERRA ANTARCTICA (1999); Cape Roberts Science Team, *Initial Report on CRP-3, Cape Roberts Project, Antarctica,* 7 TERRA ANTARCTICA 1-203 (forthcoming 2000).

96. *See* Benjamin P. Flower et al., *Milankovitch-Scale Climate Variability Recorded Near the Oligocene/Miocene Boundary*, 154 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS 433 (1997); James C. Zachos et al., *Orbitally Paced Climate Oscillations Across the Oligocene/Miocene boundary,* 388 NATURE 567 (1997).

97. *See generally* Flower, *supra* note 96 *see also* Imbrie & Imbrie, *supra* note 28.

98. *See* Barrett, *supra* note 35, at 64.

99. *See id*. (citing R. S. Hill, *Fossil Leaf*, 245 DSIR BULL. N. Z., 143-144 (1989)).

cool to cold temperate terrestrial climate on the flanks of the adjacent Transantarctic Mountains.[101] The trees may have existed near sea level in refugia between ice fields, as coastal enclaves of vegetation that persisted through repeated phases of glacial advances.[102]

The relative mild climates of the early Miocene[103] were "terminated by a succession of $\delta^{18}O$ increases", the most prominent (Fig. 5) and rapid being the "Mi3" event at ~13.8 Ma.[104] Sea levels dropped about 50 m from about 16 to 12 Ma.[105] An increase of ice-rafted debris in Southern Ocean cores confirms a major expansion[106] and semi-permanent establishment[107] of the East Antarctic Ice Sheet during this time.

E. Middle Miocene to Pliocene (15-2 Ma)

Just how permanent the East Antarctic Ice Sheet has been over the past fifteen million years has become one of the most contentious questions debated today among Antarctic specialists. Early interpretations of the oxygen-isotope record suggested that the West Antarctic Ice Sheet was established by late Miocene times and that the full Antarctic Ice Sheet had essentially been in place since that time, operating in a polar mode (very cold internal temperatures) similar to the present-day ice sheet.[108] However, other early studies of marine Southern Ocean phytoplankton raised the possibility of an

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100. *See generally* D. C. Mildenhall, *Terrestrial Palynology*, 245 DSIR BULL. N. Z., 119-127 (1989).

101. *See* Barrett, *supra* note 77.

102. *See generally* Hill, *supra* note 99; *see also* Mildenhall, *supra* note 100.

103. *See* Kemp & Barrett, *supra* note 84.

104. *See* Flower, *supra* note 8, at 36 (citing Benjamin P. Flower & James P. Kennett, *Middle Miocene Ocean/Climate Transition: High-Resolution Oxygen and Carbon Isotopic Records from Deep Sea Drilling Project Site 588A, Southwest Pacific*, 8 PALEOCEANOGRAPHY 811 (1993); Benjamin P. Flower & James P. Kennett, *Middle Miocene Deepwater Paleoceanography in the Southwest Pacific: Relations with East Antarctic Ice Sheet Development*, 10 PALEOCEANOGRAPHY 1095 (1995)). As with the Oligocene, the major events of the Miocene portion of the stable isotope curve for benthic foraminifers have been numbered, the Mi3 being the third event from the bottom. The most prominent was ~1.0 ‰. The most rapid was less than 200,000 years.

105. *See* Flower, *supra* note 8, at 36 (citing James D. Wright et al., *Early and Middle Miocene Stable Isotopes: Implications for Deepwater Circulation and Climate*, 7 PALEOCEANOGRAPHY 357 (1992); Flower & Kennett, *Middle Miocene Ocean/Climate Transition: High-Resolution Oxygen and Carbon Isotopic Records from Deep Sea Drilling Project Site 588A, Southwest Pacific*, 8 PALEOCEANOGRAPHY 811 (1993)).

106. *See* Flower, *supra* note 8, at 36 (citing Detlef A. Warnke et al., *Miocene-Pliocene Antarctic Glacial Evolution: A Synthesis of Ice-Rafted Debris, Stable Isotope, and Planktonic Foraminiferal Indicators, ODP Leg 114*, 56 ANTARCTIC RES. SERIES 311 (1992)).

107. *See* Flower, *supra* note 8, at 36; *see also* Barrett, *supra* note 35, at 65.

108. *See* Kennett, *supra* note 50, at 3856-57.

early Pliocene warm interval during which the West Antarctic Ice Sheet may have collapsed.[109]

This argument was taken one step further with reports by Peter-Noel Webb and David M. Harwood of planktonic diatoms and large clusters of diatoms (up to ~ 100 microns in diameter) of various ages in pre-Quaternary continental glacial deposits. These glacial deposits comprise the Sirius Group of sediments high up in the Transantarctic Mountains (Fig. 4).[110] These authors suggested the deposits were emplaced by relatively warm ("wet-based" and therefore inherently unstable) ice sheets from East Antarctica that overtopped the mountains while moving toward the Ross Sea.[111] They believed the marine diatoms had been eroded by ice from sedimentary interior basins on East Antarctica that had been previously flooded by marine waters during major deglaciations of the Antarctic Ice Sheet.[112] These events occurred as late as ~2.8 Ma.[113] In their view, a true "polar" ice sheet ("dry-based", cold and stable)[114] like that on Antarctica today did not develop until about 2.5 Ma, the time major glaciations began in the Northern Hemisphere. Their concept of a major collapse of much of the Antarctic Ice Sheet during and before the Pliocene is now referred to as the "Dynamicist school of thought."[115]

The "Dynamicists" were soon opposed by the "Stabilists" who believed that a true polar ice sheet has existed over the continent continuously for the past fifteen million years.[116] They contend that

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109. *See* Paul F. Ciesielski & Fred M. Weaver, *Early Pliocene Temperature Changes in the Antarctic Seas*, 2 GEOLOGY 511, 513-515 (1974).

110. *See* Barrett, *supra* note 35, at 65.

111. *See generally* P.N. Webb et al., *Cenozoic Marine Sedimentation and Ice-Volume Variation on the East Antarctic Craton,* 12 GEOLOGY 287, 289-90 (1984).

112. *See id.*

113. This date was given by the youngest diatoms present during the late Pliocene. *See generally* David M. Harwood, *Late Neogene Climatic Fluctuations in the Southern High Latitudes: Implications of a Warm Pliocene and Deglaciated Antarctic Continent*, 81 S. AFR. J. SCI. 239 (1985); *see also* Steven M. Bohaty & David M. Harwood, *Southern Ocean Pliocene Paleotemperature Variation from High-Resolution Silicoflagellate Biostratigraphy,* 33 MARINE MICROPALEONTOLOGY 241, 248-67 (1998) (where Pliocene peak warming intervals are identified at ~4.2, ~4.3, ~4.5, and ~3.6 Ma from proxy records of planktonic microfossil abundances on the Kerguelen Plateau (fig. 7)).

114. *See* ROGER LEB. HOOKE, PRINCIPLES OF GLACIER MECHANICS 5 (1998).

115. *See* Molly F. Miller & Mark C. G. Mabin, *Antarctic Neogene Landscapes – In the Refrigerator or the Deep Freeze,?* 8 GSA TODAY, April 1998, at 1-3.

116. *See* Michael L. Prentice & Robley K. Matthews, *Cenozoic Ice-Volume History: Development of a Composite Oxygen Isotope Record*, 16 GEOLOGY 963, 964-966; *see also* James P. Kennett & Peter F. Barker, *Latest Cretaceous to Cenozoic Climate and Oceanographic Developments in the Weddell Sea, Antarctica: an Ocean-Drilling Perspective*, 113 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS, 937, 952-960 (1990); George H. Denton et al., *Cainozoic History of the Antarctic Ice Sheet, in* THE GEOLOGY OF ANTARCTICA 365, 410-414 (R. J. Tingey, ed., Claredon Press 1991).

the marine diatoms found in the Sirius Group were either wind blown onto the exposed outcrops and therefore the Sirius deposits could be much older[117] or were deposited with ejecta from an extra-terrestrial bolide (meteor) impact occurring in the Southern Ocean about 2.15 Ma.[118] This contention is supported by the fact that diatoms may be exceedingly small and are notoriously subject to transport over long distances by wind. For example, non-marine and brackish species from Patagonia, South America, have been recovered in some quantity in ice cores at the South Pole.[119] Not well explained by eolian (wind) transport, however, is how marine diatoms, particularly those clumped together in large clusters or those too large to be entrained by wind, wound up within and not just on the surface of eroding outcrops of the Sirius Group.[120]

The Sirius Group contains a rather diverse set of thick glacial and stratified sediments (including those from fluvioglacial, glacial-marine, fiord, and lacustrine [lake] environments), that suggest many advances and retreats of inland ice through gaps in the Transantarctic Mountains.[121] A wide variety of well-preserved evidence[122] (e.g., twigs, leaves, moss, pollen, seeds, and insects) has been put forth to support warmer climates when these deposits were laid down. For example, the Beardmore Glacier area (Fig. 1) contains finger-sized pieces of mature but stunted *Northofagus* wood that suggest mean annual temperatures of -12°C,[123] which is about 20° C warmer than presently in that area.[124]

The main disputed issue is the age of the Sirius Group. The Stabilists, who cite bolide impacts and wind-blown origins for the diatoms located there, believe it is considerably older than proposed

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117. *See* Miller & Mabin, *supra* note 115, at 3 (citing Lloyd H. Burckle & N. Potter, Jr., *Pliocene-Pleistocene Diatoms in Paleozoic and Mesozoic Sedimentary and Igneous Rocks from Antarctica: A Sirius Problem Solved*, 24 GEOLOGY 235, 236-238 (1996); A. P. Stroeven et al., *On Marine Microfossil Transport and Pathways in Antarctica During the Late Neogene: Evidence from the Sirius Group at Mount Fleming*, 24 GEOLOGY 727, 729-730 (1996)).

118. *See generally* R. Gersonde et al., *Geological Record and Reconstruction of the Late Pliocene Impact of the Eltanin Asteroid in the Southern Ocean*, 390 NATURE 357, 357-363 (1997).

119. *See* David D. Kellogg and Thomas B. Kellogg, *Diatoms in South Pole Ice: Implications for Eolian Contamination of Sirius Group Deposits,* 24 GEOLOGY 115, 116-118 (1996).

120. *See* David M. Harwood & Peter-Noel Webb, *Glacial Transport of Diatoms in the Antarctic Sirius Group: Pliocene Refrigerator,* 8 GSA TODAY, Apr. 1998, at 1, 4-8 (1998).

121. *See* Barrett, *supra* note 35, at 67.

122. *See, e.g.,* Allan C. Ashworth et al., *A Weevil from the Heart of Antarctica,* 5 QUATERNARY PROCEEDINGS 15 (1997).

123. *See* Barrett, *supra* note 35, at 67 (citing Francis, *supra* note 60).

124. *See id*.

by the Dynamicists.[125] The Stabilists also point to glacial, geomorphic, and paleoclimate data from the McMurdo Dry Valley region to suggest that cold polar desert conditions have prevailed there for many millions of years, at least since the middle Miocene. This would rule out a dynamic ice sheet and episodes of more temperate climate during that period.[126] The Stabilists point to unconsolidated, unweathered, and uneroded ash beds within the Dry Valleys as old as 4 to 15 Ma. The pristine condition of the ash beds seems to rule out chemical weathering in warmer, moister conditions that would have prevailed during interglacial climates.[127] In addition, space-age technology (cosmogenic exposure-age analyses) used to date rocks at the surface suggests exposure times of greater than four million years.[128] These arguments are formidable, and are held by some[129] to represent the majority view of the investigators who have examined the question.

A recent review summarizes well the issues under debate and introduces articles by proponents for both sides of the diatom-transport issues.[130] The matter is not yet settled, however, and proxy evidence from the world's oceans and ice-sheet modeling studies are cited as support for both points of view.[131] Evidence for early Pliocene warmth and/or sea level rise is documented from outcrops

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125. *See, e.g.*, Arjen P. Stroeven et al., *Atmospheric Transport of Diatoms in the Antarctic Sirius Group: Pliocene Deep Freeze*, 8 GSA TODAY, Apr. 1998, at 1, 4-5; *see also* Barrett, *supra* note 35.

126. *See* Denton et al., *supra* note 116, at 397-398; George H. Denton et al., *East Antarctic Ice Sheet Sensitivity to Pliocene Climatic Change from a Dry Valleys Perspective*, 75(A) GEOGRAFISKA ANNALER 155, 165-168 (1993).

127. *See generally* David R. Marchant et al., *Late Cenozoic Antarctic Paleoclimate Reconstructed from Volcanic Ashes in the Dry Valleys Region of Southern Victoria Land*, 108 GSA BULL. 181, 188 (suggesting that mean annual temperatures have been no more than 3°C above present at any time during the Pliocene); David R. Marchant et al, *Pliocene Paleoclimate and East Antarctic Ice-Sheet History from Surficial Ash Deposits*, 260 SCIENCE 667, 668-669 (1993); David R. Marchant et al., *Miocene Glacial Statigraphy and Landscape Evolution of the Western Asgard Range, Antarctica*, 75(A) GEOGRAFISKA ANNALER 303, 322-330 (1993); David R. Marchant et al., *Miocene-Pliocene-Pleistocene Glacial History of Arena Valley, Quartermain Mountains, Antarctica*, 75(A) GEOGRAFISKA ANNALER 269, 295-302 (1993); David R. Marchant & George H. Denton, *Miocene and Pliocene Paleoclimate of the Dry Valleys Region, Southern Victoria Land: A Geomorphological Approach*, 27 MARINE MICROPALEONTOLOGY 253, 267-269 (1996).

128. *See* Susan Ivy-Ochs et al., *Minimum ^{10}Be Exposure Ages of Early Pliocene for the Table Mountain Plateau and the Sirius Group at Mount Fleming, Dry Valleys, Antarctica*, 23 GEOLOGY 1007, 1008 (1995); Mark D. Kurz & Robert P. Ackert, *Stability of the East Antarctic Ice Sheet? New Chronological Evidence from Bennett Platform, Antarctica,* 78 EOS (TRANSACTIONS, AMER. GEOPHYSICAL UNION) S185 (1997).

129. *See* Barrett, *supra* note 35, at 65.

130. Miller & Mabin, *supra* note 115.

131. *See id*. at 2 (noting that among other evidence the same modeling study is cited as support by both sides, namely that of Philippe Huybrechts, *Glaciological Modelling of the Late Cenozoic East Antarctic Ice Sheet: Stability or Dynamism?*, 75(A) GEOGRAFISKA ANNALER 221 (1993)).

on Antarctica[132] and within the marine record elsewhere,[133] but a question remains as to whether the magnitude of such events was sufficient to account for a major meltdown of the Antarctic Ice Sheet. It has also been argued that the oxygen isotopic record does not record a major warming during the early Pliocene and that no change in ice-sheet volume has been recorded by the distribution of ice-rafted debris.[134] New ice-volume calculations, however, based on a newly developed and as yet low-resolution Mg-temperature curve, show a strong reduction in ice volume at this time.[135] As stated by proponents for the Dynamicist view, "it appears that there were brief intervals during the Pliocene when the refrigerator door was left open."[136]

F. Quaternary (2.0-0 Ma)

Regardless of the controversy over the early Pliocene stability of the Antarctic Ice Sheet, one would expect the last two million years of its history to be better understood from marine sediment records and, for the past ~400,000 years, from ice cores. As noted previously, deep-sea records, particularly those that record $\delta^{18}O$ paleotemperatures, indicate that the pattern of Quaternary ice-volume change is cyclical, having been modulated by variations in the Earth's tilt and the ellipticity of its orbit (orbital forcing).[137] Between about 900-700 Ka, a 100,000 year cycle corresponding to an eccentricity variation became dominant.[138] Northern Hemisphere ice sheets entered the picture at about 2.7 Ma, apparently in response to oceanic circulation changes induced by the closure of the Isthmus of Panama.[139] Most of

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132. *See generally* Francis, *supra* note 60, at 50 (citing Patrick G. Quilty, *The Pliocene Environment of Antarctica*, 130(2) ROYAL SOC. OF TASMANIA, PAPERS AND PROC. 1, 4 (1996)).

133. *See generally* D.T. Cronin & H. J. Dowsett eds., *Pliocene Climates*, 10 QUATERNARY SCIENCE REVIEW 115-296 (1991); PRISM PROJECT MEMBERS, *Middle Pliocene Paleoenvironments of the Northern Hemisphere,* PALEOCLIMATE AND EVOLUTION WITH EMPHASIS ON HUMAN ORIGINS 197-208 (1995); Richard Z. Poore and L. Cirbus Sloan eds., *Climates and Climate Variability of the Pliocene*, 27 MARINE MICROPALEONTOLOGY 1-326 (1996); Bohaty & Harwood, *supra* note 113.

134. *See* James P. Kennett and David A. Hodell*, Stability or Instability of Antarctic Ice Sheets During Warm Climates of the Pliocene?*, 5 GSA TODAY, Jan. 1995, at 1, 11-13.

135. *See* Lear et al., *supra* note 88, at 270 (fig. 1E).

136. *See* Harwood & Webb, *supra* note 120, at 7.

137. *See generally* Flower, *supra* note 8, at 39 (citing Cesare Emiliani, *Pleistocene Temperatures*, 63 J. GEOLOGY, 538-578 (1955)); *see also* IMBRIE & IMBRIE, *supra* note 28.

138. *See* Flower, *supra* note 8, at 38 (citing A. C. Mix et al., *Benthic Foraminifer Stable Isotope Record from Site 849 (0-5 Ma): Local and Global Climate Changes*, 138 PROC. OCEAN DRILLING PROGRAM, SCI. RESULTS 371, 375-379, 385-387 (1995)).

139. *See* Jan Backman, *Pliocene Biostratigraphy of DSDP Sites 111 and 116 from the North Atlantic Ocean and the Age of Northern Hemisphere Glaciation*, 32 STOCKHOLM CONTRIBUTIONS IN GEOLOGY 115, 128-32 (1979); *see also* Lloyd D. Keigwin, Jr., *Pliocene Closing of the Isthmus of*

the variation in global ice volume (about 80 to 90 % or 120 m of sea-level equivalent) has generally thought to have been dominated by Northern Hemisphere ice sheets.[140] During the last glacial maximum at ~ 20 Ka, sea level was about 120 m lower than that of today.[141]

The potential role of the relatively unstable West Antarctic Ice Sheet, however, has been cited recently as a wild card in this otherwise stable picture of the Antarctic Ice Sheet. Beneath 1,030 m thick ice at the fast-flowing Ice Stream B[142] (drill hole UpB, Fig. 1), some 700 km from the margin of the West Antarctic Ice Sheet, a deformable clay-rich glacial sediment (till) beneath the ice was sampled that yielded extinct diatoms along with isotopic data that showed that the fossils had been deposited in open-marine waters.[143] In other words, the ice at this location had disappeared, allowing an incursion of the sea at some time during the past 1.3 million years (possibly as recently as 400,000 years ago), presumably during an exceedingly warm interglacial period.[144] A wind-blown source for the diatoms was excluded because the sediments contained significant amounts of the cosmogenic radioactive isotope beryllium-10, which denoted deposition in the open sea.[145] According to glaciologists, a 700 km retreat would leave little room for an ice sheet.[146] That in turn leaves little doubt that the West Antarctic Ice Sheet collapsed and flooded the world's coasts at that time, a time perhaps not much warmer than today.[147]

Panama, Based on Biostratigraphic Evidence From Nearby Pacific Ocean and Caribbean Sea Cores, 6 GEOLOGY 630, 632-33 (1978).

140. This view, however, does not adequately take into account the less well understood contribution of the Antarctic ice sheet.

141. *See* Richard G. Fairbanks, *A 17,000 Glacio-Eustatic Sea Level Record: Influence of Glacial Melting Rates on the Younger Dryas Event and Deep-Ocean Circulation*, 342 NATURE 637-642 (1989).

142. Ice streams are routes along which the ice flows very rapidly, at approximately 400 m/yr at this locality, where the sediment surface is about 600 m below sea level. *See* Reed P. Scherer et al., *Pleistocene Collapse of the West Antarctic Ice Sheet*, 281 SCIENCE 82, 82 (1998) (citing Richard B. Alley et al., *Deformation of Till Beneath Ice Stream B, West Antarctica,* 322 NATURE 57, 58 (1986); D. D. Blankenship et al., *Seismic Measurements Reveal a Saturated Porous Layer Beneath an Active Antarctic Ice Stream,* 322 NATURE 54 (1986); Hermann Engelhardt et al., *Physical Conditions at the Base of a Fast Moving Antarctic Ice Stream,* 248 SCIENCE 57 (1990)).

143. *See* Scherer et al., *supra* note 142, at 84.

144. *See id.* at 84 (suggesting that the meltdown occurred during marine isotope stage [MIS] 11). *See generally* Reed Scherer, *Quaternary Interglacials and the West Antarctic Ice Sheet* (in preparation) (manuscript at 1, 4-5).

145. *See generally* Scherer et al., *supra* note 142, at 82, 84.

146. *See* Richard A. Kerr, *Signs of Past Collapse Beneath Antarctic Ice*, 281 SCIENCE 17, 17 (1998) (quoting Robert Bindschadler of NASA's Goddard Space Flight Center in Greenbelt, Maryland).

147. *See id.*

Other evidence of relatively warm interglacial conditions during the Quaternary has come to light during a recent fast-ice-based drilling project off the Transantarctic Mountains in the eastern Ross Sea. During the austral spring of 1997, the Cape Roberts Project (Fig. 1) cored a meter-thick shell bed dated between 1.15 and 0.86 Ma.[148] This shell bed contained an astounding variety of over sixty species of fossil marine invertebrates[149] as well as calcareous planktonic nannofossils called thoracospherids.[150] The latter prefer relatively warm conditions and do not inhabit these waters today.[151] Diatoms in the shell bed are mostly open-marine species. Essentially absent are the sea-ice inhabiting diatoms that currently pervade the site.[152] From this it is inferred that the environment in McMurdo Sound was much different from today.[153] It has been suggested that this also was a time of West Antarctic Ice Sheet collapse.[154]

IV. STABILITY OF THE WEST ANTARCTIC ICE SHEET

The recent studies previously cited call into question the stability of the West Antarctic Ice Sheet even during the relatively recent Quaternary times. As the world's only large ice sheet grounded with its margins well below sea level, it is vulnerable to collapse.[155] It has already lost two-thirds of its mass since the Last Glacial Maximum, which occurred some 21,000 years ago.[156] Its recent history has been reviewed by Oppenheimer, who concluded from its somewhat erratic behavior that it will likely disintegrate during the next 500-

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148. *See* S.M. Bohaty et al., *Quaternary Diatom Biostratigraphy and Paleoenvironments of the CRP-1 Drillcore, Ross Sea, Antarctica,* 5 TERRA ANTARCTICA 431, 436-438 (1998).

149. *See generally* Marco Taviani et al., *Pleistocene Macrofossils from CRP-1 Drillhole, Victoria Land Basin, Antarctica*, 5 TERRA ANTARCTICA 485, 485 (1998).

150. *See* Giuliana Villa & Sherwood W. Wise, Jr., *Quaternary Calcareous Nannofossils from the Antarctic Region,* 5 TERRA ANTARCTICA 479, 481-484 (1998).

151. *See id*. at 481-82.

152. *See* Bohaty et al., *supra* note 148, at 441.

153. *See id.* at 443.

154. *See* Scherer et al., *supra* note 142 (speculating that this apparent meltdown occurred during marine isotope stage (MIS) 12, about 900,000 years ago); *see also* R. P. Scherer, *Quaternary Collapse of the West Antarctic Ice Sheet: MIS 11, Yes, but was it a Unique Event?* (visited June 8, 2000) <http://www.agu.org/meetings/waisfm99.html> (search under "Scherer").

155. *See* R.B. Alley & I. M. Whillans, *Changes in the West Antarctic Ice Sheet,* 254 SCIENCE 959, 959 (1991); Douglas R. MacAyal, *Irregular Oscillations of the West Antarctic Ice Sheet,* 359 NATURE 29, 29 (1992); Robert Bindschadler, *West Antarctic Ice Sheet Collapse?,* 276 SCIENCE 662-63 (1997); R. A. WARRICK ET AL., *supra* note 22.

156. *See* Robert Bindschadler, *Future of the West Antarctic Ice Sheet*, 282 SCIENCE 428, 428 (1998).

700 years.[157] This will cause sea level rise to accelerate at the beginning of the 22nd Century.[158]

This doomsday scenario was painted by glaciologist Johannes Weertman of Northwestern University twenty-five years ago. He warned that the ice sheet would collapse quickly if the climate warms.[159] Weertman explained that even a slight warming-induced retreat of the ice's grounding line (where it begins to float off the bottom to form its fringing ice shelves) will move the grounding line into thicker ice. [160] "The thicker the ice, the faster it flows outwards and the faster it thins. The faster it thins, the sooner it floats, moving the grounding line even farther inward and accelerating a retreat" that could destroy the West Antarctic Ice Sheet in a century or two.[161] The effect on our coastal cities would be catastrophic.

Not all investigators agree. Some point out that the confinement of the major ice shelves within enclosed embayments such as the Ross Sea provides a modicum of stability, as does spotty resistance of the ice sheet's bed, which helps hold them together.[162] One modeling study (Fig. 9) suggests that Antarctic mean annual air temperature would have to increase by 9° C before major decay would take place. A rise of 5°C would even cause ice sheet growth.[163] However, a more recent modeling study suggests that a relatively minor increase in water temperature can offset the effects of increased ice accumulation that results in rapid ice sheet retreat during an early stage of climatic warming.[164]

Another recent study suggests that the Greenland Ice Sheet may be even more vulnerable to collapse than the West Antarctic Ice

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157. *See* Michael Oppenheimer, *Global Warming and the Stability of the West Antarctic Ice Sheet,* 339 NATURE 325, 330 (1998).

158. *But see* Bindschadler, *supra* note 156, at 429 (presenting a projection based on other data that estimates the future lifetime of the West Antarctic Ice Sheet at 4,000-7,000 yrs).

159. *See* J. Weertman, *Glaciology's Grand Unsolved Problem*, 260 NATURE 284 (1976); *see also* Kerr, *supra* note 146, at 19.

160. *See* Kerr, supra note 146.

161. *See id*. at 19.

162. *See id*.

163. *See* Barrett, *supra* note 35, at 57 (citing P. Huybrechts, *Glaciological Modelling of the Late Cenozoic East Antarctic Ice Sheet: Stability or Dynamism,?* 75(A) GEOGRAFISKA ANNALER 221, 236 (1993) (concluding that field studies have suggested a modest rise in air temperature could increase marine evaporation and hence snow accumulation on Antarctica). *See, e.g.*, Eugene W. Domack et al., *Advance of East Antarctic Outlet Glaciers During the Hypsithermal: Implications for the Volume State of the Antarctic Ice Sheet Under Global Warming*, 19 GEOLOGY 1059, 1061 (1991) (citing T. Huybrechts & J. Oerlemans, *Response of the Antarctic Ice Sheet to Future Greenhouse Warming*, 5 CLIMATE DYNAMICS 93 (1990)).

164. *See* Roland C. Warner & W. F. Budd, *Modelling the Long-Term Response of the Antarctic Ice Sheet to Global Warming,* 27 ANNALS GLACIOLOGY 161, 163-66 (1998).

Sheet because of its closer proximity to the equator.[165] Like the West Antarctic Ice Sheet, it represents about 6-m sea level equivalent. The study concludes that during the previous interglacial between 110-130 thousand years ago, much of Greenland's ice melted, whereas the West Antarctic Ice Sheet was little affected. It is of little comfort, however, to know that the Greenland Ice Sheet might melt before the West Antarctic Ice Sheet, particularly if both were to collapse.

Because of the currently high equator-to-pole temperature gradient (the temperature difference between those two extremes), global warming would cause temperatures at both poles to rise much faster than global mean annual temperature. This is where man's influence may come into play most dramatically. Figure 10 depicts the episodic 7° C decline in global temperatures over the past one hundred million years estimated from the deep-sea oxygen isotope method with notes as to where Antarctic and Northern Hemisphere ice sheets probably first appeared. Superimposed above that and on a much shorter time scale, future temperature rise as a result of anthropogenic emissions of CO_2 and other greenhouse gases is plotted according to two scenarios. The first is a "restricted" mode in which emissions are limited to early 1990's levels (5 gigatons per year (Gt/yr)). The second is an "unrestricted" mode in which there are no restraints on emissions. If emissions are unrestricted, mean global temperatures are expected to rise around 1-3 ° C in the next one hundred years and twice that amount by the end of the following century.[166] Traced back in time, such temperatures were last experienced on the planet 12-14 and 35-40 million years ago, respectively.[167] These were the times of the advent of the first semi-permanent ice sheets on East Antarctica and of the inception of the East Antarctic Ice Sheet itself, according to paleoclimatologists.[168] Once the ice sheets are disposed of, these authors predict that continued greenhouse temperature change over the next few hundred years should result in climate perturbations "comparable to or exceeding any that have been reached in the last 600 million years."[169]

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165. *See generally* Kurt M. Cuffey & Shawn J. Marshall, *Substantial Contribution to Sea-Level Rise During the Last Interglacial from the Greenland Ice Sheet*, 404 NATURE 591, 591 (2000); *see also* Callahan, *supra* note 11.

166. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 20, at 6.

167. *See* Barrett, supra note 35, at 54 (citing Thomas J. Crowley & Kwang-Yul Kim, *Comparison of Long Term Greenhouse Projections with the Geologic Record*, 22 GEOPHYSICAL RES. LETTERS 933 (1995)).

168. *See id.*

169 *See id.*

V. CONCLUSIONS

Our knowledge of the history of the Antarctic Ice Sheet is limited in that it must rely heavily on proxy indicators of ice volume and temperatures rather than direct evidence from ice sheet deposits. Nevertheless, a sufficiently detailed picture of that history is coming into focus to provide an understanding of the major steps in its growth and evolution of when our planet went into "refrigeration," culminating in the current "ice ages" of the past two and a half million years. The geologic record over the past fifty-six million years provides clearly defined end points for that spectrum, ranging from the unglaciated "greenhouse" world of the Late Paleocene Thermal Maximum to the present-day "icehouse" world with its now "polar" (-20^{o} C) Antarctic Ice Sheet.

Geoscientists strongly debate the details of this history as well as the causes and effects of volume changes of the Antarctic Ice Sheet. They constantly work to refine their data and expand their databases through the acquisition of new and more detailed records. This often requires the development of new technologies to acquire the necessary geologic sections from the field and to interpret these in the lab. Much work remains to be done, however, to satisfactorily define the historic record of the ice sheet and decipher its natural cycle.

Nevertheless, incomplete as our historical knowledge of the Antarctic Ice Sheet and past global climate cycles is, it does provide a basis for predicting the future under two scenarios:

1) If nature is left to take its course and the rather predictable orbital modulation of climate continues into the future as it has during the late Quaternary, one would expect the climate to move from the current interglacial mode into a glacial one within the next millennium or two.[170]

2) If man's loading of the atmosphere with greenhouse gasses continues unabated, then global temperatures will rise and deglaciation of Antarctica will be inevitable. In other words, man will run in reverse the global experiment[171] that nature has run over the past

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170. *See Mitchell*, *supra* note 23, at 53, 55, 58.

171. Man's own release of industrially produced greenhouse gases has been aptly labeled an "inadvertent experiment being performed on the atmosphere by human activities" by V. Ramanathan. *See* V. Ramanathan, *The Greenhouse Theory of Climate Change: A Test by an Inadvertent Global Experiment,* 240 SCIENCE 293, 294 (1988).

fifty-five million years. The path that process would take is indicated by backtracking the geologic history of the Antarctic Ice Sheet (e.g., Fig. 10),[172] which is best done with the aid of computer modeling.[173] Not all conditions would be the same, however, in that the configuration of the continents has changed considerably over those fifty-six million years. Also, plants have evolved new types of vegetative covers such as grasses, and the composition of the atmosphere has not remained constant through time; i.e., a different set of boundary conditions exist now as opposed to then. Many of these factors, however, can be taken into account in the modeling.[174]

To improve computer models as well as our own understanding, scientists need more direct and detailed evidence of the behavior of the Antarctic Ice Sheet.[175] This, however, is a difficult record to obtain due to the logistics of working in this remote and inhospitable region where operational costs are high relative to other parts in the world. New technologies have to be developed to overcome these logistical difficulties. Tantalizing geologic records are known to exist around the margins of the continent where prograding sedimentary sequences deposited during past advances and retreats of the ice sheets have been imaged by seismic stratigraphy.[176] This is a powerful technique that utilizes earth-penetrating sound waves to provide an x-ray-like cross section through sedimentary sequences (Fig. 11). Coring these sequences with conventional weight-driven piston and gravity cores has been frustrated by inability to penetrate overconsolidated sediments compacted by the more recent ice advances. As a result, pre-Quaternary sediments are seldom retrieved by this means. Drilling these sequences with the scientific drill ship has met with limited success due to the constant heave of the ship and the prevalence of glacial drop stones ("erratics") that limit core recovery and quality, although more such drilling has been proposed.[177] Fast-ice-based diamond coring, such as that used by the recently

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172. *See* Huybrechts, *supra* note 163; *see also* Warner & Budd, *supra* note 164.

173. *See* Robert J. Oglesby, *Use of Climate Models to Extend Paleoclimatic Data*, 3 TERRA ANTARCTIC REPORTS 131 (1999).

174. *See id.*

175. *See* Peter N. Webb & Alan K. Cooper eds., *Antarctic Late Phanerozoic Earth System Science,* 16 SCAR ANTARCTIC OFFSHORE STRATIGRAPHY PROJECT REPORT 1, 1 (1999).

176. *See generally* Barrett, *supra* note 35, at 63 (citing Alan K. Cooper et al. eds., *Geology and Seismic Stratigraphy of the Antarctic Margin*, 68 ANTARCTIC RES. SERIES 1 (1995)); *see also* Alan K. Cooper et al., *Cenozoic Prograding Sequences of the Antarctic Continental Margin: A Record of Glacio-Eustatic and Tectonic Events*, 102 MARINE GEOLOGY 175, 177-79 (1991).

177. *See generally* Peter F. Barker et al., *Ice Sheet History from Antarctic Continental Margin Sediments: The ANTOSTRAT Approach*, 5 TERRA ANTARCTICA 737, 747, 756 (1998); *see also* Webb & Cooper, *supra* note 175, at 1, 3, 8.

completed Cape Roberts Project, has consistently provided high quality cores with an average 95% recovery during that expedition.[178] Fast sea ice, however, is found over only a limited number of basins that contain the right strata needed to answer the outstanding geologic questions. The adaptation of diamond coring techniques for use on ice-strengthened and ice-breaker vessels is still under development,[179] although suitable systems should become available for routine use during the coming decade.[180] Concerted efforts are also planned to purposefully sample sediments and bedrock beneath the existing ice sheets, although such operations face their own technical difficulties that need to be overcome.

In short, polar science is high risk and needs to be planned within a broad, long term framework that takes into account the logistical difficulties of working in these regions. An omnipresent logistical factor that complicates such work is the vagary of the polar weather. During the first year of the Cape Roberts Project, an early season storm forced cessation of drilling after only seven days of coring. The rig was nearly lost as the sea ice was broken up to within a kilometer of the drill site by incoming waves.[181] The project, however, enjoyed excellent ice conditions during its last two years when the sea ice platform was cold and thick. The final 940 m hole, a spectacular engineering feat in itself, was terminated only because the basal Cenozoic sediments (34 Ma in age) were reached above bed rock over ten times that age.[182] The same heavy sea-ice conditions that favored this type of drilling, however, severely frustrated contemporaneous efforts in Prydz Bay on the other side of the continent (Fig. 1) with the drill ship *JOIDES Resolution*. The ship was unable to reach several of its primary sites, which had been expected to yield

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178. *See generally* Cape Roberts Science Team, *Initial Report on CRP-3, Cape Roberts Project, Antarctica*, 7 TERRA ANTARCTICA (forthcoming 2000) (manuscript at 201, 203 (Table 7.2)).

179. *See* Yngve Kristoffersen, *Approaches to Marine Shallow Drilling on the Antarctic Shelf*, 16 SCAR REPORT 39-40 (1999).

180. For a status report on the current state of technology, see G. L. Holloway, Report on Drilling Systems for Antarctic Research Vessels 49 (SHALDRILL Committee of Antarctic Earth Science Working Group) (1997) (unpublished report) (executive summary available on request from the Antarctic Marine Geology Research Facility, Florida State University).

181. *See* Cape Roberts Science Team (1998), *supra* note 95, at 127.

182. *See* Cape Roberts Science Team (2000), *supra* note 95, at 185. This project also benefitted from the use of state-of-the-art core description/processing equipment at the drill site and in a lab at McMundo Station (100 km to the south), such as a microwave acid-digestion unit for preparation of palynology samples (*see supra* note 181 at 22-23).

an older record of the East Antarctic Ice Sheet, possibly a record of its inception.[183]

Despite the logistical difficulties and setbacks, the future for Antarctic exploration to extend our understanding of ice sheet history is bright, considering international interest and commitment toward acquiring that knowledge.[184] All parties of the global change controversy recognize the need for sound baseline studies of nature's natural glacial cycles before man's potential role in influencing earth climate can be adequately assessed. The major question is whether we will gain that knowledge in time to make sound predictions for the future of the Antarctic Ice Sheet before the impact of man's activities is felt in an irreversible way.[185] The race is on.

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183. *See* Alan Cooper et al., 188 PROC. OCEAN DRILLING PROGRAM, INITIAL REP. (forthcoming 2001) (CD-ROM available from Ocean Drilling Program, Texas A&M Univ., College Station, TX 77845-9547). This ship also lacks the microwave digestion unit (*see supra* note 182), which severely limited shipboard analysis of pollen and spores, particularly during its most recent cruise to the Kenquplen Plateau (*see generally* Millard F. Coffin et al., 1983 Proc. Ocean Drilling Program, Initial Rep. (2000) (cd-rom available from Ocean Drilling Program, Texas A & M Univ., College Station, TX 77845-9547)).

184. *See generally* OCEAN DRILLING PROGRAM, LONG RANGE PLAN 1989-2002 (Joint Oceanographic Institutions, Inc., 1990); Webb & Cooper, *supra* note 175.

185. Ironically, by that time, one of the primary archives for the study of global warming, the ice sheet itself (and the ice cores that can be taken through it), will be gone.

APPENDIX

Figure 1. Antarctica, with locations of key features and areas mentioned in text. RIS — Ross Ice Shelf, LIS — Larsen Ice Shelf, RFIS — Ronne-Filchner Ice Shelf, MR — Maud Rise, KP — Kerguelen Plateau (Barrett, *supra* note 35, at fig. 10). UpB — upper ice stream B drill hole, CRP — Cape Roberts Project.

Figure 2. Increase of carbon dioxide and methane over the last two centuries based on analyses of air bubbles trapped in ice cores; solid lines denote instrument readings from the atmosphere (Orombelli, *supra* note 15 at fig. 7).

Figure 3. Global mean annual temperatures for the past 100 years based on tree-ring data and, for the past 200 years, ice core data and instrumented readings (Kerr, *supra* note 25).; *see also* Thomas J. Crowley, *Causes of Climate Change Over The Past 1000 Years*, 289 SCIENCE 270 (2000) (providing a detailed analysis of the data represented by this figure).

Figure 4. The Antarctic ice sheet today, with ice drainage patterns (elevations to the nearest thousand meters) and the main geographic regions of the continent (Barrett, *supra* note 35, at fig. 1, as adapted from Drewry, *supra* note 35). The East Antarctic Ice Sheet (60 m sea-level equivalent) is dammed on its west side by the Transantarctic Mountains, which separate it from the relatively less stable West Antarctic Ice Sheet (6 m sea-level equivalent) (Barrett, *supra* note 35).

Figure 5. Two proxy indicators of ice sheet volume and/or sea bottom temperatures for the past 65 million years (Barrett, *supra* note 35 at fig. 9): 1) On the left, oxygen isotope rations ($\delta^{18}O$ expressed in parts per thousand [0/00%] for deep-sea benthic foraminifers from the Atlantic Ocean (Miller et al., *supra* note 52). The averaged long-term curve shows a steady increase in $\delta^{18}O$ values (= a fall in global temperatures and/or an increase in ice volume) beginning around the early Eocene, whereas the short-term curve denotes major steps such as the Oll and Mi3 events; 2) The curves to the right show variations in global sea levels from an independent method, seismic sequence analysis (Bilal U. Haq et al., *Chronology of Flucuating Sea Level Since the Triassic*, 235 SCIENCE 1156, 1159 (1987). This analysis shows a long-term fall in global sea levels since the early Eocene with short-term fluctuations, most of which are attributed to ice volume changes. The time scale is that of Berggren et al. (1985), which was superceded in 1995 (Berggren et al., *supra* note 93).

Figure 6. Dispersal of the Southern (Gondwana) continents away from Antarctica via plate tectonics ("continental drift"), resulting in its thermal isolation once all connections to Australia and South America were severed by earliest Miocene time and the deep-water circumantarctic current was established. At that point, oceanic currents from the equatorial regions could no longer bring warmth to Antarctica. Stippled areas show shallow shelves and shelf basins (Barrett, *supra* note 35, at fig. 4, as modified from Kennett, *supra* note 69).

Figure 7. Paleogeographic reconstruction for the Prydz Bay region (see fig. 1) for the earliest Oligocene showing the advance of an East Antarctic Ice Sheet to sea level and the propagation of ice bergs that delivered ice-rafted debris to sites drilled by the Ocean Drilling Program on the Kergulen Plateau, some 1,000 km away (Wise et al., *supra* note 45, at fig. 8.18).

Figure 8. Summary of well-documented (solid pattern) and more speculative (unconfirmed; hatched-pattern) reports of middle Cenozoic glaciomarine sediments from Antarctic and Southern Ocean localities plotted against the record of deep-sea isotopic temperatures and global ice-volume (as a percentage of present-day ice-volume) computed from benthic foraminiferal oxygen isotope records. Two estimates of ice volume are given based on temperatures no colder than 1° C (black-shaded) and 1° to 4° C (hatched pattern) respectively; time scale (Berggren et al., *supra* note 93) (from James C. Zachos et al., *Abrupt Climate Change and Transient Climates During The Paleogene: A Marine Perspective*, 101 J. GEOLOGY 191, 196 (fig. 3) (1993)).

Figure 9. Maps and graph of ice-sheet size and location derived from a computer modal for mean-annual sea-level temperatures of 5, 9, 10, 15, 19, and 20° C above present-day values (Huybrechts, *supra* note 163).

Figure 10. Changes in global temperature over the past 100 million years compared with that expected from future greenhouse warming over the next 2,000 years (Barrett, *supra* note 35, at fig. 2). The "restricted" scenario for the future assumes that CO_2 emissions to the atmosphere will be held to early 1900's levels (5 giga-tons per year), whereas the "unrestricted" curve assumes no restraints on emissions. The "unrestricted" (worst-case) scenario returns atmospheric temperatures to that of 12-13 million years ago by the end of this century and to the level last experienced 35-40 million years ago (when the Antarctic Ice Sheet first formed) by the end of 2200 A.D.

Figure 11. Seismic stratigraphic profile with interpretation (below) showing a cross-section of prograding glaciomarine strata on the Antarctic margin deposited during past advances and retreats of the ice sheets (Shipboard Scientific Party, *Leg 178 Summary: Antarctic Glacial History and Sea-Level Change*, 178 PROC. OCEAN DRILLING PROGRAM, INITIAL REP. 1, 44 (fig. F17) (Barker et al., eds.) (1999). This is one example of many such seismic sequences that await scientific exploration by high-quality diamond-coring techniques to be developed during the next decade.

HOW WELL CAN INTERNATIONAL WATER ALLOCATION REGIMES ADAPT TO GLOBAL CLIMATE CHANGE?

A. DAN TARLOCK*

TABLE OF CONTENTS

I. INTRODUCTION

The consistent conclusions of climate change modeling exercises are that many of the world's major river basins may experience more severe droughts and floods in the coming decades and that aquatic ecosystems will, therefore, experience increased stresses. This Article examines the relationship between international water law and the projected impacts of global climate change on major river basins. The global climate change policy debate has two interrelated components. The first and major component seeks to find the most efficient and equitable means to reduce the root cause of

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anthropocentric climate change, increasing greenhouse gas emissions,[1] in an effort to mitigate projected temperature increases. The second component accepts the projected increases and seeks to understand both the effects of global climate change and the impacts of those effects in order to adapt to them.[2] The anticipated non-mitigation, global climate change response is adaptation to possible projected changes.

Water use regimes are prime candidates for adaptation for four reasons. First, the projected effects of global climate change may be substantial and dramatic, but they will be geographically unevenly distributed. The projected effects will be positive and negative, depending on the location of the basin. Thus, there is a need for varied local and regional responses rather than a uniform, global response, such as a carbon tax or tradable emission rights. Second, these effects, which may already be occurring, will likely materialize before mitigation becomes effective, if mitigation does, in fact, ever become effective. Third, water management regimes have some capacity to adjust to the projected adverse impacts, and adaptation is likely to be less costly than wholesale greenhouse gas emission rollbacks. Fourth, aquatic ecosystems can tolerate some level of stress for prolonged periods of time and still be good candidates for restoration.

The thesis of this Article is that adaptation to the projected adverse hydrologic impacts of global climate change requires the presence of a reasonably well-developed property rights regime in the effected basin, and that the regime must be supported by public and private adaptive management institutions. A property rights regime is a necessary condition but, alone, is insufficient to create fair risk-sharing and is insufficient to permit equitable adjustments to the inevitable inefficiencies of any sharing regime. A property rights regime can help accomplish the necessary reallocation in a way that allows users to share risks and to shift water fairly and efficiently among competing consumptive and non-consumptive uses, such as hydropower uses. Property rights regimes, however, have not historically performed an effective role in conserving aquatic

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1. *See generally* Jonathan B. Weiner, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L.J. 677 (1999).

2. I adopt the distinction between *effects* and *impacts* offered by Dr. Nigel Arnell. He defines effects as "the biophysical consequences of changes in the climatic variables driving the hydrological system" and impacts as the consequences of the effects on specific resource users. *See* Nigel Arnell, *The Impact of Climate Change on Water Resources*, THE GLOBE (Dec. 1997) (visited Apr. 30, 2000) <http://www/nerc.ac.uk/ukgeroff/globe40.htm>.

ecosystems, because property rights are seldom dedicated to this function. Nonetheless, property rights can play an important role in aquatic ecosystem protection and restoration. There is, however, also a need to manage the flow of river basins, including the maintenance of flows which mimic the system's natural hydrograph, better than we have in the past to accommodate the demand for existing and future consumptive and non-consumptive uses.

International water management and allocation regimes will face more difficult adaptation problems than domestic water law regimes for three primary reasons. First, although property rights must be defined and enforced before adaptation can take place, international water use regimes generally have less developed property rights than domestic regimes.[3] For example, the general principles of international water law, reflected in the 1997 United Nations Convention on the Non-Navigation Uses of International Watercourses, create uncertain national rights regarding the use of shared waters. This uncertainty increases the transaction costs of adaptation because property rights must first be defined with greater precision. Second, international regimes are less flexible than domestic ones. Some international rivers have been allocated by treaties that create firm property rights, but the rights may calcify over time and prevent adjustment to changed conditions. The purpose of an international water allocation treaty is generally to allow the construction of upstream and downstream dams, and the ensuing regimes generally assume a fixed, perpetual water supply and flow allocation regime. No provision is usually made for future changed circumstances. Therefore, the parties to such international treaties are likely to insist that the status quo be maintained, no mater how inefficient, inequitable, or environmentally destructive. Finally, ecosystem protection remains subordinate to multi-purpose regional water development.

II. THE EFFECTS AND IMPACTS OF GLOBAL CLIMATE CHANGE: A CASCADE OF UNCERTAINTIES

Predictions about the consequences of global climate change in a given watershed or river basin must account for hydrologic, economic, and political uncertainty.[4] Global climate change may

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3. *See* Joseph W. Dellapenna, *Adapting the Law of Water Management to Global Climate Change and Other Hydropolitical Stresses*, 35 J. AM. WATER RESOURCES ASS'N 1301, 1313 (1999).

4. *See generally* NATIONAL RESEARCH COUNCIL, GLOBAL ENVIRONMENTAL CHANGE: RESEARCH PATHWAYS FOR THE NEXT DECADE (1999) (explaining the gap between what we know

alter precipitation and run-off patterns throughout the world, and the effects are extremely uncertain. A recent Intergovernmental Panel on Climate Change (IPCC) assessment concluded that "[w]armer temperatures will lead to a more vigorous hydrologic cycle," and, although both the amount and timing of rain fall may change, the geographic and temporal scale of the change is uncertain.[5] Some regions, such as sub-Saharan Africa, may experience decreased precipitation and more extended droughts. Other regions will see increased precipitation and more frequent, more severe floods. Increased precipitation may not, however, translate into more available water supplies in all regions. In water-short areas with historically variable rainfall patterns, increased precipitation may actually exacerbate the problems associated with providing reliable water supplies. More precipitation may fall as winter rain rather than snow, and snowpacks may melt earlier, as warmer average temperatures indicate an earlier spring and faster water evaporation. Increased out-of-cycle rainfall is the projected pattern for parts of the western United States.[6] Wetter, warmer weather could impair the ability of the existing systems of carry-over storage to provide reliable regional water supplies.[7] Existing reservoirs may not be able to capture the increased winter run-off, and serious summer shortages may occur.[8]

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and what we need to know about the relationships between climate change and human and natural systems).

5. Ichtiaque Rasool, *Special Issue on the Global Hydrological Cycle*, THE GLOBE (Dec. 1997) (visited Apr. 30, 2000) <http://www.nerc.ac.uk/ukgeroff/globe40.htm>.

6. U.S. Global Change Research Program, National Assessment of the Potential Consequences of Climate Variability and Change: Draft Report of the Water Sector (visited Aug. 24, 2000) <http://www.nacc.usgcrp.gov/sectors/water/draft-report/full-report.html>.

The National Assessment of the Potential Consequences of Climate Variability and Change for the United States ("National Assessment") was called for by a 1990 federal law and has been conducted under a plan approved by the National Science and Technology Council — the cabinet-level body of agencies responsible for scientific research.

A wide range of activities has been underway for several years under the coordination of the federal agencies of the U.S. Global Change Research Program (USGCRP). Among them are five comprehensive sectoral assessments addressing impacts on water resources, forests, coastal ecosystems, human health, and agriculture. This report addresses the state of the science for assessing the impacts of climate changes and variability for the water resources and water systems of the United States.

7. An early study by an Environmental Defense Fund economist concluded that water deliveries for federal and state water projects that serve California's San Jaoquin Valley could be reduced by as much as 25 to 28 percent. *See generally* Daniel J. Dudek, CLIMATE CHANGE IMPACTS UPON AGRICULTURE AND RESOURCES: A CASE STUDY OF CALIFORNIA (1990).

8. *See* Sandra Postel, PILLAR OF SAND: CAN THE IRRIGATION MIRACLE LAST? 85-86 (1999). There is also a significant school that argues that global climate change will be good for the United States and other temperate countries. *See generally* Thomas Gale Moore, CLIMATE OF FEAR: WHY WE SHOULDN'T WORRY ABOUT GLOBAL WARMING (1998) (counting increased water

Many sophisticated modeling experiments exist for predicting the location and timing of the effects of increased temperatures on water resources, but "estimates of the effects and impacts of climate change on water resources are very uncertain."[9] There are three levels of uncertainty. First, there is meta uncertainty over the future rate of greenhouse gas emissions. Second, projected climate change scenarios must be translated into hydrologic ones, and numerous problems abound. Low flow models are more reliable than high flow ones; the confidence level of flow change predictions is high, but the confidence levels for quality and aquatic ecosystem changes are not as high. Third, there is a geographic scale problem. It is difficult to translate large-scale models into specific watersheds and to translate watershed models into regional predictions.

These uncertainties cascade into economic and political ones. River basins are physically and socially-politically dynamic. Changes in hydrology occur simultaneously with social and political change and the attendant landscape change that they may bring.[10] Population-driven, increased demand is the most important variable. In many basins, such as the Colorado River and the Nile, the population's demand for a reliable water supply is increasing. More people compete for the use of existing water entitlements. This competition both creates pressures for increased water use and creates shifts among established uses, often from agricultural uses to municipal and industrial uses.

Population pressure is not the sole source of new claim; in some basins, there are new claimants for uses that are not contemplated in the existing allocation regime. For example, in the Nile basin, upstream states now have the capacity to put waters to use. This capacity did not exist when Egypt and Sudan agreed to share the entire flow of the river. In other basins, environmental advocates are demanding that more water be allocated to uses such as wetlands protection, restoration, and the conservation of endangered species.

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supplies among the estimated $99 billion benefits that the global climate change will produce for the United States).

9. Arnell, *supra* note 2.

10. For example, a large-scale experiment is underway to attempt to model the relationship between forest clearing and the Amazon River's water balance, which may have a substantial impact on the global water balance. *See* J.H.C. Gash & A.D. Culf, *The Water Cycle in the Amazon Basin*, THE GLOBE (Dec. 1997) (visited Apr. 30, 2000) <http://www.nerc.ac.uk/ukgeroff/globe40.htm>.

III. AN ADAPTION MODEL

Consumptive water users can adapt to an altered hydrologic regime in four basic ways: reallocation of existing uses: conservation; temporarily forgoing a use; or, permanently foregoing a use. Each strategy requires the existence of a robust property rights regime. A robust property rights regime, augmented by adaptive management institutions, can provide fair and efficient processes for allocating the risks of future shortages among users. Property rights regimes set the ground rules for curtailment and permit the creation of reallocation markets, which are the most likely sources of new supplies. They can also create conservation incentives to compliment conservation mandates, but there are many national and international institutional barriers to the use of this model for adapting to global climate change.

A robust property rights regime must be dynamic. A dynamic regime is one that can respond quickly to changed conditions and to market demand. Therefore, the legal and political barriers to change must be capable of rapid modification, in order for a robust property rights regime to exist. Most property regimes have a limited capacity to adapt to changed conditions, but they respond reasonably well to changes in market demand because property rights are alienable at low transaction costs.

Water law can display the opposite characteristics. Water law is a risk allocation regime, which contemplates periods of reduced entitlements in times of shortage and is premised on constant adaptation to changed conditions. However, the transaction costs of water transfers are higher than other forms of property rights because water rights are correlative and have a community interest component. Nonetheless, water law can be the foundation for adaptation. For example, the western water doctrine of prior appropriation allocates the risks of shortages by a simple principle: priority of use. It also allows the transfer of water rights at an acceptable cost.[11]

The problem is whether the extreme risks of global climate change can be allocated within the framework of existing international water law regimes. International water law is a mixed riparian and appropriative regime. The laws of riparian rights and prior appropriation have different capacities to adjust to an altered

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[11] *See generally* LAWRENCE J. MACDONNELL, THE WATER TRANSFER PROCESS AS A MANAGEMENT OPTION FOR MEETING CHANGING DEMANDS (University of Colorado School of Law Natural Resources Law Center 1990).

hydrologic regime, but both systems share a common problem: major political, institution and legal barriers to declaring winners and losers, which is necessary if water is to be reallocated in times of severe water shortages. International water allocation also faces an additional problem: the inflexibility of most international water allocation regimes. Generally, international water allocation agreements are negotiated so that a dam can be built, and it is expected that any resulting water shortages will be short-term. Therefore, the allocation agreement often provides only for temporary reallocations and contains no mechanism to address long term declines in expected available supply.

Western United States water law, which forms the basis for international water law, is a potential adaptation model. The western doctrine of prior appropriation is premised on shortages allocated by priority schedules that provide a clear and complete risk allocation scheme in advance of the shortages. However, such risks do not materialize with any regularity in major river basins, so the law has not been fully tested for this purpose. For example, the Department of Interior has never had to enforce the priorities of the 'law of the river' on the lower Colorado River; although, it has put California on notice that it can no longer use Arizona's surplus share. The focus of federal and state water policy from the conservation era has been to minimize the risks of shortages by constructing large carry-over storage facilities, as the Bureau of Reclamation has done on the Colorado River. Thus, reservoirs and groundwater basins probably will be subjected to only the mildest form of rationing during droughts. States have tried to accommodate unlimited growth on a limited water budget by providing ample margins of safety against shortages. Most irrigators have been buffered against the harshness of prior appropriation both by carryover storage and formal and informal mechanisms that share the burdens of shortages by pro rata rather than by pro tanto delivery reductions.

The law of prior appropriation is a formal risk allocation mechanism, but the expectation that it will be used during water shortages on a large scale is low. In contrast, riparian rights remains a tort regime that does not declare winners and losers in advance, but it provides some post hoc measure of compensation to losers. Despite the efforts of some to firm up riparian rights, the humid states that have adopted riparian rights have not joined the efforts because they assume that water will continue to be an abundant resource rather than a scarce resource.

IV. INTERNATIONAL WATER LAW

A. The United States Origins of Customary and Treaty International Water Law

Modern international water law is an evolving regime based on the United States model of prior appropriation, as modified by the Supreme Court's doctrine of equitable apportionment. Like United States domestic water law, international water law has historically been designed to promote multiple use development by recognizing that each riparian state has an equal right to use common waters, subject to indeterminate sharing rules. Multiple-use of interstate streams was promoted by the United States law of equitable apportionment, which became the basis for international water law.[12] Equitable apportionment projected the principal that prior uses should be protected across state lines and, ultimately, across national boundaries. In the early twentieth century, original jurisdiction, interstate water use disputes were adjudicated by the United States Supreme Court. Up-stream withdrawals along the Arkansas River in Colorado reduced available supplies downstream in Kansas.[13] Chicago's pollution, which discharged into the Mississippi River as a result of the reversal of the flow of the Chicago River, triggered a lawsuit by Missouri.[14] Missouri alleged that Chicago's discharge contributed to a cholera epidemic in Saint Louis. In this dispute, two lawsuits required the United State Supreme Court to develop a law of interstate water use, resulting in the use of the law of equitable apportionment to resolve conflicts between states.

The Supreme Court initially looked to the classic international law rule that all states have equal legal rights to fashion the principle of equitable apportionment, and the resulting doctrine now forms the basis of the sharing rules said to apply to international rivers. The core idea of equitable apportionment is that each state is entitled to a fair share of a common resource because each state has an equal right to develop the available resource. In the United States federal system, states are only quasi-sovereign; and, thus, it was possible for the Supreme Court to hold that the use of common resources, such as interstate streams and groundwater basins, must be shared among

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12. I have developed this point at greater length in A. Dan Tarlock, *Safeguarding International River Ecosystems in times of Scarcity*, UNIV. OF DENVER WATER L.J. (forthcoming 2000).

13. *See* Kansas v. Colorado, 206 U.S. 46 (1906).

14. *See* Missouri v. Illinois, 200 U.S. 496 (1906).

co-riparian states. Concrete sharing rules are difficult to define, though, because states often have widely different abilities to put inchoate shares to actual use.

The Supreme Court has developed a flexible formula that balances the need to accommodate new uses with the protection of existing economies. The open-ended equitable apportionment formula applied by the Supreme Court purports to weigh the comparative merits of different river uses over a long period of time. In fact, the Court has consistently rewarded early development by protecting prior uses against subsequent uses. For example, although in 1982 the Court suggested that it would deny existing uses protection and, instead, support a new and more efficient use of the water when "reasonable conservation measures by existing users can offset the reduction in supply due to diversion,"[15] two years later, the court preserved the priority of a small reclamation district.[16] The Court, however, did leave open the possibility that a new diversion could displace an existing one if the state made a strong showing of an immediate demand for a highly valued use.

Prior appropriation is not absolute, though, because the Supreme Court generally follows the law of the state in which the conflict arises. In humid states, the Court has not been called upon to protect large numbers of pre-existing consumptive uses, but it has been called upon to allocate mass flows and to protect lake levels.[17] Thus, focus on *in situ* uses provides a precedent for sharing the risks of ecosystem protection that is lacking in prior appropriation regimes. For example, the Supreme Court has protected the ecological integrity of the Great Lakes system by substantially limiting out-of-basin diversions to protect pre-existing navigation uses.[18] The Court has also prevented diversions that could impair the waste assimilative capacities of a river.[19] But, in appropriation states, instream flows have not been protected.

Recent attempts to claim instream flows on the Platte River illustrate the resistance of the law of equitable apportionment to new management concepts. In the 1930's, the Supreme Court adjudicated rights to the North Platte River between Nebraska and Wyoming

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15. Colorado v. New Mexico, 459 U.S. 176, 190 (1982).

16. *See* Colorado v. New Mexico, 467 U.S. 310 (1984).

17. *See* A. Dan Tarlock, *The Law of Equitable Apportionment Revisited, Updated, and Restated*, 56 U. COLO. L. REV. 381, 396-398 (1985).

18. *See* Wisconsin v. Illinois, 278 U.S. 367 (1929).

19. *See* New Jersey v. New York, 282 U.S. 336 (1931).

users.[20] In the late 1980s, Nebraska reopened the settled dispute to protest some new diversions by Wyoming.[21] Environmental groups unsuccessfully attempted to intervene by arguing that any new decision must guarantee adequate winter flows, not apportioned, for whooping crane populations. However, the Court's first decision in the reopened litigation did not deal with environmental issues.[22] Fortunately, though, the Court's opinion does not preclude environmental management of the Platte; it only renders it less legally secure. The three basin states, Colorado, Nebraska and Wyoming, ultimately signed a Memorandum of Agreement with the Secretary of Interior to develop a basin-wide wildlife protection plan, and as of mid-2000, they are negotiating a final plan. However, the hard fact is that no public or private entity can claim rights to a wildlife protection flow under the equitable apportionment doctrine.[23]

B. The Evolving Regime of Customary International Water Law

Modern international water law is built upon the assumption that all states whose territories contribute to an international drainage basin have a right to an equitable share of the waters of the basin. The doctrine of equitable utilization or equitable participation is designated as a rule of customary international law.[24] This principle was adopted prior to the rise of the environmental movement in the late 1960s and has been reaffirmed in subsequent non-binding declarations, such as the 1972 Stockholm Conference on the Environment,[25] the 1977 World Water Conference in Mar del Plata,[26] and the 1992 United Nations Conference on Environment and Development in Rio de Janeiro.[27] Commentators have recently advocated an expanded sharing principle, a "community of

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20. *See* Nebraska v. Wyoming, 325 U.S. 589 (1945).

21. *See* Nebraska v. Wyoming, 507 U.S. 584 (1993).

22. *See id*.

23. Instream flow rights have been recognized under both Nebraska law and the federal Endangered Species Act. *See* J. David Aiken, *Nebraska Instream Appropriation Law and Administration,* INSTREAM FLOW PROTECTION IN THE WEST, 16-1 (1993).

24. *See* Sharon A. Williams, *Public International Law and Water Quality Management in a Common Drainage Basin: The Great Lakes,*18 CASE W. RES. J. INT'L L. 155, 165 (1986).

25. *See Conference on the Human Environment*, June 16, 1972, 11 I.L.M. 1416.

26. *See Report of the United Nations Water Conference, Mar del Plata, March 14-25 1977*, U.N. Doc. E/CONF. 70/29 (77.II.A.12), at 3-38 (1977).

27. *See Conference on Environment and Development: Rio Declaration on Environment and Development*, June 14, 1992, 31 I.L.M. 874, 879.

property" model, which is premised on co-riparian cooperation.[28] Under this model, the rivers and associated resources would be managed jointly without regard to international borders, and the model is based on the principle that all riparian states are entitled to equitable participation in the development of the resource.[29] However, this more progressive vision is not yet reflected in state practice. International water law remains simply a modest restraint on unilateral water resources development and promotes fair access to a common resource, which nation-states may use with minimal consideration of basin-wide impacts.

The most recent formulation of international water law is the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses (the Convention).[30] On May 21, 1997, the United Nations General Assembly approved the Convention.[31] On one level, the Convention will not have a substantial impact on the existing use of international bodies of water, if it ever comes into force, because the Convention is subordinate to existing allocation treaties. Article 3 of the Convention provides that "nothing in the present Convention shall affect the rights and obligations of a watercourse State arising" from prior agreements.[32] This Article only expresses the hope that countries will "consider harmonizing" pre-existing treaties with the Convention.[33]

Existing allocation regimes are premised on the availability of a guaranteed supply of water comprised of the average annual river flow augmented by carry-over storage. If droughts and increased evaporation occur, the available water from international rivers will be consistently less than the parties to the allocation originally expected, but existing allocation regimes generally have no

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28. *See* Joseph Dellapenna, *Treaties as Instruments for Managing Internationally-Shared Water Resources: Restricted Sovereignty vs. Community of Property*, 26 CASE W. RES. J. INT'L L. 27, 36 (1994).

29. *See id.*

30. *United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/51/869 (1997), *reprinted in* 36 I.L.M. 700 (1997) [hereinafter *Convention*].

31. *See* George William Sherk et al., *Water Wars in the Near Future? Reconciling Competing Claims for the World's Diminishing Freshwater Resources – The Challenge of the Next Millennium*, (visited Apr. 3, 2000) <http://www.dundee.ac.uk/cepmlp/journal/html/article3-2.html>.

32. *See Convention*, *supra* note 30, at 704.

33. *See id.*

mechanisms to adjust to such changed conditions.[34] Thus, international water law, as reflected in the Convention, will not promote adaptation in international river basins for two principal reasons. First, equitable apportionment shares the principal defect of the doctrine of riparian rights: uncertainty. It is not possible to predict the entitlement that the rules produce. Further adjudication or a treaty is necessary to create firm property rights. Otherwise, states have an incentive to hoard and waste water, rather than to share, reallocate and conserve it.[35] Second, although the Convention is progressive, it still gives comparatively little weight to ecosystem protection. Therefore, it will be difficult to integrate ecosystem protection into any property rights based scheme of adaptation.

The Convention reporters were sensitive to the tension between development and environmental protection and tried to mitigate it.[36] The Convention is progressive in that it seeks to combine the older idea that water law should create secure property rights in order to encourage development with the newer idea that the law should encourage aquatic ecosystem protection and restoration. Also, the final version of the Convention integrates some elements of the idea of ecosystem protection with multiple-use development. However, the integration is incomplete, and the Convention still subordinates ecosystem protection to consumptive use and development.

Pollution reduction and prevention is an important component of ecosystem protection, but focusing on pollution is too narrow, as it ignores the more subtle and long-term threats to ecosystems from diversions, barriers and land use practices. Modern, environmentally sensitive legal regimes attempt to correct this problem by mandating or encouraging long-term, monitored, adaptive ecosystem management that mimics the rivers' hydrograph. The concept, though, remains vague and controversial,[37] as well as very difficult and costly to integrate into

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34. *See* David J. Lazerwitz, *The Flow of International Water Law: The International Law Commission's Law of the Non-Navigational Uses of International Watercourses*, 1 IND. J. GLOBAL LEGAL STUD. 247, 269- 70 (1993).

35. *See* Lee J. Alston et al., *Land Reform Policies: The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon*, J. ENVTL ECON. & MGT. (forthcoming 2000).

36. *See* Albert Utton, *Which Rule Should Prevail in International Water Disputes: That of Reasonableness or That of No Harm*, 36 NAT. RES. J. 635, 639 (1996).

37. Many ecologists criticize the concept as simply a restatement of multiple use development. *See* REED F. NOSS & ALLEN Y. COOPERRIDER, SAVING NATURES LEGACY: PROTECTING AND RESTORING BIODIVERSITY 283-290 (1994). Proponents of multiple use development often see the concept as a new anti-development regime. *See, e.g.*, Rebecca Thompson, *Ecosystem Management: Great Idea, But What Is It, Will It Work, and Who Will Pay?*, 9 NAT. RES. & ENV'T 42 (1995).

existing river management regimes. In the end, international rules seem to adopt the view that adverse environmental impacts are an inevitable consequence of development and may be mitigated, rather than prevented, by affirmative management.

Article 7 of the Convention initially enjoined states from using water in such a way that would "cause significant harm to other watercourse states,"[38] but two major objections surfaced, which led to a major revision. Proponents of multiple-use development raised the first objection. They criticized the proposed standard as a departure from the common understanding of equitable apportionment because it made development subordinate to environmental quality. Environmentalists criticized the original language in Article 7 because, in their view, it did not go far enough in prohibiting environmental harm, as it only prohibited harm "capable of being established by objective evidence."[39] Thus, it did not include the crucial concept of risk prevention. The basic solution, proposed by the last reporter, made the duty to prevent pollution subordinate to the right of equitable utilization, while creating a flexible process to resolve disputes.[40] Article 7 was redrafted to impose a process duty on states not to cause significant pollution that was subject to an exception for extraordinary circumstances:

> Watercourse States shall exercise due diligence to utilize an international watercourse in such a way as not to cause significant harm to other watercourse States, absent their agreement, except as may be allowable under an equitable and reasonable use of the watercourse. A use which causes significant harm in the form of pollution shall be presumed to be an inequitable and unreasonable use unless there is: (a) a clear showing of special circumstances indicating a compelling need for ad hoc adjustment; and (b) the absence of any imminent threat to human health and safety.[41]

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38. Utton, *supra* note 36, at 636.

39. *See id.*

40. *See* EDITH BROWN WEISS ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 878-879 (1998).

41. Robert Rosenstock, *First Report of the Non-Navigational Uses of International Watercourses*, International Law Commission, 45th sess. at ¶ 25, U.N. Doc. A/CN.4/451 (1993).

The final version of Article 7 accords equitable utilization a strong preference over the no-harm doctrine and environmental flow maintenance.[42] This final version is a victory for slower developing upstream states, and it provides:

> 1. Watercourse states shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse states.
> 2. Where significant harm nevertheless is caused to another watercourse state, the State whose use causes such harm shall, in the absence of agreement to such use, take all appropriate measures, having due regard for the provisions of Articles 5 and 6, in consultation with the affected State, to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation.[43]

The Convention is also an advance beyond prior formulations of equitable apportionment because it places greater emphasis on conservation and alternatives. Article 6 requires the consideration of "geographic, hydrographic, hydrological, climatic, ecological and other natural factors," as well as consideration of factors of a national character[44] and makes relevant any available alternatives of "comparable" value when deciding whether a planned use is equitable and reasonable.[45] Unlike United States law, Article 5 (f) makes "[c]onservation, protection, and the economy of use of the water resources" [46] a relevant factor in determining whether a use is reasonable and equitable. Article 5 (b) could be the basis for a state to adapt to a decline in average long term supplies by eliminating wasteful uses.

There is little firm, international, aquatic ecosystem protection law. Both the undeveloped state of the law and the possible emergence of new principles capable of supporting climate-charge driven initiatives are illustrated by the International Court of Justice's decision in the Gabikovo-Nagymaros dam decision which 1)

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42. *See* Charles B. Bourne, *The Primacy of the Principle of Equitable Utilization in the 1997 Watercourses Convention*, 1997 CANADIAN Y.B. INT'L L. 215, 224.
43. *Convention*, *supra* note 30, at 706.
44. *See* Sherk, *supra* note 31.
45. *Convention*, supra note 30, at 706.
46. *Id.* at 705.

affirmed the primacy of equitable apportionment, 2) suggested that it can include an aquatic ecosystem conservation component, 3) rejected an ecosystem protection claim by a downstream riparian state based on the precautionary principle.[47] The opinion does offer some hope that international environmental and water law will recognize that riparian states have a right to protect their riverine ecosystems from the actions of other states and also will recognize that cooperation and shared management may be required to enjoy this right. The facts of the case were not ideal for the establishment of such a claim, but the foundation for future protection through adaptive aquatic ecosystem management is presented in the majority opinion, as well as in the Separate Opinion of Vice President Weeramantry, which posited that the interrelated principles of environmentally sustainable development and cautionary environmental assessment and management are erga omens customary rules.[48]

C. Case Studies

1. The Great Lakes

The Great Lakes system illustrates a potential adaptation model in which all basin users share fairly the risks of climate variability. The Great Lakes are one of America's largest fresh water reserves and, as such, are comparatively less vulnerable to the projected effects of global climate change. However, the amount of fresh water in the lakes makes them a prime candidate, at least in the eyes of many in Canada and the United States, for trans-basin diversions to augment supplies in water-short areas. Global climate change helps fuel the persistent regional fears that the lakes will be tapped to augment water supplies outside the basin. On one level, the lakes are a classic example of an under-developed property rights regime. However, there is an inchoate Law of the Lakes, and its most interesting feature is the preference it accords to non-consumptive uses over consumptive ones. The Law of the Lakes also gives considerably more weight to the conservation of the lakes' ecological services than other allocation regimes. The seven littoral states, the Canadian provinces of Ontario and Quebec, and the national governments of the United States and Canada have evolved a weak

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47. *See* Gabikovo-Nagymaros Project (Hungary v. Slovakia), 1997 I.C.J. 1 (Sept. 25).
48. *See id*. at 88 (giving the separate opinion of Vice president Weerantry).

legal regime to protect the most important regional component of the lakes, the maintenance of naturally fluctuating levels, which can be the basis for adapting to global climate change. The present regime has minimized conflicts by limiting and discouraging consumptive use, but it has also retarded the development of a firmer property rights regime for the lakes.

The Great Lakes have a variable climate that produces fluctuating lake levels.[49] If warmer weather produces more prolonged droughts, longer periods of low water levels will likely occur.[50] Historically, two strategies have been used to share the risks of fluctuating levels. First, high levels are assumed to pose a risk that all shoreline property owners and commercial navigation must anticipate. For example, in the mid-1980s, a great deal of attention was focused on engineering options, such as dredging, to mitigate the potential and actual flooding caused by high water levels.[51] This high water level issue evaporated, though, during the drought years of the late 1980s. Second, the littoral states and the United States federal government have been more proactive in stabilizing levels by limiting in-basin and out-of-basin diversions. The current law of the Great Lakes assumes that the lakes are fully allocated and that there should be no major, new diversions. A recent International Joint Commission (IJC) report characterizes the lakes as a "nonrenewable resource" because less than one percent of the lakes' waters are renewed annually by precipitation.[52] The report concludes that "[i]f all interests in the Basin are considered, there is never a surplus of waters in the Great Lakes system."[53] The question is whether this assumption can sustain itself in the face of prolonged droughts if regional and non-regional users attempt to tap the lakes.

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49. *See* Stanley A. Changnon, *Understanding The Physical Setting: The Great Lakes Climate and Lake Level Fluctuations, in* THE LAKE MICHIGAN DIVERSION AT CHICAGO AND URBAN DROUGHT 39 (Stanley Changnon ed., 1994).

50. *See* INT'L JOINT COMM'N, PROTECTION OF THE WATERS OF THE GREAT LAKES: FINAL REPORT TO THE GOVERNMENTS OF CANADA AND THE UNITED STATES 24 (Feb. 22, 2000) (visited July 20, 2000) <www.ijc.org/boards/cde/finalreport/finalreport.html>; *see also* DRAFT REPORT OF THE WATER SECTOR OF THE POTENTIAL CONSEQUENCES OF CLIMATE VARIABILITY, *supra* note 6.

51. A study done pursuant to a 1977 Canada-U.S. Reference to the International Joint Commission on the costs and benefits of limited regulation of Lake Erie to reduce the damage from high water levels, concluded that "no further or more detailed studies of limited Lake Erie regulation for the purpose of reducing high water levels be considered in view of the adverse impacts and the wide disparity between the costs and benefits of such regulation." INT'L JOINT COMM'N, LIMITED REGULATION OF LAKE ERIE 44 Great Lakes — St. Lawrence Water Level Information Office, Water Issues Division, Meterological Service of Canada — Ontario, Environment Canada — Ontarior Region ed., 1983).

52. *See* Changnon, *supra* note 49.

53. *Id.*

Lake use is controlled by three overlapping legal regimes: state/provincial, national, and international. All three regimes can be characterized as immature legal regimes in that the use of the Great Lakes is regulated far less than other major water resources. Furthermore, the Great Lakes are physically managed less than other water resource systems such as the Colorado and Columbia Rivers or even the Mississippi River. The Great Lakes are characterized by minimally quantified and managed rights. The reasons for this characterization are both physical and institutional. The basin is basically a closed, balanced system. There are only five major in-basin or out-of-basin diversions. Most diversions are non-consumptive, and there is one major diversion into the basin, which is the Long Lac-Ogoki diversion from the James Bay basin into Lake Superior. The Lakes flow very slowly from Superior to the Saint Lawrence River. At the present time, only the levels of Lakes Ontario and Superior are regulated by dams and locks.[54] The lack of regulation is a function of the fact that "[f]or the most part, the Great Lakes act as a natural system and water will flow through the system only as quickly as nature will allow."[55] Sometimes, water takes as long as twelve to fifteen years to flow through the system. For this reason, the rights of users and littoral states remain largely inchoate, with the exception of the Chicago diversion. As a matter of United States federal common law, all littoral states have an equal right to a fair share of interstate waters along or within their borders, but these rights must be claimed and confirmed by a judicial proceeding or by congressional legislation.

a. The United States Federal Government's Interest

The United States federal government has an overarching interest in the allocation and use of the lakes, and, constitutionally, the federal government has much power over the Great Lakes. Disregarding Canadian interests in the lakes, the federal government could do anything from draining the lakes to reestablishing an inland sea in the Great Basin in Idaho, Nevada, and Utah to dedicating their use exclusively to be Great Basin States. The real issue is not, however, what the federal government *could* do, but what it *has done* and is *likely* to do. Federal power over the Great

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54. *See* Michael J. Donahue et al., *Great Lakes Diversion and Consumptive Use: The Issue in Perspective*, 18 CASE W. RES. J. INT'L L. 19, 25-26 (1986).

55. GREAT LAKES COMM'N, WATER LEVEL CHANGES: FACTORS INFLUENCING THE GREAT LAKES 5 (1986).

Lakes has followed the pattern of federal power over water resources established in the nineteenth century. Aside from navigation protection, the federal government has deferred to state water policy. Congress has allowed the littoral states to develop an anti-basin diversion strategy and has ratified it by legislation,[56] which allows states to prohibit new out-of-basin diversions.

b. The State Interest

By virtue of their ownership of the Lake beds (lands underlying the mean high water mark) and their control of littoral access, the seven Great Lakes states and the Provinces of Ontario and Quebec have the primary interest in regulating the Lakes. State and provincial power is, of course, subordinate to the power of the national governments to regulate lake use. The power of the national government to regulate lake use is plenary in the United States, but it is more circumscribed in Canada, due to the greater constitutional powers of the provinces. The littoral states and Canadian provinces have used their political power to control the use of the lakes in two related ways. In 1985, they agreed to the non-binding Great Lakes Charter, which provides that all states consult with each other and the Province of Ontario before they approve an out of basin diversion under state law.[57] The Charter was ratified by Congress in 1986, and this charter, which allows any governor to veto a diversion, presumptively exempts out-of-state diversions from the dormant commerce clause; however, its constitutionality has never been tested.[58]

Since 1986, there have been several small, municipal diversions approved. The potential use of the Charter to control lake use by preventing out-of-basin diversions for the alleviation of a prolonged drought is illustrated by the fate of former Illinois Governor James Thompson's proposal to triple Lake Michigan diversions during the

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56. *See* 43 U.S.C. § 1926d-20 (1986) (requiring the consent of all of the littoral state governors to an out-of-basin diversion).

57. *See* Peter V. MacAvoy, *The Great Lakes Charter: Toward A Basinwide Strategy for Managing the Great Lakes*, 18 CASE W. RES. J. INT'L L. 49, 55 (1986).

58. A widely circulated, 1998 joint Canada-United States legal study prepared for the Great Lakes Governors has concluded that the Water Resources Development Act of 1986 violates, inter alia, the dormant commerce clause, the non-delegation doctrine and the due process clause. For a skeptical assessment of these assertion, see Joseph W. Dellapenna, *The International Joint Commission Considers Water Exports From the Great Lakes*, 3 ABA WATER RESOURCES COMMITTEE NEWS LETTER, Jan. 2000 at 10.

summer drought in 1988.[59] As the Mississippi River's water level dropped, barge navigation was impeded, and Governor Thompson wanted the trans-basin diversion to augment the river's record-low flow. The proposal, allegedly drafted to aid downstate grain exporters who were major campaign supporters, was blocked by protests from Ohio, Wisconsin, Minnesota and Canada. Governor Thompson dropped the proposal in the face of intense interstate and foreign opposition.[60] The chief legal basis for the objections to his proposed quick navigation fix was Illinois' failure to follow the Great Lakes Charter consultation procedures.[61]

If prolonged lake level declines occur, the Great Lakes states will invoke the doctrine of equitable apportionment in an attempt to prevent new diversions and to ensure that the natural lake flow regimes continue to function. Each littoral state has an equal right to use interstate waters that border it. This right includes both the right to consume a fair share of the water and the right to be free from pollution. Equitable apportionment is the source of the rights of states which border a common water source to (1) confine use of that resource to littoral or riparian states and (2) develop a framework to share the resource in times of shortage. Equitable apportionment can be a global climate change risk sharing mechanism, but the difficulties of judicial administration severely limit its potential role. Courts are reluctant to anticipate allocation problems, and any courts that do attempt judicial allocations are subject to congressional scrutiny.

Equitable apportionment, of course, cannot create increased lake flows to counter higher possible evaporation levels, but apportionment could perform two more functions. First, it could prevent the use of the Great Lakes to solve other climate change-induced water shortages, such as increased irrigation demand in the Great Plains or diminished navigable capacity along the Mississippi. Second, equitable apportionment could ensure that the costs of lake level decline are shared equally by all of the Great Lake states.

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59. *See* Maureen Irish, *Canadian Practice in International Law,* 27 CANADIAN Y.B. INT'L L. 407-409 (1989).

60. *See* STANLEY A. CHANGNON ET AL., DROUGHT AND NATURAL RESOURCES MANAGEMENT IN THE UNITED STATES: IMPACTS AND IMPLICATIONS OF THE 1987-89 DROUGHT 43-112 (1991).

61. *See* Irish, *supra* note 59, at 407-409 (containing a summary of the Canadian parliamentary debates in opposition to the proposal).

c. International Interests

All of the Great Lakes, except Lake Michigan, are international, as well as interstate, waters. In reality, all five Great Lakes are international water bodies, because Lake Michigan drains into international water. Thus, international institutions, as well as those of the states and provinces, have a stake in use decisions. Therefore, the provinces of Ontario and Quebec and the federal government of Canada are stakeholders in any major decision affecting any one of the five lakes. In brief, both customary international law and the 1909 Boundary Waters Treaty[62] limit the power of both the United States and Canada to unilaterally undertake a large diversion.[63] Article I of the 1909 Boundary Waters Treaty affirms the right of free navigation, and Article III requires International Joint Commission approval before the natural level or flow of the boundary waters can be altered.[64] Lake Michigan is excluded from the Treaty. However, the Treaty has been invoked by both sides of the Chicago diversion controversy. The United States and Canada have claimed that a diversion in excess of Chicago's original Army permit violates the Treaty because it lowers the natural levels of the other four lakes, and Chicago has argued that the exclusion of Lake Michigan grandfathered Chicago's pre-treaty proposed diversion of 10,000 c.f.s. The issue was not resolved in the litigation, but the controversy illustrates the relevance of the Treaty to all lake-use decisions.[65]

Customary international water allocation law is equally unsuited for providing a framework for co-riparians to adapt to global climate change. The international community has accepted the principle of equitable apportionment as the ground rule of international water allocation. The core idea of equal development opportunity is at the heart of the Convention and will be the basis for the argument that development has priority over aquatic ecosystem protection. The Convention's innovations are commendable, but the fact remains that the protection of a river system's ecological integrity remains secondary to the promotion of development. Specifically, the Convention makes it difficult to promote the protection of the ecological integrity of river systems for two principal reasons. First,

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62. Treaty Relating to Boundary Waters Between the United States and Canada, Jan. 11, 1909, U.S.-Great Britian, 36 Stat. 2448 [hereinafter Boundary Waters Treaty].

63. *See* Williams, *supra* note 24, at 156, 163-65.

64. *See* Boundary Waters Treaty, *supra* note 62.

65. *See* Herbert H. Naujoks, *The Chicago Diversion Controversy Part II*, 30 MARQ. L. REV. 228, 247-54 (1947) (arguing that Sanitary District v. United States, 266 U.S. 405, 426 (1925) rejects Chicago's claim and supports that of the U. S. federal government and Canada).

flood plain protection and wetland protection are largely excluded from these new rules, which are focused almost exclusively on pollution prevention. Second, rivers are still not viewed as ecosystems.

More recently, some legal commentators have suggested that any national effort to prohibit the export of water from its territory violates GATT or NAFTA, but this is an untenable position. International law gives a nation complete control over the development and use of its resources, as long as the nation does not cause or allow trans-boundary pollution.[66] Therefore, GATT and NAFTA should be read only to embody the principle that if a country decides to turn a natural resource into a commodity, it must permit trade in a non-discriminatory manner. International law does not require a country to share its raw resources with other countries. NAFTA countries have addressed this issue by declaring that raw water is not a good,[67] but this declaration is a soft law and does not apply to GATT.

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66. *See* Bengt Broms, *Sovereignty Over Natural Resources*, in 10 ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW 306 (1987) (giving a history of the relationship between the right to develop and state sovereignty). In modern environmental law, however, the sovereign right to develop continues to be the real practice of the international community. The principle is beginning to play a role in water use controversies. The Canadian Provinces and the United States that border the Great Lakes are concerned about the environmental risks and other risks posed by possible withdrawals for bulk tanker shipments. The right to develop is the conceptual basis for an anti-export strategy. It can be argued that GATT and NAFTA invalidate all flat export bans. GATT, Article XI, bans "prohibitions other than duties, taxes or other charges" on exports and imports, but Article XX allows a state to defend an export ban that is necessary to conserve exhaustible natural resources. The Water Resources Act of 1986, 42 U.S.C. § 1926d-20 (1986), allows any Great Lakes state to veto any withdrawal from the basin. The opposing argument is that neither GATT nor NAFTA changes the basic principle that state sovereignty allows a state to decide whether or not to allow trade in raw natural resources. Several World Trade Organization (WTO) decisions have rejected the conservation defense when a nation has attempted to conserve marine resources outside its territory. However, these decisions do not preclude the application of environmental and other conservation measures to a nation's internal waters because the measures are premised on the protection of state sovereignty over internal resources. *See generally* WTO Appellate Body Report, United States-Standard for Reformulated and Conventional Gasoline, 35 I.L.M. 603 (1966); WTO Appellate Body Report, United States-Import Prohibitions of Certain Shrimp Products, WT/DS58/AB/R (1998); *see also* Bret Puls, *The Murky Waters of International Environmental Jurisprudence: A Critique of Recent WTO Holdings in the Shrimp/Turtle Controversy*, 8 MINN. J. GLOBAL TRADE 343 (1999). Traditional water conservation management does not violate the fundamental premise of trade law that all trade partners be treated in a non-discriminatory manner. *See generally* INTERNATIONAL JOINT COMMISSION, PROTECTION OF THE WATERS OF THE GREAT LAKES: INTERIM REPORT TO THE GOVERNMENTS OF CANADA AND THE UNITED STATES (Aug. 10, 1999).

67. The three NAFTA countries have agreed to exclude non-bottled water from the agreement. Also, all Canadian provinces, with the exception of Quebec, have agreed to ban bulk water removal from the Canadian portion of the country's major drainage basins. The policy will be implemented by each province and contains several exemptions and exclusions

2. The Two Niles: The African and the American (the Colorado River)

The stories of the two Niles illustrate the difficulties of adapting existing allocation regimes to global climate change. Both basins suffer similarly in that each is a long, hard working river in an arid region, with rapidly increasing populations,[68] whose water resources must be shared among many competing uses. Thus, each is a possible loser as average temperatures increase.[69] Also, both basins are over-appropriated. For example, the Nile's mean annual discharge is slightly larger than assumed in the 1959 Nile Waters Agreement, but current discharge is still less than the current demand.[70] In each basin, the nations or states that contribute the most to the river use it the least. The disparity is most pronounced regarding the Nile; the upper riparian humid equatorial nations of Burundi, Kenya, Rwanda, Tanzania, Uganda, Zaire, and Ethiopia contribute 86% of the supply but consume less than 10% percent of it.[71] Arid Egypt and Sudan account for over 90% of water withdrawals.[72] The upper Colorado River basin uses water more proportionately, but three of the four basin states, including New Mexico, Wyoming and Utah, are expected to use less than their entitlements for the foreseeable future.

There are also major differences between the two basins. In the Nile basin, the major water use will continue to be irrigation for agriculture, and the question is whether the lower basin states of Sudan and Ethiopia can increase their irrigated acreage given Egypt's present monopolization of the river. The problem is compounded by projected usage increases in Kenya, Tanzania and Uganda. Also, the regimes of the basins are different. The Nile allocation regime is an

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such as bottled water, water packaged in small, portable containers, water used in food production, and water used to meet short term safety, security, or humanitarian needs. *See Accord for the Prohibition of Bulk Water Removal From Drainage Basins*, (visisted Aug. 1, 2000) <http:www.wcel.org/wcelpub/2000/13104.pdf>.

68. In the twentieth century, the population of Egypt increased from 10 million to 65 plus million and continues to grow rapidly. The total basin population is projected to increase from the present 246 million to 812 million by 2040. *See* Jule Smith, *Nine Nations, One Nile* (article on file with this journal) <http://www-personal.umuch,edu/~wddrake/smith.html.>. *See generally* ROBERT ENGLEMAN, PROFILES IN CARBON: AN UPDATE ON POPULATION, CONSUMPTION AND CARBON DIOXIDE EMISSIONS (Population Action International, 1998) (arguing that population control and carbon emission reduction should be linked).

69. *See* Diana Liverman, *Climate Change and the Borderlands: An Introduction and Assessment*, BORDERLINES (May 1999) (visited Apr. 30, 2000) <http://www.zianet.com/irc1/borderline/1999/b156/b156clim.html>.

70. *See* Smith, *supra* note 68 (stating that the mean annual discharge is calculated at 91.9 km^3, and the demand among Egypt, Ethiopia and the Sudan is calculated at 102.9 km^3).

71. *See id.*

72. *See id.*

incomplete regime that breeds intense political conflict. The 1959 Nile Waters Agreement was negotiated between Egypt and its immediate upstream neighbor, the newly independent Sudan, to allow the construction of the High Aswan Dam. The agreement allocates a fixed amount of water to each state and the evaporation losses between Egypt and the Sudan, but it does not appear to bind the other basin states.[73] Ethiopia is the source of 85% of the flow, but Egypt has already put 110% of the river's capacity to use.[74] Furthermore, global climate change may alter the river's flow and exacerbate tensions.[75] Ethiopia has ambitious development plans on the Blue Nile and perceives the treaty to be inequitable.[76] Moreover, the treaty provides only a weak mechanism for short-term drought relief.[77] In short, at present, there is no incentive for all basin states to agree on drought contingency plans until each state has some recognized entitlement.

In contrast to the Nile regime, the Colorado River is completely allocated among the seven basin states and the United States and Mexico by treaty, interstate compacts, congressional statutes, and Supreme Court decisions. The status of this regime suggests that adjusting to changed conditions should be easier. Many experts have suggested that the projected effects of global climate change can be mitigated by increased reliance on water markets or through adjustments in existing allocation regimes. However, international water allocation is a prime example of the lack of adaptation mechanisms in existing allocation institutions. International river agreements are often negotiated so that a dam can be built, and the underlying expectation is that any resulting shortages will be short-

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73. The issue is complicated by several major agreements signed when Italy controlled Ethiopia and countries of the Upper Nile basin were colonies of Belgium and Great Britian. For example, the 1891 Protocols Between the Governments of Great Britain and Italy, for the Demarcation of Their Respective Spheres of Influence in Eastern Africa prohibit Ethiopia from constructing any works that interfere with the flow of the Nile. A 1929 Exchange of Notes Regarding the Use of the Nile waters for Irrigation between Egypt and Great Britain representing her Upper Basin Colonies and the Sudan confirms Egypt's prior rights. Egypt maintains that these agreements are still in force, but the other countries argue that they terminated when Italy was driven out of Ethiopia and when Kenya, Tanzania and Uganda became independent states. *See* Christina M. Carroll, *Past and Future Legal Framework for the Nile Basin*, 12 GEO. INT'L ENVTL. L. REV. 269, 276-279 (1999).

74. *See* Sherk, *supra* note 31.

75. *See generally* Michael Hulme, *Global Climate Change and the Nile Basin*, in THE NILE: SHARING A SCARE RESOURCE 139 (P.P. Howell & J.A. Allan eds., 1994).

76. *See* Ilan Berman & Paul Michael Wihbey, *The New Water Politics of the Middle East*, STRATEGIC REVIEW 45, 49, Summer, 1999.

77. *See* A. Dan Tarlock, *Now Think Again about Adaptation*, 9 ARIZ. J. INT'L & COMP. L. 169, 178 (1992).

term and will be mitigated by the reservoir's carry-over storage. The agreements often provide only for temporary reallocations and contain no mechanism to address long term declines in expected available supply. Furthermore, there are usually no provisions for the maintenance of minimum environmental flows. These problems are exacerbated by the fact that once a regime goes into effect, strong reliance interests begin to build, and protection of user expectations is, of course, essential to the legitimacy of any allocation regime. However, expectations can calcify if the parties fear that any change which increases the risk of a decrease in available water will put them in a worse position. Therefore, parties to the agreements will block any proposed reallocation adjustments, no matter how drastically conditions change. The Colorado regime in the United States is an example of a regime suffering from excessive fears of change.

The Mexico-United States allocation regime is a classic example of a regime that provides no effective mechanism for fairly sharing the risks of changed conditions. The Mexican-United States Treaty, which allocates the Colorado River between the two countries, provides that the United States need not fulfill its delivery duty in extraordinary drought.[78] It is not clear whether this provision would apply to global warming, but Mexico may not be guaranteed a long-term firm entitlement. To complicate matters further, if the normal drought mechanisms are used, the resulting allocations may be widely perceived as inefficient and unfair; and, therefore, the allocations will not be followed. In short, adaptation may not be a realistic option when an allocation regime lacks mechanisms to deal with changed conditions.[79] The current interest in restoring the Colorado Delta ecosystem in Mexico raises additional adaptation problems. The most radical potential restoration strategy is to breach the Glen Canyon Dam. There is, however, no guarantee that any of the increased flow of the Colorado River would reach Mexico.[80]

Water marketing has been proposed as an adaptation strategy for overcoming treaty limitations. Economists have long criticized water law because it ignores higher, alternative values of water. They assert that too much water is used to grow surplus or low-valued

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78. *See* Article X, Treaty Respecting Utilization of Waters of the Colorado and Tijuana Rivers and the Rio Grande, United States-Mexico, 59 Stat. 1219. (1944).

79. *See generally* Charles J. Meyers & Richard L. Noble, *The Colorado River: The Treaty with Mexico*, 19 STAN. L. REV. 367, (1967).

80. *See* Scott K. Miller, *Undamming Glen Canyon: Lunancy, Rationality, or Prophecy?*, 19 STAN. ENVTL. L.J. 121, 199-202 (2000).

crops, that too much water is used in a wasteful manner, and argue further that increased transfers are desirable. Prior appropriation allocates the risks of shortages by a simple principle: priority of use. The question, then, is how flexible the water transfer system will be in the future. Two sets of problems must be addressed, one institutional, and the other distributional. The first inquiry is whether water users will respond sufficiently to market incentives. The second and more difficult inquiry is whether the redistributions commanded by the market are fair and consistent with ecosystem sustainability in both the short run and long run.[81]

International water transfers face a number of barriers that differ in degree, if not in kind, from those faced by domestic water transfers. The first barrier is conceptual, or physiological. In order for water to be transferred, it must be perceived as a commodity. Domestic legal systems that allow the creation of semi-exclusive water rights solve this problem. Once a property right exists, the major step toward commodification has been taken. Alienability is a standard, but not inevitable, attribute of a property right. Many countries will exhibit a dual attitude toward water in that water will be recognized as a commodity within the country's borders but not outside its borders. Countries will invoke state sovereignty as the basis for the right to keep water out of the market. Canada has taken this position with respect to its waters as a result of the possibility of the transport of bulk water from the Great Lakes, as well as from other waters, for resale in arid countries.

Articles III and VIII of the 1922 Colorado River Compact have been cited for the proposition that the Compact precludes inter-state, inter-basin, or international water transfers. Article III (a) gives each basin a perpetual right to "the exclusive beneficial consumptive use of 7,500,000 acre-feet per year",[82] and Article VIII provides that all rights, except 5,000,000 acre feet of present perfected rights, shall be satisfied "solely from the water apportioned to that basin in which they are situate."[83] Too much is read into these words; the provisions were primarily intended to preserve the Upper Basin future rights against the faster growing Lower Basin, to block an appropriation of surplus waters beyond those expressly allocated by the compact, and to limit any future Lower Basin rights to the

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81. *See* Tarlock, *supra* note 77, at 173-178; *see generally* A. Dan Tarlock, *Western Water Law, Global Warming and Growth Limitations*, 24 LOY. L.A. L. REV. 979 (1991).

82. Colorado River Compact, H.R. Doc. No. 605, at 9.

83. *Id.* at 11.

7,500,000 acre feet, plus the hypothetical 1,000,000 care foot surplus. These provisions should be waivable by the intended beneficiaries if no other state interest or federal interest is injured. In addition, any water transfer must be consistent with the law of rivers, federal reclamation law, and state transfer law.

The dichotomy between water as a sovereign resource and a commodity is present in water allocation agreements. Transfers of compact surplus entitlements between Upper Basin and Lower Basin states have been proposed to accommodate new environmental and urban needs, and there is movement in this direction. In 1999, the Bureau of Reclamation authorized voluntary transfers of surplus entitlements among Lower Basin states.[84] The Department of Interior's Final Rule for Offstream Storage of Colorado River Water allows authorized state entities in the three lower Colorado River Basin states of Arizona, California and Nevada to store unused Colorado River entitlements water, water within their Compact or surplus entitlements, in off-steam reservoirs and aquifers.[85] After unused surplus entitlements have been offered to entitlement holders in the storing states, the Secretary of Interior may release the water pursuant to a voluntary Interstate Release Agreement for use in another Lower Basin states. It is important to introduce such flexibility into a rigid regime in a way that does not risk impairing existing entitlements, but the idea has been fiercely opposed by many stakeholders in the Basin as inconsistent with the law of the river. For example, American Indian tribes argue that the rules allow the use of water that is subject to federally reserved Indian water rights.[86] Also, environmental groups argue that the rule will have indirect and cumulative negative impacts on wildlife and critical habitat.

The Colorado River basin states and stakeholders must ultimately come to the realization that the scientific and economic assumptions behind the Colorado River compacts must be adjusted to the changing demands on the river, both in the United States and in Mexico. The 1944 treaty between Mexico and the United States has been amended to incorporate maximum salinity levels into the Mexican delivery obligation, so the precedent has been set to address environmental problems on the Mexican portion of the Colorado.

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84. *See* 43 C.F.R. § 414 (1999).
85. *See id.*
86. *See* 64 Fed. Reg. 58994 (1999).

Voluntary transfers among basin states and between the United States and Mexico are a fair way to accomplish this.[87]

V. CONCLUSION

The development of water-related adaptation strategies will have to wait until science provides a better understanding of the relationship between global climate change and normal variations on workable geographic scales. This Article has suggested that property rights-based water allocation regimes have some potential to adapt fairly and efficiently, but these regimes must be supplemented by adaptive management institutions for the protection of vulnerable ecosystems. International water law can best be described as an inchoate property regime balanced by limited ecosystem protection. Before they can be the basis of adaptation to global climate change, existing allocation regimes must be modified to permit more flexible responses to changed conditions, and new regimes must be created within the framework of the United Nations Convention on the Non-Navigational Uses of Watercourses. These new regimes must provide sharing regimes, including water markets, that permit adjustment to changed conditions. They also must provide for the maintenance of base river flows to guarantee the provision of ecosystem services in the face of the possible stresses of global climate change.[88]

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87. *See generally* Dale Pontious, WESTERN WATER POLICY REVIEW ADVISORY COMM'N, COLORADO RIVER BASIN STUDY 24 (1997).

88 *See* Andre Knoll Kaemper, *The Contribution of the International Water Law Commission to International Water Law: Does it Reverse the Flight From Substance*, 27 NETHERLANDS YEARBOOK OF INTERNATIONAL WATER LAW 39, 62-67 (1996).

STANDING AND CLIMATE CHANGE: CAN ANYONE COMPLAIN ABOUT THE WEATHER?

DAVID R. HODAS*

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I. INTRODUCTION

Air pollution can be a local, regional, or international phenomenon, but when can someone have standing in court to complain about emissions that change the world's climate? The question of standing in a climate change context focuses on one of the central conceptual disputes within standing jurisprudence, namely what should be the role of courts in reviewing action or inaction by administrative agencies when the harm complained of is widely, if not universally, shared. Since everyone breathes and lives in the earth's climate, who can claim particular enough injury to seek redress in court when either the government fails to fulfill its international regulatory obligations mandated by treaty or statutes implementing that treaty, or when members of the regulated community fail to comply with the law?

In the context of climate change from greenhouse gas emissions, the world is presently in the throes of drafting a legal regime to

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stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[1] Because of the scientific and economic uncertainty associated with climate change issues, achieving international consensus on legal responses is an ongoing challenge.[2] The United Nations Framework Convention on Climate Change has been adopted, and entered into force, but mandates no specific greenhouse gas emissions reductions. The Kyoto Protocol, negotiated to implement the Framework Convention, attempts to establish national emission caps to begin the process of reducing emissions. Many states, including the U.S., have not yet ratified the Kyoto Protocol, and it is not yet in force as law, but intensive international negotiations are underway to resolve outstanding disputes.[3] Nevertheless, it, or something like it, will eventually go into effect,[4] along with some schedule of greenhouse gases emission caps, as a legal requirement, and with some type of emission trading market mechanism[5] as a central measure to achieve cost-effective[6] implementation.[7]

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1. UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT: FRAMEWORK CONVENTION ON CLIMATE CHANGE, 31 I.L.M. 849, 854 (1992). Although teasing out the natural from the human caused changes in our climate is exceedingly difficult, the current international scientific consensus is that "the balance of evidence suggests that there is a discernible human influence [from greenhouse gas emissions] on global climate." INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 1995: THE SCIENCE OF CLIMATE CHANGE (J.T. Houghton et al. eds., 1995), 3-5. The evidence of increased atmospheric CO_2 is well established, and the basic physics of the greenhouse effect is well understood. *See id.* Evidence of increasing global temperature is now appearing, as are some predicted effects — such as shrinking glaciers and increased storm intensity. *See id.* What is unknown is how fast the changes will occur, how drastic the changes will be, how the changes will be regionally distributed and manifested, and whether the changes will be reversible within the context of human history. *See id.*

2. *See e.g.*, ENVIRONMENT, ENERGY, AND RESOURCE LAW: 1999 THE YEAR IN REVIEW (Marla E. Mansfield et al. eds., Section of Environment, Energy, and Resources, A.B.A., 1999) for an excellent summary of the status of the ongoing discussions. Many of the different conceptual issues in instrument design are reviewed in David Driesen, *Choosing Environmental Instruments in a Transnational Context*, 27 ECOLOGY L. Q. 1 (2000).

3. The next Conference of the Parties under the Framework Convention is scheduled for November 2000 at the Hague. The announced goal for CoP6 is to finalize negotiations on outstanding issues for blocking acceptance of the Kyoto Protocol, to begin implementation of the Kyoto Protocol, and the negotiate a second budget period to begin after 2012 that will require emission reductions beyond those mandated in the Kyoto Protocol. *See* Jan Pronk, Address to Pew Center For Climate Change on Innovative Policy Solutions to Global Climate Change (April 25, 2000), and John Prescott, Address to Pew Center For Climate Change on Innovative Policy Solutions to Global Climate Change (April 26, 2000).

4. *See* SEBASTIAN OBERTHÜR AND HERMANN E. OTT, THE KYOTO PROTOCOL: INTERNATIONAL CLIMATE POLICY FOR THE 21ST CENTURY, 76-91 (Alexander Carius & R. Andreas Kraemer eds., Springer 1999) (describing the process as "negotiation by exhaustion").

5. It is scientifically irrelevant where in the world a pound of CO_2 is emitted from since each molecule remains in the atmosphere for about 100 years and contributes to the global

But any emission trading arrangement will be useful only if the underlying commodity (the emission credit) is verifiable, durable, and enforceable.[8] Given the range of implementation policy choices, from taxes to emission caps to trading, the range of carbon offset projects and the huge amounts of money at stake, the incentives to mismanage, cut corners, or to engage in outright fraud will be enormous. Thus, the public will have a significant interest in assuring that the government chooses policies and rules that advance implementation[9] and only approves emission credit projects that are legitimate, verifiable, and enforceable. International and national transparency, and public participation in the government approval process, will be essential, as will judicial review of government decisions under the Administrative Procedure Act (APA),[10] National Environmental Policy Act (NEPA)[11] or other statutes implementing U.S. climate change obligations. After projects have been approved, project monitoring and enforcement also will be critical. Inevitably the government will have insufficient resources to monitor and enforce the enormous variety, quantity, and diversity of emission

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increase of the gas's concentration. Thus, a reduction any where in the world is as equally valuable as any reduction achieved anywhere else in the world. From an economic efficiency perspective, an emission trading scheme makes great sense.

6. The practicality of worldwide emission trading is currently being tested in the private sphere, by BP Amoco, and Shell, who have adopted firm-wide caps for carbon dioxide emissions allocated to each operating facility. *See, e.g.*, Robert Kleigerb, *Shell Includes Kyoto Mechanisms in Action on Climate Change,* JOINT IMPLEMENTATION Q., Apr. 2000, at 4.

7. *See* JAE EDMONDS ET AL. INTERNATIONAL EMISSIONS TRADING & GLOBAL CLIMATE CHANGE (Dec. 1999), ANNIE PETSONK, ET AL., MARKET MECHANISMS & GLOBAL CLIMATE CHANGE (Oct. 1998), and JOINT IMPLEMENTATION Q. (An on-line "Magazine on the Kyoto Mechanisms" designed "to exchange the latest information on AIJ and the Kyoto Mechanism." Current and back issues of this magazine may be downloaded from the Joint Implementation Network website at <http://www.northsea.nl/jiq/>); and GLOBAL GREENHOUSE EMISSIONS TRADER (This "quarterly newsletter dedicated to greenhouse gas emissions trading" is produced by the Greenhouse Gas Emissions Trading Project of the United Nations Conference on Trade and Development).

8. So, for a nation to claim an emission credit for, say, planting trees that sequester carbon in their roots, trunk and branches, there must be some means to verify that the trees have been planted, that they will grow unimpeded by forest fire or poaching for firewood, and that they produce a net increase of growing trees — *i.e.*, other trees have not been cut down because these are growing. *See* RICHARD OTTINGER, ET AL., ENVIRONMENTAL COSTS OF ELECTRICITY 127-196 (1990).

9. For instance, decisions concerning automobile fuel economy standards, such as what vehicles are included in the standards and what those standards will be, can have an important role in the aggregate in responding to climate change. *See, e.g.*, City of Los Angeles v. National Highway Safety Admin., 912 F. 2d 478 (D.C. Cir. 1990, *overuled* by Florida Audubon Soc'y v. Bentsen, 94 F. 3d 658 (D.C. Cir. 1996).

10. *See* 5 U.S.C. §701 (2000).

11. *See* 42 U.S.C. § 4321 (1994).

offset credit projects. Thus, as with all other environmental laws, some sort of citizen suit enforcement will be necessary.[12]

As with other areas of Congressionally authorized citizen participation, judicial involvement is predicated on the citizen participant having standing under the Constitution. To maintain an action in federal court a plaintiff must have a sufficient interest in the litigation to satisfy the Constitution's Article III case or controversy requirement. This standing requirement is jurisdictional and must be satisfied at all levels of federal litigation.[13] The basic elements of standing under Article III are well established:

> [T]o satisfy Article III's standing requirements, a plaintiff must show (1) it has suffered an "injury in fact" that is (a) concrete and particularized and (b) actual or imminent, not conjectural or hypothetical; (2) the injury is fairly traceable to the challenged action of the defendant; and (3) it is likely, as opposed to merely speculative, that the injury will be redressed by a favorable decision.[14]

When the action is brought by an association on behalf of a member or members, the association will have standing "when its members would otherwise have standing to sue in their own right, the interests at stake are germane to the organization's purpose, and neither the claim asserted nor the relief requested requires the participation of individual members in the lawsuit."[15]

This article will attempt to answer whether, under Supreme Court jurisprudence, a citizen can have standing to challenge a government rule on climate change grounds or challenge a government order approving an emission credit project approval or to enforce project requirements. The answer to this question depends on how the recent Supreme Court standing jurisprudence is understood to define the meaning of "injury in fact," causation and redressability. Must the plaintiff be directly harmed by the pollutant

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12. *See, e.g.*, 33 U.S.C. § 1365 (1994); 42 U.S.C. § 7604 (1994); 42 U.S.C. § 6972 (1994). For a detailed analysis of the role of citizen suits in the enforcement of environmental law, see David R. Hodas, *Enforcement of Environmental Law in a Triangular Federal System: Can Three Not Be A Crowd When Enforcement Authority Is Shared By The United States, the States, and Their Citizens*?, 54 MD. L. REV. 1552 (1995).

13. *See* Laidlaw, 120 S. Ct. at 704 (noting "we have an obligation to assure ourselves that [petitioner] had Article III standing at the outset of the litigation").

14. *Id*. (citing Lujan v. Defenders of Wildlife, 504 U.S. 555, 560-61 (1992)).

15. *Id*. (citing Hunt v. Washington State Apple Adver. Comm'n, 432 U.S. 333, 343 (1977)).

itself, as is the case in the classic nuisance and pollution cases? Or, may the plaintiff complain about the impact of climate change that will be widespread and suffered by all persons where the threatened impact is only a statistical artifact rather than a particular event or effect that is harmful to the plaintiff? Thus, the climate change standing problem goes to the central question of what is injury, how particularized it must be, and is standing to be essentially a constitutionalization of the special injury rule in public nuisance?

II. THE SPECTRUM OF CITIZEN STANDING

Conceptually, climate change from greenhouse gases is but one data point along the analytical spectrum of all types of air pollution. Air pollution from a single polluter emitting noxious fumes that harm neighbors has long been regulated by common law and more recently by statute.[16] Those victims have always had standing to complain since they are the objects of action or inaction that causes them injury.[17] Air pollution can also be the result of many diffused emitters, that produce acute local or regional problems such as smog/urban air pollution[18] or more chronic regional effects of many diffuse emitters, such as acid precipitation from coal-fired power plants, which harm forests, human lungs, and buildings many hundreds of miles downwind.[19] In these last two cases, as with nuisances, victims can have standing to seek judicial redress under the Clean Air Act.[20] However, air pollution can also take the form of long-term climatic effects from increased atmospheric concentrations of pollutants over time, such as CFC emissions that harm the stratosphere ozone layer, or the cumulative effects from the increased concentrations of greenhouse gases, such as carbon dioxide

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16. *See, e.g.*, *In re* Aldred's Case, 77 Eng. Rep. 816 (1611) (wretched stench from pig sty constituted private nuisance when it interfered with a landowner's enjoyment of his property); Boomer v. Atlantic Cement Co., 257 N.E. 2d 870 (1970); WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW 125 (2d ed., West 1994); Trail Smelter Arbitration (U.S. v. Can.), 3 R.I.A.A. 1938 (1949).

17. *See* Lujan v. Defenders of Wildlife, 504 U.S. 555, 561-62 (1992) (When a plaintiff is the object of an action or inaction, "there is ordinarily little question that the action or inaction has caused [plaintiff] injury, and that a judgment preventing or requiring the action will redress it.").

18. *See, e.g.*, 42 U.S.C. §108(a) (repealed 1994), under which regional pollutants such as ozone, particulates, carbon monoxide, and nitrogen dioxide are regulated.

19. *See* 42 U.S.C. §7651 Subch. IV-A--Acid Deposition Control (1994).

20. *See, e.g.*, Texans United For A Safe Econ. Ed. Fund v. Crown Cent. Petroleum Corp., 207 F. 3d 789 (5th Cir. 2000); Natural Resources Defense Council v. EPA, 507 F. 2d 905, 910 (9th Cir. 1974).

(CO_2), in the atmosphere.[21] Although the cumulative increases in atmospheric concentrations of greenhouse gas emissions are well documented, it is difficult, if not impossible, to attribute any particular weather event to be the direct result of those increased concentrations, even though statistically, scientists may be able to see evidence of broad human influence within the climate system. Although the effects of climate change may be more devastating than nuisance-based air pollution, with climate change everyone experiences weather changes, rather than the nuisance which has identifiable, particular victims.

Justice Scalia, the most forceful advocate for severely limiting standing so that courts are available only to protect minorities from particularized harm, suggests that when "allegedly wrongful governmental action . . . affects 'all who breathe,'" no one has standing to seek redress in court.[22] Justice Scalia's philosophy is directed most pointedly at "the judiciary's long love affair with environmental litigation,"[23] best exemplified by Judge Skelly Wright's opinion in *Calvert Cliffs*: "our duty, in short, is to see that important legislative purposes, heralded in the halls of Congress, are not lost or misdirected in the vast hallways of the federal bureaucracy."[24] To Justice Scalia, "[t]he ability to lose or misdirect laws [by denying standing where no particular harm to particular individuals or minorities is in question] can be said to be one of the prime engines of social change . . . ."[25] As we will see, this philosophy has been central to Justice Scalia's standing opinions in recent years, all of which aim to reverse, or at least severely limit the Court's standing jurisprudence which emerged in 1970, and for our purposes is best understood by the Court's rational in *Students Challenging Regulatory Agency Procedures (SCRAP)*: "[t]o deny standing to persons who are in fact injured simply because many others are also injured, would mean that the most injurious and widespread . . . actions could be questioned by nobody."[26] Justice

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21. *See* United Nations: Protocol on Substances that Deplete the Ozone Layer, 26 I.L.M. 1541, 1550 (1987); FRAMEWORK CONVENTION ON CLIMATE CHANGE, *supra* note 1.

22. *See* Antonin Scalia, *The Doctrine of Standing as an Essential Element of the Separation of Powers*, 17 SUFFOLK U. L. REV. 881, 896 (1983).

23. *Id*. at 884.

24. Calvert Cliffs' Coordinating Comm. v. Atomic Energy Comm'n, 449 F.2d 1109, 1111 (D.C. Cir. 1971).

25. Scalia, *supra* note 22, at 897 (noting that Sunday blue laws first were widely unenforced before they were repealed by legislatures).

26. United States v. Students Challenging Regulatory Agency Procedures (SCRAP), 412 U.S. 669, 687-88 (1973).

Scalia's concerns are better resolved by existing doctrines such as nonreviewability of prosecutorial discretion[27] and separation of powers jurisprudence, limiting one branch of government's ability to aggrandize power to itself or encroach on the power of another branch,[28] which is what the Court has done in its most recent pronouncements on standing,[29] in which it rejects the narrow philosophy of Justice Scalia and returns to the modern standing doctrine it announced in 1970.

In law, this spectrum of the local to global character of air pollution manifests itself in various ways. For instance, the more local the phenomenon, the more readily the problem and victims are identifiable, and the sooner law develops a response. The tort response of public and private nuisance exemplifies this.[30] As air pollution expanded along the spectrum to more regional issues, such as urban smog and other interstate problems, the tort-based liability response appropriate to localized air pollution was no longer adequate. In response, the Clean Air Act of 1970 eventually emerged, with its subsequent amendments, as a federal attempt, with state cooperation, to regulate regional air pollution.[31]

The global end of this spectrum represents an altogether different problem. Here, increased concentration of gases emitted worldwide affect changes in global climate. Unlike local or regional air pollution, where the emissions impose noxious consequences on downwind victims, the CFCs and greenhouse gases[32] are either inert, useful or harmless when emitted. It is only their slow accumulation in the atmosphere which changes the climate broadly. CFCs, gases purely human in origin, are now being eliminated from production as a result of a global international agreement. In the case of CFCs, the danger of destruction of the stratospheric ozone layer was great and the consequences to human health and the environment enormous, and the relatively few major industrial entities that manufactured CFCs had the technical capability to invent,

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27. *See* Heckler v. Chaney, 470 U.S. 821 (1985).

28. *See, e.g.,* Bowsher v. Synar, 478 U.S. 714 (1986); Commodity Futures Trading Comm'n v. Schor, 478 U.S. 833 (1986).

29. *See* Friends of the Earth, Inc. v. Laidlaw Envtl. Services (TOC), Inc., 120 S. Ct. 693 (2000); Federal Election Commission v. Akins, 524 U.S. 11 (1998).

30. *See, e.g.*, David R. Hodas, *Private Actions for Public Nuisance: Common Law Citizen Suits for Relief from Environmental Harm*, 16 ECOLOGY L. Q. 883, 884-85 (1989).

31. 42 U.S.C. § 7401 (1994).

32. "[T]hose gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation" such as CO_2, methane, and nitrous oxide. UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT: FRAMEWORK CONVENTION ON CLIMATE CHANGE, 31 I.L.M. 849 (1992), Art. 1, ¶ 5.

manufacture and market alternative, less destructive, products, so the international legal system was able to respond relatively quickly and elegantly to the problem.[33]

However, climate change from increased concentration of greenhouse gases is at the extreme global end of our conceptual spectrum. First, CO_2 is not a human invented gas, but is an essential by-product of respiration — it is essential to living, and is the necessary feedstock of photosynthesis, from which plants convert sunlight to food for the earth, and release oxygen for us to breathe. Moreover, each person's CO_2 emission from burning fossil fuels and other human activities insignificantly increases atmospheric concentrations, which slowly change the climate in hard to define ways; because each molecule of carbon dioxide can stay in the atmosphere for a century or more, the accumulative effects are both large and long-lived. Although the location of an air pollution issue along this spectrum affects the nature of the regulatory instruments chosen and legal regime necessary to support those instruments, it does not change the basic analytical concept that all human-caused air pollution is regulated by legal systems that set goals, standards, expectations, and require implementation, monitoring and compliance mechanisms. The same legal tool chest is used each time, but the tools are selected as the job requires. In the case of climate change, any legal regime designed to regulate CO_2 emissions must be comprehensive, international and affect individual conduct. Standing should not depend on the policy choice of which regulatory and legal tools fit which type of air pollution best.

III. STANDING AS A CONSTITUTIONAL DOCTRINE: EMERGENCE AND DECLINE

Standing, as a constitutional doctrine, is relatively new, not entering into our jurisprudence until the first half of the twentieth century, as "a creation of justices allied with the progressive movement or the New Deal — most notably Justices Brandeis and Frankfurter, defenders of the regulatory–state who sought to develop devices immunizing government from judicial review."[34] Before this effort to protect New Deal legislation from Lochnerian attack, the standing doctrine was construed narrowly to limit claims against the

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33. *See generally* RICHARD ELLIOT BENEDICK, OZONE DIPLOMACY: NEW DIRECTIONS IN SAFEGUARDING THE PLANET (1991) (an excellent and thorough account of this history by the chief U.S. ozone negotiator from 1985 to 1990).

34. GEOFFREY R. STONE ET AL., CONSTITUTIONAL LAW 100 (3d ed. 1996).

government to those persons who could show some common law interest that was at stake. Under this approach, standing was found for persons seeking to protect private property from government interference, but not for those seeking to invoke the power of government.[35] However, with the rise of the administrative state and expanding concepts of public participation in decision-making, standing evolved to encompass judicial review of public welfare statutes by beneficiaries the laws were intended to protect. Increasingly, the narrow common law or legal interest test for standing was challenged in the 1960's as courts began to interpret statutes designed to provide public benefits and protection to include the right to allow persons intended to be protected by the statute to bring suit.[36] Thus, citizens concerned with destruction of the environment in the Hudson River Valley were held to have standing under the Federal Power Act to challenge the approval of a pump storage plant.[37] This evolution led to the abandonment of the narrow standing concept in 1970, when the Supreme Court ushered in the modern doctrine of standing, by broadening standing as a matter of statutory interpretation under the Administrative Procedure Act[38] to require the plaintiff only to show "injury in fact," which could consist of economic, aesthetic, environmental or other harm.[39]

A. Judicial Expansion of Standing

This liberalization of the "injury in fact" test was confirmed and constitutionalized two years later in *Sierra Club v. Morton*,[40] where the Court held that "aesthetic, conservational or recreational harm" could be a constitutionally sufficient injury to support standing to challenge government approval of a permit for a ski development.[41] Over the next two decades, this expansive concept of standing, particularly in environmental cases, became well established. For

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35. *See id*. at 100-01.

36. This evolution was paralleled by a similar expansion of the definition of protected interest under the 14th Amendment due process clause for purposes of procedural due process. *See, e.g.*, Goldberg v. Kelly, 397 U.S. 254 (1970); Charles A. Reich, *The New Property*, 73 YALE L.J. 733 (1964).

37. *See* Scenic Hudson Preservation Conference v. Federal Power Comm'n, 354 F. 2d 608, 615-16 (2d Cir. 1965).

38. 5 U.S.C. §702 (1994).

39. *See* Association of Data Processing Serv. Org. v. Camp, 397 U.S. 150, 153-54 (1970).

40. 405 U.S. 727 (1972).

41. *Id*. at 734-35 (but finding that to have standing, the organization must meet the requirements of associative standing or standing in its own right by showing that "it or its members" used the land in dispute).

instance, a year later, the Court held, for purposes of a motion to dismiss, that a group of law students alleged sufficient injury for standing purposes to challenge an Interstate Commerce Commission railroad freight tariff to meet the Article III Constitutional minima by showing an

> attenuated line of causation to the eventual injury of which the [students] complained — a general rate increase would allegedly cause increased use of non-recyclable commodities as compared to recyclable goods, thus resulting in the need to use more natural resources to produce such goods, some of which resources might be taken from the Washington area, and resulting in more refuse that might be discarded in national parks in the Washington area.[42]

Several years later, a group of persons opposed to nuclear power plants proposed to be built near them, filed suit to challenge the validity of the Price-Anderson Act, which set a liability cap for a nuclear plant accident at $560 million.[43] The group argued that without the financial subsidy of the liability limitation the utility would not be able to afford to construct the plant, and therefore, the aesthetic and environmental injuries the plant, if constructed and operated, would cause was directly attributable to the act, giving plaintiff's standing. The Court agreed that the plaintiffs had standing to challenge the act: "[c]ertainly the environmental and aesthetic consequences of the thermal pollution of the two lakes in the vicinity of the disputed power plants is the type of harmful effect which has been deemed adequate in prior cases to satisfy the 'injury in fact' standard."[44] Standing existed because there was injury in fact, fairly traceable to the financial subsidy of the Price–Anderson Act, which could be redressible by a ruling that the act was invalid.

Within the context of environmental issues, the modern approach to standing remained unremarkable within the Supreme Court for the next decade. However, with the advent of the policies of

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42. U.S. v. SCRAP, 412 U.S. 669, 688 (1973) (finding, in other words, that the increased freight rates might result in less recycling of cans and bottles, which would result in increased litter in Washington's Rock Creek Park, which would impair the plaintiff's aesthetic interest in using the park). This opinion has been characterized by Justice Scalia as at the outer limits of standing jurisprudence. *See* Lujan v. National Wildlife Federation, 497 U.S. 871, 889 (1990).

43. *See* Duke Power Co. v. Carolina Envtl. Study Group, 438 U.S. 59, 62-65 (1978).

44. *Id.* at 73-74.

President Reagan during the 1980's to reduce governmental efforts to protect the environment, a new breed of environmental litigation emerged — the citizen, as private attorney general, suit.[45] The explosion and success of these suits, together with litigation by citizens challenging the administration's efforts to reduce environmental regulation and protection, resulted in jurisdictional questions, such as standing, becoming crucial tactical shields to defend these actions. For instance, in 1987, a polluter was finally able to fend off a Clean Water Act citizen suit by making a technical jurisdictional argument about the temporal nature of the allegations in *Gwaltney of Smithfield, Ltd. v. Chesapeake Bay Foundation, Inc.*[46] Two years later, the Court held that the 60 day notice requirement common to all environmental suit statutes was a jurisdictional prerequisite to sit in a federal court.[47]

Although *Gwaltney* turned on a statutory interpretation question, it reflected a much more narrow approach to environmental litigation, particularly in its characterization of the statutory requirements as subject matter jurisdictional, and therefore, noncurable. This constriction soon became apparent in standing also.

B. Judicial Constriction of Standing

1. Lujan v. National Wildlife Federation[48]

The first case to suggest a narrowing of the standing doctrine was *Lujan v. National Wildlife Federation*.[49] In that case, the NWF sought to challenge the criteria the DOI was using to reclassify the types of uses to be permitted on about two million acres of federal land in the west, these new use classifications would allegedly be used by the agency in its land withdrawal review program, under which the Bureau of Land Management (BLM) would determine which land would be removed from protection (withdrawal status).[50] BLM argued that each of the thousands of parcel redesignations must be challenged separately and discretely. At the time of the suit, the Agency had changed the land use designation status for several

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45. *See* Hodas, *supra* note 12, at 1618-20.
46. 484 U.S. 49 (1987).
47. *See* Hallstrom v. Tillamook County, 493 U.S. 20, 25-26 (1989).
48. 497 U.S. 871 (1990).
49. *See id*. at 882-89.
50. *See id*. at 875-79.

small parcels to permit mining and other surface disturbing activities. The DOI, seeking to avoid judicial scrutiny of its program, sought to dismiss the case on the grounds that the plaintiff did not have standing.[51] The plaintiff's standing claim was based on the affidavits of several NWF members, who said they hiked "in the vicinity" of the parcels, and their aesthetic and environmental interests would be harmed by the redesignations allowing mining and other surface disturbing activities.[52] The "adverse effect" or "aggrievement" alleged in the affidavits, diminished recreational use and aesthetic enjoyment from the termination of the withdrawal classification, were clearly "among the *sorts* of interests those statutes [FLPMA and NEPA] were specifically designed to protect."[53] To Justice Scalia, writing for the majority, the sole issue was whether "the facts alleged in the affidavits showed that those interests of [the affiants] were actually affected."[54] The Supreme Court held that, for purposes of summary judgment, hiking "in the vicinity" was a statutorily insufficient allegation of aesthetic or environmental interest in the land to support a claim of harm caused by agency action.[55] In so ruling, the Court also held that any ambiguity in the affidavits as to what "in the vicinity" meant would not be read in favor of the affiants (the non-moving party).[56]

Contrary to its holding twenty one years earlier that an "in the vicinity" allegation was sufficient to establish "injury in fact,"[57] the Court dismissed the action for lack of standing, and refused to allow a remand for more detailed affidavits to be developed.[58] The Court of Appeals had said that the trial court, on the government's motion for summary judgment, "was obliged to resolve any factual ambiguity in favor of NWF, and would have had to assume, for the purposes of summary judgment, that [the affiant] used the 4500 affected acres."[59] Justice Scalia disagreed: under Fed. R. Civ. P. 56(e), the plaintiff's obligation to show that its members have been or are threatened to be "adversely affected" by the government's action "is

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51. *See id.* at 880.
52. *See id.*
53. *Id.* at 886 (emphasis in original).
54. *Id.*
55. *See id.* at 888-89.
56. *Id.*
57. Duke Power Co. v. Carolina Envtl. Study Group, 438 U.S. 59, 73-74 (1978) (holding that standing existed for plaintiffs who live near a power plant that might cause environmental and aesthetic harm to two lakes "in the vicinity" of the proposed power plants).
58. *See* NWF, 497 US at 898-900.
59. NWF v. Burford, 878 F. 2d 422, 431 (D.C. Cir. 1989).

assuredly not satisfied by averments which state only that one of [the] respondent's members uses unspecified portions of an immense tract of territory, on some portions of which mining activity has occurred or probably will occur by virtue of the government action."[60] This narrow approach to summary judgment and injury allegations was consistent with Justice Scalia's similarly narrow definition of agency action. Although NWF sought review of BLM's land withdrawal review program, which "BLM, over the past decade, has attempted to develop and implement,"[61] Justice Scalia saw no identifiable "agency action" as a program, only "1250 or so individual classification terminations and withdrawal revocations,"[62] each of which must be individually challenged. According to Justice Scalia, even if, as NWF alleged, "violation of the law is rampant within this program . . . [NWF] cannot seek *wholesale* improvement of this program by court decree, rather than in the offices of the Department or the halls of Congress, where programmatic improvements are normally made."[63] The dissent, in contrast, did not see the litigation as a broad, unfocused policy dispute better left to Congress, but as a classic challenge to agency action alleged to be arbitrary, capricious or otherwise not in accordance with law, for which judicial review and relief is normally appropriate.[64]

2. Lujan v. Defenders of Wildlife[65]

Standing was further constricted by Justice Scalia two years later in *Lujan v. Defenders of Wildlife*.[66] When *NWF* was announced, it was unclear whether it represented a change in approach towards standing that was more narrow in scope, and restrictive in its application, or whether it was merely an anomalous litigation result driven by the particulars of the affidavits. In other words, if this was a decision meant to rearticulate standards for summary judgment,[67] it was trivial with respect to the standing doctrine (i.e., it was simply a drafting lesson for lawyers crafting affidavits). If it was more than a case concerned with the seemingly minor technicalities of an affidavit, then what did it teach with respect to standing? Did *NWF*

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60. 497 U.S. at 889.
61. *Id.* at 914 (Blackmun, J., dissenting).
62. *Id.* at 890 (quoting the District Court opinion, 699 F. Supp. 327, 332).
63. *Id.* at 891 (emphasis in original).
64. *See id.* at 913-14.
65. 504 U.S. 555 (1992).
66. *Id.*
67. *See* NWF at 902-03, 908 (Blackmun, J., dissenting).

reflect Justice Scalia's long held academic views that the doctrine of standing should limit citizen's ability to influence governmental policy through the device of litigation?[68] The Court appeared to answer the question in *Defenders of Wildlife*, when it ruled that an environmental group lacked standing to challenge a Department of Interior rule interpreting § 7 of the Endangered Species Act to make it inapplicable to extraterritorial impacts of federal action.[69]

The court below had found that Defenders of Wildlife had standing, and ruled in their favor on the merits.[70] A divided Supreme Court, however, found no standing, and declined to consider the case on the merits.[71] The case involved, for standing purposes, the allegation that funds provided by the United States supported dam projects in Sri Lanka and Egypt that would threaten the habitat and extinction of endangered and threatened species.[72] The affidavits of two Defenders of Wildlife members were offered to support the association's standing. Joyce Kelly

> stated that she traveled to Egypt in 1986 and 'observed the traditional habitat of the endangered Nile crocodile there and intend[s] to do so again, and hope[s] to observe the crocodile directly,' and that she will suffer harm in fact as the result of [the] American role in overseeing the rehabilitation of the Aswan High Dam . . . .[73]

Amy Skilbred "averred that she traveled to Sri Lanka in 1981 and 'observed th[e] habitat' of 'endangered species such as the Asian elephant and the leopard' at what is now the site of the Mahaweli project funded by the Agency for International Development . . . ."[74] She stated that the project will harm the animal's habitat, threaten the continual existence of the species, and will harm her because she "intend[s] to return to Sri Lanka in the future and hope[s] to be more fortunate in spotting at least the endangered elephant and

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68. *See* Antonin Scalia, *The Doctrine of Standing as an Essential Element of the Separation of Powers,* 17 SUFFOLK U.L. REV. 881, 896 (1983).
69. *See* 504 U.S. at 578.
70. *See id.* at 559.
71. *See id.* at 578.
72. *See id.* at 563.
73. *Id.* (alteration in original).
74. *Id.* (alteration in original).

leopard."[75] She had no current plans to return since Sri Lanka was in the midst of a civil war at the time.[76]

With respect to the facts, the court was in agreement, but as to how these facts fit into the law of standing, the court was splintered. Justice Scalia's opinion rejected standing on four grounds. First, the affiants intention to return to these countries "some day," absent "any description of concrete plans . . . do not support a finding of . . . 'actual or imminent' injury . . . ."[77] Second, the theories of standing proposed by Defenders were rejected by Justice Scalia as so implausible as to be unacceptable as a matter of law.[78] Defenders had argued that standing could be established by one of three alternative theories of causation, the "ecosystem,"[79] "animal,"[80] and "vocational nexus"[81] approaches. "Under these [animal nexus and vocational nexus] theories, anyone who goes to see Asian elephants in the Bronx Zoo, and anyone who is a keeper of Asian elephants in the Bronx Zoo, has standing to sue . . . ."[82] To Justice Scalia, "[t]his is beyond all reason . . . . [i]t goes . . . into pure speculation and fantasy, to say that anyone who observes or works with endangered species, anywhere in the world, is appreciably harmed by a single project affecting some portion of that species with which he has no more specific connection."[83]

Defenders' ecosystem nexus theory was also rejected by Justice Scalia as a matter of law. Under this theory,

> any person who uses *any part* of a 'contiguous ecosystem' adversely affected by a funded activity has standing even if the activity is located a great distance away. This approach . . . is inconsistent with our opinion in *National Wildlife Federation,* which held that a plaintiff claiming injury from environmental damage must use the area affected by the challenged

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75. *Id.* (alteration in original).

76. *See id.* at 564.

77. *Id.* (quoting Whitmore v. Arkansas, 495 U.S. 149, 155 (1990)).

78. *See id.* at 566-67.

79. *Id.* at 565. (Under this theory, "any person who uses *any part* of a 'contiguous ecosystem' adversely affected by a funded activity has standing even if the activity is located a great distance away.") This theory was rejected by Justice Scalia as inconsistent with National Wildlife Federation.

80. *Id.* at 566. ("[A]nyone who has an interest in studying or seeing the endangered animals anywhere on the globe has standing").

81. *Id.* ("[A]nyone with a professional interest in [endangered] animals can sue").

82. *Id.*

83. *Id.* at 566-67.

> activity and not an area roughly 'in the vicinity of it.' To say that the [Endangered Species] Act protects ecosystems is not to say that the Act creates (if it were possible) rights of action in persons who have not been injured in fact, that is, persons who use portions of an ecosystem not perceptibly affected by the unlawful action in question.[84]

Third, Justice Scalia found no standing because, in his view, relief from the court would not fully redress the complained of injury, because a court order invalidating the rule would not necessarily stop the projects.[85] Finally, Justice Scalia denied that Congress could create and vest a "public" right in individuals to support judicial review of the executive branch's failure to adhere to the law.[86] To Justice Scalia, "the concrete injury requirement has . . . separation-of-powers significance,"[87] so that Congress cannot convert "the public interest in proper administration of the laws (specifically, in agencies' observance of a particular, statutorily prescribed procedure) . . . into an individual right by a statute that denominates it as such, and that permits all citizens . . . to sue."[88]

Only Chief Justice Rehnquist, Justice White and Justice Thomas joined the plurality opinion of the Court. Justices Kennedy and Souter concurred with the seemingly "trivial" view that absent airplane tickets to return the affiants' connection to the location was too remote to support standing.[89] On the other hand, both Justice Kennedy and Souter accepted, as a matter of law, "the possibility . . . that in different circumstances a nexus theory similar to those proffered here might support a claim to standing."[90] They refused, however, to reach the redressability issue and rejected Justice Scalia's constitutional bar to Congress creating new causes of action: "Congress has the power to define injuries and articulate chains of causation that will give rise to a case or controversy when none existed before . . . . In exercising this power, however, Congress

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84. *Id.* at 565-66.
85. *See id.* at 568-71.
86. *See id.* at 571-78.
87. *Id.* at 577.
88. *Id.* at 576-77.
89. *See id.* at 579-80 (Kennedy, J., concurring).
90. *Id.* at 579.

must at the very least identify the injury it seeks to vindicate and relate the injury to the class of persons entitled to bring suit."[91]

Justice Stevens believed that standing was established here because Congress having found endangered species to be of "'aesthetic, ecological, educational . . . value to the Nation and its people,'" the Court has "no license to demean the importance of the interest that particular individuals may have in observing any species or its habitat."[92] In his view, the injury alleged here was imminent,[93] could be redressed by a court order, and was not subject to any separation of power limitation. However, because he believed the government should prevail on the merits, he concurred in the judgment of reversal.[94]

Justice Blackmun, with Justice O'Connor joining, vigorously dissented from the plurality's "slash-and-burn expedition through the law of environmental standing."[95] In their view, standing was clearly established by the affidavits; they rejected, as a return to "code-pleading formalism," the notion that airplane tickets would determine the outcome.[96] They viewed the majority as creating a set of "rigid principles of geographic formalism" applicable only to environmental claims, which are now placed under "special constitutional standing disabilities."[97] They rejected Justice Scalia's redressability argument because of "its invitation of executive lawlessness, ignorance of principles of collateral estoppel, unfounded assumptions about causation, and erroneous conclusions about what the record does not say,"[98] and rejected the separation of powers analysis as a new, unjustified, inappropriate and arbitrary *per se* rule.[99]

Under a scorecard analysis, six justices believed that an airplane ticket was necessary. Four justices (only three of whom remain on the Court) rejected the various nexus theories as a matter of law. Five justices accepted the nexus approach as legally valid. Four justices (only three of whom remain on the Court) agreed with

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91. *Id.* at 580.

92. *Id.* at 582 (Stevens, J., concurring).

93. *See id.* at 583 (Justice Stevens would measure "'imminence' . . . by the timing and likelihood of the threatened [injury] . . . rather than — as the Court seems to suggest . . . — by the time that might elapse between the present and the time when the individuals would visit the area if no such injury should occur").

94. *See id.* at 585.

95. *Id.* at 606 (Blackmun, J., dissenting).

96. *See id.* at 593.

97. *Id.* at 595.

98. *Id.* at 601.

99. *See id.* at 601-06.

Justice Scalia's redressability theories or separation-of-powers ideas. The question we face is this: how powerful is Justice Scalia's plurality opinion? Is it a second data point on a trend line beginning with *NWF*, leading inexorably to the narrow standing theory proposed by Justice Scalia in his *Suffolk Law Review* article? If so, in the climate change context, standing will be nearly impossible to achieve. Although, *Defenders of Wildlife* has been harshly criticized in the academic community,[100] it was read by many lower courts as a strong signal that standing was to be more rigorously evaluated in environmental litigation.[101] However, because *Defenders of Wildlife* was only a plurality opinion, the law of standing remained unsettled.[102]

3. Steel Co. v. Citizens for a Better Environment[103]

This battle over the environmental standing paradigm was not waged again until 1998 in *Steel Co. v. Citizens for a Better Environment*.[104] In this case, citizens were seeking civil penalties from the defendant for failing to file its Toxic Release Inventory (TRI) under the Emergency Planning and Community-Right-To-Know Act (EPCRA).[105] By the time the complaint was filed, the defendant had filed its TRI with the government.[106] The defendant sought to dismiss the case on two grounds. First, that the statute did not permit citizen suits for wholly past violations, and second, that even if the statute authorized such suits, the plaintiff did not have

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100. *See, e.g.*, Cass R. Sunstein, *What's Standing after Lujan? Of Citizen Suits, "Injuries," and Article III*, 91 MICH. L. REV. 163 (1992); Karl S. Coplan, *Refracting the Spectrum of Clean Water Act Standing in Light of Lujan v. Defenders of Wildlife*, 22 COLUM. J. ENVTL. L 169 (1997); Robert B. June, *The Structure of Standing Requirements for Citizen Suits and the Scope of Congressional Power,* 24 ENVTL. L. 761 (1994). *But see* Harold J. Krent & Ethan G. Shenkman, *Of Citizen Suits and Citizen Sunstein*, 91 MICH. L. REV. 1793 (1993) (finding a "middle ground" between Justice Scalia's complete denial of citizen standing and Sunstein's granting of universal citizen standing).

101. *See, e.g.*, Broadened Horizons Riverkeepers v. U.S. Army Corps of Eng'r, 8 F. Supp. 2d 730, 733 (E.D. Tenn 1998) (alleged injuries "not NEPA injuries-in-fact because they are conjectural in the sense that they cannot be fairly traced to governmental action or inaction."); Friends of the Earth Inc., v. Crown Cent. Petroleum Corp., 95 F. 3d 358 (5th Cir. 1996); Friends of the Earth Inc., v. Gaston Copper Recycling Corp., 9 F. Supp. 2d 589, 596 (D. S.C. 1998); Ogden Projects, Inc. v. New Morgan Landfill Co., 911 F. Supp. 863, 868-70 (E.D. Pa. 1996) (Defenders of Wildlife required dismissal of Clean Air Act suit where individual plaintiff resided 85 miles from air polluter).

102. *See* Coplan, *supra* note 100, at 169-70.

103. 523 U.S. 83 (1998).

104. *Id.*

105. *See* 42 U.S.C. §§ 11001 to 11050 (1994).

106. *See* Steel Co., 523 U.S. at 88.

standing.[107] In a lengthy decision, devoted mostly to a debate among the justices as to whether the court should address the statutory issue before the constitutional one or vice versa, the court dismissed, with brief analysis, for lack of standing.[108] The court found that the relief sought, an award of civil penalties for past violations, would not redress plaintiff's alleged injury because the civil penalties would be paid to the U.S. Treasury, and not to or on behalf of plaintiffs.[109] Any deterrent effect the civil penalties might engender were, to the majority, too speculative to render them redress for constitutional purposes.[110] This conclusion by Justice Scalia, although entirely consistent with his philosophy espoused in his *Suffolk Law Review* article, was presented without analysis or support[111] despite vigorous dissent.

To Scalia, in seeking civil penalties payable to the U.S. Treasury, the citizens were not seeking to remedy their own injury but sought "vindication of the rule of law - the 'undifferentiated public interest' in faithful execution of EPCRA. This does not suffice . . . although a suitor may derive great comfort and joy from the fact that the United States Treasury is not cheated, that a wrongdoer gets his just desserts, or that the Nation's laws are faithfully enforced, that psychic satisfaction is not an acceptable Article III remedy . . . ."[112] Nor, to Justice Scalia, does the deterrent value of penalties provide redress — "such a principle would make the redressability requirement vanish."[113]

But to Justice Stevens, this rigid definition of remedy was wrongheaded: "the Court fails to specify why payment to respondent — even if only a peppercorn — would redress respondent's injuries, while payment to the Treasury does not."[114] To Justice Stevens, civil penalties are conceptually identical to punitive damages — which provide redress for the individual and states; nor is it any different, according to Justice Stevens, from the deterrence value of private criminal prosecutions, which were routine in Colonial America and the early days of the United States.[115] There is redress, even if plaintiff does not receive the

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107. *See id.*
108. *See id.* at 109-10.
109. *See id.* at 106.
110. *See id.* at 108-09.
111. *See id.*
112. *Id.* at 106-07 (quoting Defenders of Wildlife, 504 U.S. at 577).
113. *Id.* at 107.
114. *Id* at 127 (Stevens, J., concurring).
115. *See id.* at 127-28.

penalties or money because "the wrongdoer will be less likely to repeat the injurious conduct that prompted the litigation. The lessening of the risk of future harm is a concrete benefit."[116]

If one were to plot these cases (*NWF, Defenders of Wildlife and Steel Co.*) on a graph, the data would reveal an apparent abandonment of the modern law of standing.[117] In *NWF*, the Court required explicit geographic contact, rejecting "in the vicinity," which had been adequate in *Duke Power*. In *Defenders of Wildlife*, the plurality added a severe concreteness of injury test, rejected logical, scientifically justifiable, and pragmatic nexus theories of causal connection as legally inadequate (an unspoken rejection of *SCRAP*), questioned the concept of redress where anything less than a complete remedy is possible, and began to limit Congress' ability to define injury and authorize citizen suits to enforce federal laws. Finally, in *Steel Co.*, the Court appeared to repudiate the deterrent effect of civil penalties as citizen redress, thereby effectively limiting citizen suits only to cases where injunctive relief is appropriate. Thus, with the *Steel Co.* opinion, the court appears to have redefined, in terms most hostile to environmental claimants, all of the constitutionally "irreducible minimum"[118] prerequisites of standing: injury in fact, causation and redressability. It would appear that in these three opinions Justice Scalia has ended the federal courts' love affair with environmental litigation, to which he so vehemently objected in his *Suffolk* article.[119]

IV. REVIVAL OF CITIZEN STANDING: STANDING AND DEMOCRACY

Yet, what appeared to be Justice Scalia's triumph in *Steel Co.* was short-lived. A non-environmental case decided three months after *Steel Co.* undermined Justice Scalia's central standing theme, that broadly held grievances should be brought to Congress, not the Courts.[120] At first glance, *Akins*, which ruled that voters had standing to challenge a Federal Election Commission final decision that a lobbying group (AIPAC) was not a "political committee" within the definition of the statute, and was not required to disclose

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116. *Id.* at 128, n. 26.

117. *See* Defenders of Wildlife, 504 U.S. at 560 (Justice Scalia even narrows the definition of "injury in fact" to a pre-Association of Data Processing Serv. Org. concept of "a legally-protected interest").

118. Valley Forge Christian College v. Americans United for Separation of Church and State, Inc., 454 U.S. 464, 472 (1982).

119. *See* Scalia, *supra* note 22, at 884.

120. *See* Federal Election Comm'n v. Akins, 524 U.S. 11 (1998). Steel Co., 523 U.S. 83, was argued October 6, 1997 and decided March 4, 1998, while Akins was argued on Jan. 14, 1998 and decided June 1, 1998.

its donors, contributions, or expenditures, seems unrelated to the environmental standing cases. However, *Akins*, which turned on the Court's conceptualization of what is a generalized grievance (for which standing is not available under the Constitution) and what is a concrete and particular harm broadly shared, goes to the heart of the injury prong of standing in the climate change context.

In *Akins*, Justice Breyer held that voters' inability to obtain information that Congress, through the Federal Election Campaign Act of 1971,[121] required to be disclosed was a constitutionally "genuine 'injury in fact.'"[122] Here the "concrete and particular" injury suffered was the deprivation of the Congressionally created right that voters receive designated "information [which] would help them . . . to evaluate candidates for public office . . . ."[123] To the Court, this harm was consistent with the finding of harm in previous informational cases, and so the decision was unremarkable,[124] and distinguishable from taxpayer standing cases, where a plaintiff rarely has standing to sue.[125] Unlike *Akins*, the taxpayer in *United States v. Richardson*[126] who sought disclosure of CIA expenditures based upon the Accounts Clause of the Constitution[127] so that he could "properly fulfill his obligations as a member of the electorate in voting"[128] was not injured in fact. Thus, the central question in *Akins* was why standing is sometimes allowed but sometimes denied when "the political process, rather than the judicial process, may provide the more appropriate remedy for a widely shared grievance."[129] Justice Breyer explained that the generalized grievance bar to standing involved a two part test — the harm must not only be widely shared but must also be of "an abstract and indefinite nature — for example, harm to the 'common concern for obedience to law.'"[130] It is the

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121. 2 U.S.C. § 431 to 456 (1994).

122. 524 U.S. at 21.

123. *Id.*

124. *See* Public Citizen v. Dep't. of Justice, 491 U.S. 440, 449 (1989) (noting that deprivation of information required to be disclosed by federal statute "constitutes a sufficiently distinct injury to provide standing to sue").

125. *See*, *e.g.*, Flast v. Cohen, 392 U.S. 83 (1968).

126. 18 U.S. 166 (1974).

127. *See* U.S. CONST. art. I, § 9, cl. 7 ("[a] regular statement and account of the receipts and expenditures of all public money shall be published from time to time").

128. Richardson, 418 U.S. at 176.

129. Akins, 524 U.S. at 23.

130. *Id.*

abstractness of the injury that deprives the standing, not the wide dispersal of the harm.[131]

Where a widely shared harm is nevertheless concrete, standing can exist constitutionally. The wide sharing of injury is analytically distinct from concreteness:

> [T]he fact that a political forum may be more readily available where an injury is widely shared . . . does not, by itself, automatically disqualify an interest for Article III purposes . . . . This conclusion seems particularly obvious where (to use a hypothetical example) large numbers of individuals suffer the same common-law injury (say, a widespread mass tort), or where large numbers of voters suffer interference with voting rights conferred by law. We conclude that, similarly, the informational injury at issue here, directly related to voting, the most basic of political rights, is sufficiently concrete and specific such that the fact that it is widely shared does not deprive Congress of constitutional power to authorize its vindication in the federal courts.[132]

Thus, where Congress enacts a law designed to protect or enhance rights of citizens, and authorizes persons protected to seek judicial redress when the protection is denied, and thus the harm inflicted, the citizen has standing to seek such redress in federal court, even though every other citizen is similarly adversely affected. On the other hand, general obligations placed on Congress by the Constitution such as the Accounts Clause, do not define concrete harm to citizens when Congress allegedly fails to meet its affirmative obligation. In those cases, as with other political issues, the remedy is left to the political process, not the Courts.

Not surprisingly, Justice Scalia vigorously dissented. First, he objected to the idea that Congress, by statute, could create an injury-in-fact while a constitutional obligation on Congress does not.[133] He also objected to the distinction between taxpayers (no standing) and

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131. *See id.* at 24 ("The abstract nature of the harm . . . deprives the case of the concrete specificity that characterized those controversies which were 'the traditional concern of the courts at Westminster'; and which today prevents a plaintiff from obtaining what would, in effect, amount to an advisory opinion.") (internal citations omitted).

132. *Id.* at 24 - 25 (internal citations omitted).

133. *See* Akins, 521 U.S. at 33 (Scalia, J., dissenting).

voters (standing) as "a silly distinction, given the weighty governmental purpose underlying the 'generalized grievance' prohibition - viz., to avoid 'something in the nature of an Athenian democracy or a New England town meeting to oversee the conduct of the National Government by means of lawsuits in federal courts.'"[134] This led to his most serious concern, that the Court has abandoned the line between generalized grievances (no standing) and particularized ones (standing). To Justice Scalia, it matters not whether generalized grievances are concrete or abstract, all "undifferentiated" grievances "common to all members of the public . . . must be pursued by political, rather than judicial, means."[135] *Akins* permitted Congress to authorize a citizen to vindicate an informational right of concern to all voters, and inevitably rejects Justice Scalia's admonition in *Defenders of Wildlife*[136] that "'[t]o permit Congress to convert the undifferentiated public interest in executive officers compliance with the law into an 'individual right' vindicable in the courts is to permit Congress to transfer from the President to the courts the Chief Executive's most important constitutional duty . . . .'"[137]

Thus, as of June 1998, the Court was placing a rigorous burden on plaintiffs to articulate concrete, differentiated, non-speculative harm to establish standing, but voters need not. If in environmental cases undifferentiated, widely shared harm would not justify standing, can there be standing to challenge governmental decisions affecting climate change or to bring citizen suits to enforce climate change obligations? As of June 1998, the line of environmental standing cases in the Supreme Court and lower courts suggested no. The lower courts' analysis of standing on the climate change issue mirrored the debate in the Supreme Court.

V. CLIMATE CHANGE: LOWER COURTS STRUGGLE WITH STANDING

Although the Supreme Court has not yet addressed the question of standing and climate change, the District of Columbia circuit has faced the question twice, with mixed results.[138] The first case

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134. *Id.* at 33 (internal citations omitted).

135. *Id.* at 35.

136. For an extended analysis of the tensions between *Akins* and *Defenders of Wildlife*, *see* Cass Sunstein, *Information Regulation and Informational Standing: Akins and Beyond*, 147 U. PA. L. REV. 613 (1999).

137. *Id.* at 36 (quoting Defenders of Wildlife, 504 U.S. at 577).

138. In another case, a NEPA challenge to funding decisions that allegedly contributed to the greenhouse effect, standing based on deprivation of information was denied. *See*

involved a challenge by Los Angeles, New York, the State of California and environmental groups to a decision by the National Highway Traffic Safety Administration not to prepare an environmental impact statement (EIS) on corporate average fuel economy (CAFÉ) standards.[139] The plaintiffs alleged that the Agency "should have prepared an EIS in order to consider the adverse climatic effects of the increase in fossil fuel consumption that would result from setting a CAFÉ standard lower than 27.5 mpg."[140] This increased fuel consumption would allegedly "lead to a global increase in temperatures, causing a rise in sea level and a decrease in snow cover that would damage the shoreline, forests, and agriculture of California;" which would injure the economic and recreational interests of members of the plant environmental group that lived there.[141] A divided court found that plaintiff had standing, although a differently divided court ruled against the plaintiffs on the merits. Judge Wald, with Justice (then Judge) Ruth Bader Ginsburg concurring, agreed that the "failure to prepare an EIS explaining the effects of the rollbacks on global warming presents the risk of overlooking an environmental injury that will personally affect its members," who because of their "geographical nexus" to the location where the consequences would be felt, would be harmed by a warmer climate's effect on coastal and agricultural resources.[142] Because NRDC had established that its members met the "geographical nexus" requirement of injury-in-fact, standing was established even though "the effects of a change in global atmosphere would obviously be felt throughout this country, and indeed, the world."[143] The causation prong of the standing test was met because "[n]o one disputes the causal link between carbon dioxide and global warming" and the Agency decision to reduce the fuel economy standard would increase these emissions.[144] To meet the causation and redressability requirements, "NRDC had only to

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Foundation on Econ. Trends v. Watkins, 794 F. Supp. 395 (D.C. Cir. 1992). In this case, however, the standing question was determined by the Circuit's recent narrowing of "information" standing, i.e., that deprivation of information did not constitute sufficient injury for purposes of standing. *See* Foundation on Econ. Trends v. Lyng, 943 F.2d 79, 82-85 (D.C. Cir. 1991). The court did not address whether plaintiffs had standing based on injuries from climate change directly.

139. *See* City of Los Angeles v. National Highway Traffic Safety Admin., 912 F.2d 478 (D.C. Cir. 1990), *overruled by* Florida Audubon Soc'y v. Bentsen, 94 F.3d 658 (D.C. Cir. 1996).

140. *Id.* at 483.

141. *Id.*

142. *Id.* at 494.

143. *Id.*

144. *Id.* at 495-497.

show some likelihood that a full EIS would influence [the Agency's] decision."[145]

On standing, Judge D. H. Ginsburg dissented. He argued that the change in global carbon dioxide concentration from the CAFÉ decision was too small in itself to cause the projected climate change catastrophe, and "NRDC failed to allege that a 1.0 mpg reduction would produce any marginal effect on the probability, the severity, or the imminence of global warming."[146] Therefore, the CAFÉ decision was not fairly traceable to the injury. In his view, if the majority's view on standing were followed, "the standing requirement would, as a practical matter, have been eliminated for anyone with the wit to shout 'global warming' in a crowded courthouse."[147] In his view, standing requires NRDC to allege (and ultimately show) that the decision would have an "identifiable "marginal impact."[148]

However, because such an allegation cannot be proved under the current state of the science, this approach would, in all practical terms, bar anyone from having standing to seek review of a decision affecting climate change. For several reasons, the majority explicitly rejected Judge D. H. Ginsburg for using "the wrong test for causation in the case of a NEPA plaintiff; he has fallen into the familiar trap of confusing the standing determination with the assessment of [the] case on the merits."[149] Instead, the majority cautioned that where "the relevant harms are probabilistic and systemic, with widespread impact, courts must be especially careful not to manipulate the causation requirements of standing so as to prevent the anticipated regulatory beneficiaries from gaining access to court."[150] Thus, the majority rejected Judge D. H. Ginsburg's test that NRDC must precisely establish the causal relationship between the fuel economy standard change and the harmful effects of global warming; rather they held that "our precedents require only that it show a reasonable likelihood that if [the Agency] performed an EIS, it would arrive at a different conclusion …."[151] The NRDC clearly did this.[152] Moreover, NRDC's standing was not diminished by the small

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145. *Id.* at 498.
146. *Id.* at 484.
147. *Id.*
148. *Id.*
149. *Id.* at 495.
150. *Id.* at 495 n.5.
151. *Id.* at 497.
152. *See id.* (summarizing the substantial evidence of fuel economy standards, gasoline usage, and carbon dioxide emissions over the lifetime of the 1989 model year fleet of cars).

percentage change (about 1%) in total U.S. emissions that the CAFÉ decision would cause. To the majority, that approach, ironically, "would permit virtually any contributory cause to the complex calculus of environmental harm to be ignored as too small to supply the causal nexus required for standing, and would call into question cases where we have found standing in the past."[153] Similarly, just as the correct causation test was "some likelihood"[154] that an EIS would influence the ultimate decision, so, with respect to redressability, the test is not whether changing the CAFÉ decision would reduce global warming, but whether "an EIS would redress its asserted injury, i.e., that any serious effects in global warming will not be overlooked."[155]

City of Los Angeles was decided before *Defenders of Wildlife*. The D.C. Circuit returned to this question again in 1996, several years post-*Defenders of Wildlife*, when, in a split decision, the Court, *en banc* overruled *City of Los Angeles*.[156] In this case, several environmental groups challenged the failure of the Treasury Department and I.R.S. to prepare an environmental impact statement on the effects of a tax credit for ethyl tertiary butyl ether (ETBE), a fuel additive. The environmental groups argued that the tax credit for ETBE would increase corn, sugar cane and sugar beets production of the ethanol from which ETBE was made, and this would increase agricultural activities in regions bordering wildlife areas, which would be adversely affected by the increased cultivation, which in turn would harm plaintiff's environmental and aesthetic interests in the areas, which were specified and with which members of the environmental groups had a geographic connection.[157]

A divided panel of the D.C. Circuit found that the allegations satisfied the injury in fact nexus requirement and the causation requirement because an EIS might result in the tax credit being rescinded or modified. Adopting Judge D. H. Ginsburg's views in *City of Los Angeles*, the D.C. Circuit *en banc* overruled *City of Los Angeles* and held that the relevant test is a showing that a "particularized environmental interest of [plaintiffs] that will suffer demonstrably increased risk, [and that the challenged agency

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153. *Id.* at 498 (*See, e.g.,* Committee for Auto Responsibility v. Solomon, 603 F.2d 992 (D.D. Cir. 1979) ("an increase in noise and air pollution from an individual parking lot" was "fairly traceable" even though it was only a minute percentage of the pollution from all parking lots in the metropolitan area).

154. *Id.*

155. *Id.* at 499.

156. *See* Florida Audubon Soc'y v. Bentsen, 94 F.3d 658 (D.C. Cir. 1996).

157. *See id.* at 662-63.

decision] is substantially likely to cause that demonstrable increase in risk to their particularized interest."[158] Following Justice Scalia's plurality opinion in *Defenders of Wildlife*, the court adopted Judge D. H. Ginsburg's test from *City of Los Angeles* that to demonstrate injury in fact a plaintiff "must show" that the EIS failure creates a "demonstrable risk not previously measurable (or the demonstrable increase of an existing risk) of serious environmental impacts that imperil [plaintiff's] particularized interests."[159] In doing so, the court explicitly overruled Judge Wald's opinion in the *City of Los Angeles* even though "a plaintiff seeking to challenge a governmental action with alleged diverse environmental impacts may have some difficulty meeting this standard."[160] The use of "may" is a bit disingenuous for the court goes on to prohibit, for standing purposes when litigation involved broad rulemaking, the use of any assumption that "areas used and enjoyed by a prospective plaintiff will suffer all or any environmental consequences that the rule itself may cause."[161] Nor will a showing that a plaintiff's "particularized interest is . . . more likely to sustain injury than some other person's interest" be sufficient to meet this standard.[162]

Moreover, relying on *Richardson*, the plaintiff must show that he is not simply injured as is everyone else, lest the injury be too general for court action, and suited instead for political redress.[163] Probabilistic analysis will not meet these tests — plaintiffs can not assume that farmers, as economically rational persons, will respond to the tax credit by increasing production; rather, to establish injury for standing purposes, plaintiffs must show that the tax credit will induce specific farmers to increase production in specific amounts on specific land, causing particularized environmental degradation.[164] Following the spirit of *Defenders of Wildlife*, the court also overruled

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158. *Id.* at 665.
159. *Id.* at 666.
160. *Id.*
161. *Id.* at 667.
162. *Id.*
163. *See id.*
164. *See id.* at 668 ("[W]hatever the possible environmental impacts of the ETBE tax credit, appellants have not provided competent evidence that corn farmers in particular areas of Minnesota or Michigan or sugar producers in particular regions of Florida will grow their crops in such a fashion as to lead to greater quantities of pesticide use and erosion than already exist so as to pose a significantly increased risk to the lands used by these appellate because of the presence of that credit. Even if the coming years witness some increased cultivation of land in the United States, appellants have not demonstrated that this increased cultivation would occur on land adjacent to the property in Minnesota or elsewhere that any appellants visit. Because appellants have not demonstrated such a geographic nexus to any asserted environmental injury, we cannot hold that they have standing to sue.").

the *City of Los Angeles* causation test. Instead of a probabilistic test, the court adopted a stringent test reminiscent of common law causation:

> To prove causation, a plaintiff seeking the preparation of an EIS must demonstrate that the particularized injury that the plaintiff is suffering or is likely to suffer is fairly traceable to the agency action that implicated the need for an EIS. In other words, unless there is a substantial probability . . . that the substantive agency action that disregarded a procedural requirement created a demonstrable risk, or caused a demonstrable increase in an existing risk, of injury to the particularized interests of the plaintiff, the plaintiff lacks standing.[165]

The dissenting judges, following the *City of Los Angeles* tests for standing, would find that plaintiffs had standing. Here, the dissent found that the majority "imposes so heavy an evidentiary burden on appellants to establish standing that it will be virtually impossible to bring a NEPA challenge to rulemakings [sic] with diffuse impacts."[166]

The validity of these cases turns on whether *Akins* is in fact a general rejection of Justice Scalia's political view of standing. No post-Akins case pending before the Court contained this question within the issues for which certiorari had been granted. Nevertheless, in January 2000, the answer appeared to burst forth from the court.

VI. STANDING'S MAJORITARIAN VITALITY RETURNS

In *Friends of the Earth, Inc. v. Laidlaw Environmental Services, Inc.*[167] the Court in a stunning 7 - 2 opinion, essentially rejected the anti-majoritarian view of standing Justice Scalia had been constructing since *NWF*, to limit standing in citizen suits so that the Executive can "lose or misplace" laws enacted by Congress. As presented to the Court, *Laidlaw* appeared to be a case in which the Court was to resolve a conflict among the circuit courts of appeals over mootness, i.e., does a defendants' post-litigation compliance with its Clean

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165. *Id.* at 669.
166. *Id.* at 675.
167. 120 S. Ct. 693 (2000).

Water Act permit moot a citizen's claim for civil penalties under the Act?[168] But to decide the narrow question upon which certiorari was granted, the Court had "an obligation to assure [itself] that FOE had Article III standing at the outset of the litigation."[169] In doing so, the Court, as we will see, returned standing to its 1970s vitality.

Laidlaw began as a routine citizen suit under the Clean Water Act against a permittee which was allegedly violating its permit limits, as evidenced by the discharge monitoring reports it had filed with the state.[170] *Laidlaw* first sought to avoid the citizen suit by soliciting and subjecting itself to a sweetheart prosecution by the state, and then moving to dismiss the citizen suit as barred under the CWA by the state's prior action.[171] However, finding that FOE had standing "albeit 'by the very slimmest of margins'"[172] and the state action had not been diligently prosecuted, the District Court denied Laidlaw's motion to dismiss.[173] Laidlaw then brought itself into compliance and moved to dismiss the case as moot, since it now was solely about civil penalties for past violations, citing *Steel Co.* as authority. The Court of Appeals agreed with Laidlaw and ordered the case dismissed.[174] The Court then granted certiorari to decide the mootness question; but before it could reverse the Court of Appeals order, the Court had to independently satisfy itself that FOE had standing. It is on the Court's standing analysis that we will focus.

First, the Court had to consider whether FOE had alleged constitutionally sufficient "injury-in-fact."[175] Laidlaw argued that there was "'no demonstrated proof of harm to the environment'"[176] from its mercury discharge violation so that the "'violations at issue … did not result in any health risk or environmental harm'"[177] and that FOE's "vague affidavits"[178] which contained only "unsupported

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168. *See id*. at 703.

169. *Id*. at 704.

170. *See id*. at 701-702.

171. *See id*. at 702.

172. *Id.* (citing Tr. of Hearing 39-40 (June 30, 1993) at 207-208, Laidlaw, 890 F. Supp. 470 (D.S.C., 1995) (No. 97-1246 (C.A.4)).

173. *See* Laidlaw, 890 F. Supp 470, 499 (D.S.C. 1995). "Laidlaw drafted the state-court complaint and settlement agreement, filed the lawsuit against itself, and paid the filing fee." *Id.* at 489. "[T]he settlement agreement . . . was entered into with unusual haste, without giving the [Friends of the Earth] the opportunity to intervene." *Id.* at 489. And "in imposing the civil penalty . . . [the State] failed to recover, or even to calculate, the economic benefit that Laidlaw received by not complying with its permit." *Id.* at 491.

174. *See* Laidlaw, 149 F. 3d 303 (4th Cir. 1998).

175. Laidlaw, 120 S. Ct. at 704 (citing Lujan v. Defenders of Wildlife, 504 U.S. 555 (1992)).

176. *See id.* (citing Laidlaw, 956 F. Supp. at 602).

177. Laidlaw, 120 S. Ct. at 704.

178. *Id*. at 713 (Scalia, J., dissenting).

and unexplained . . . allegations of 'concern', . . . cast into doubt the (in any event inadequate) proposition that 'subjective concerns' actually affected their conduct."[179] Given *NWF* and *Defenders of Wildlife*, one would have thought that Laidlaw's argument was quite powerful, since those cases refused to "find standing based on the 'conclusory allegations of an affidavit' . . . ."[180] Indeed, even the District Court was troubled, finding standing to exist by only "'the very slimmest of margins.'"[181] That finding having been made years before the trial court's subsequent finding that Laidlaw discharges did not result in any environmental harm or health risks, would be subject to "reexamination, particularly if later evidence proves inconsistent with [the initial standing conclusion.]."[182]

But to the majority, this was not even a close case on standing. First, the lack of environmental harm was constitutionally irrelevant. "The relevant showing for purposes of Article III standing, however, is not injury to the environment but injury to the plaintiff."[183] The Court emphatically continued: "[t]o insist upon the former rather than the latter as part of the standing inquiry (as the dissent in essence does . . .) is to raise the standing hurdle higher than the necessary showing for success on the merits . . . ."[184] Focusing its analysis solely on the harm to plaintiff, the Court was untroubled by the supposed *de minimus* allegations of injury. Unlike the District Court, which found injury in fact by the very slimmest of margins, the Court simply announced "the District Court found that FOE had demonstrated sufficient injury to establish standing."[185] Returning to the foundational principles of standing, the Court found the affidavits to have "adequately documented injury in fact"[186] because, as the Court reminded us from *Sierra Club v. Morton*, "environmental plaintiffs adequately allege injury in fact when they aver that they use the affected area and are persons 'for whom the aesthetic and recreational values of the area will be lessened' by the challenged activity"[187] and "'[o]f course, [ironically quoting Justice Scalia's use of *Sierra Club* in *Defenders of Wildlife*], the desire to use or

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179. *Id.* at 714.

180. *Id.* at 715 (*citing* Lujan v. National Wildlife Federation, 110 S. Ct. 3177).

181. *Id.* at 714 (citing Tr. of Hearing 39-40 (June 30, 1993) at 207-208, Laidlaw, 890 F. Supp. 470 (D.S.C., 1995) (No. 97-1246 (C.A.4)).

182. *Id at 715.*

183. *Id.* at 704.

184. *Id.*

185. *Id.*

186. *Id.* at 705.

187. *Id.* (quoting from Sierra Club v. Morton, 405 U.S. 727, 735 (1972)).

observe an animal species, even for purely esthetic purposes is undeniably a cognizable interest for purposes of standing.'"[188] Thus, allegations that plaintiffs' members lived near the river into which the pollutants were discharged and that they no longer picnic, hike, birdwatch, or drive near the river or wade, swim, and boat in the river because of concern for the harmful effects of the discharges were nonspeculative, nonconclusory assertions of "reasonable concerns about the effects of those discharges, [which] directly affected those affiants' recreational, aesthetic, and economic interests."[189] Thus, to the Court, the plaintiff's standing case was routinely adequate, well within *NWF* and *Defenders of Wildlife*, and affidavits of "'subjective'" fear from pollution were "entirely reasonable;" it was "enough for injury in fact."[190]

Laidlaw next argued that even if FOE alleged sufficient injury in fact, that injury was not redressible by the sole relief pending before the court, civil penalties payable to the federal government.[191] Based upon *Steel Co.*, this would seem to be a winning argument. After all, in *Steel Co.*, the plaintiff did not have standing to seek civil penalties for wholly past violations because the penalties, which would flow to the federal treasury provided no redress to plaintiffs.[192] FOE was also seeking civil penalties for past violations. Thus, if civil penalties failed to provide redress in *Steel Co.*, why should it in *Laidlaw*? The only difference was that *Steel.Co.* came into compliance after they received plaintiffs' 60 day notice of suit letter, but before suit was filed, whereas Laidlaw came into compliance after suit was filed.[193] Apparently, that difference is critical. The Court used it to justify a reconsideration of civil penalties as redress, a topic given little analysis in *Steel Co.* On reexamination, the views of Justice Stevens' dissent now prevailed: civil penalties deter future violators and so provide redress for injury in fact.

On the topic of deterrence the Court was now emphatic:

> We have recognized on numerous occasions that "all civil penalties have some deterrent effect." More specifically, Congress has found that civil penalties in Clean Water Act cases do more than promote

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188. *Id.* (citing Lujan v. Defenders of Wildlife, 504 U.S. at 562-563 (1992)).
189. *Id.*
190. *Id.* at 706.
191. *Id.*
192. *Id.* at 703 (citing Laidlaw, 149 F. 3d 303 at 306-307 (4th Cir. 1998)).
193. *Id.* at 707-708.

> immediate compliance by limiting the defendant's economic incentive to delay its attainment of permit limits; they also deter future violations. This congressional determination warrants judicial attention and respect.
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> It can scarcely be doubted that, for a plaintiff who is injured or faces the threat of future injury due to illegal conduct ongoing at the time of suit, a sanction that effectively abates that conduct and prevents its recurrence provides a form of redress. Civil penalties can fit that description. To the extent that they encourage defendants to discontinue current violations and deter them from committing future ones, they afford redress to citizen plaintiffs who are injured or threatened with injury as a consequence of ongoing unlawful conduct.[194]

Moreover, the Court explained, for civil penalties to deter violations, there must be a credible threat that they will be imposed. As a matter of human nature, Congress could reasonably conclude "that an actual award of civil penalties does in fact bring with it a significant quantum of deterrence over and above what is achieved by the mere prospect of such penalties."[195]

> [T]here may be a point at which the deterrent effect of a claim for civil penalties becomes so insubstantial or so remote that it cannot support citizen standing. The fact that this vanishing point is not easy to ascertain does not detract from the deterrent power of such penalties in the ordinary case . . . . Here, the civil penalties . . . carried with them a deterrent effect that made it likely, as opposed to merely speculative, that the penalties would redress FOE's injuries . . . .[196]

Even more important, for purposes of standing analysis, the Court reaffirmed that it was for Congress, not the courts, to make the

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194. *Id*. at 706-07 (citations omitted).
195. *Id.* at 707.
196. *Id.*

general determination as to what legal sanctions will best affect policy goals:

> How to effectuate policy — the adaptation of means to legitimately sought ends — is one of the most intractable of legislative problems. Whether proscribed conduct is to be deterred by qui tam action or triple damages or injunction, or by criminal prosecution, or merely by defense to actions in contract, or by some, or all, of these remedies in combination, is a matter within the legislature's range of choice. Judgment on the deterrent effect of the various weapons in the armory of the law can lay little claim to scientific basis.[197]

In other words, subject to some undefined outer constitutional limit, Congress has the power to define, for constitutional standing purposes, what remedies (even if wholly public) will redress (at least in part) a citizen's injuries. Apparently, *Steel Co.* now stands for the extraordinarily narrow proposition that standing will be denied if the suit seeks only civil penalties for wholly past violations that have fully abated prior to suit.[198] *Laidlaw* now provides the rule for that class of cases in which the "violations that are ongoing at the time of the complaint and that could continue into the future if undeterred."[199] In these cases, as of the time of filing the complaint, the remedy of civil penalties can redress the harm from the violations that exist as of the filing, and thus, supports standing. If after commencement of suit, the violations cease, then a defendant can seek dismissal on grounds of mootness, if it can prove to the court absolutely clearly that "'the allegedly wrongful behavior could not reasonably be expected to recur.'"[200]

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197. *Id.* (quoting "Justice Frankfurter's observations for the Court, made in a different context nearly 60 years ago, [which] hold true here as well . . . .").

198. *Id.* at 707-708.

199. *Id.* at 708.

200. *Id.* at 708. (In seeking to establish mootness, the defendant has a "heavy burden of persuasion." (citing United States v. Concentrated Phosphate Export Assn., 393 U.S. 199, 203 (1968))). On this point Justice Stevens, concurring, noted "that the case would not be moot even if it were absolutely clear that respondent had gone out of business and posed no threat of future permit violations. The District Court entered a valid judgment requiring respondent to pay a civil penalty of $405,800 to the United States. No post-judgment conduct of respondent could retroactively invalidate that judgment." *Id.* at 712 (Stevens, J. concurring). Furthermore, "civil penalties . . . for purposes of mootness analysis, should be equated with punitive damages rather than with injunctive or declaratory relief. No one contends that a defendant's

Justice Scalia, with whom only Justice Thomas joined, dissented "from all of this."[201] As to injury in fact, Justice Scalia believed there was no injury because of the lack of harm to the environment and because the affidavits presented "nothing but 'subjective apprehensions.'"[202] The dissent complains that although, even to the District Court standing was found only "by the very slimmest of margins," the Court has just rewritten standing jurisprudence:

> Inexplicably, the Court is untroubled by this, but proceeds to find injury in fact in the most casual fashion, as though it is merely confirming a careful analysis made below. Although we have previously refused to find standing based on the "conclusory allegations of an affidavit" the Court is content to do just that today. By accepting plaintiffs' vague, contradictory, and unsubstantiated allegations of "concern" about the environment as adequate to prove injury in fact, and accepting them even in the face of a finding that the environment was not demonstrably harmed, the Court makes the injury-in-fact requirement a sham.[203]

As to the redressability prong of standing, Justice Scalia adamantly objects to the Court's "cavalier" treatment of *Steel Co.* because it only involved past violations, and to the Court's suggestion that a "penalty payable to the public 'remedies' a threatened private harm . . . ."[204] To Justice Scalia, public remedies for private harms fall within the universe of "generalized grievances."[205] Just as a generalized harm cannot support injury in fact, so to, in his view "a generalized remedy that deters all future unlawful activity against all persons cannot satisfy the remediation requirement, even though it deters (among other things) repetition of this particular unlawful activity against these particular plaintiffs."[206] In *Laidlaw*, the Court has turned Justice Scalia's

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post-complaint conduct could moot a claim for punitive damages; civil penalties should be treated the same way." *Id.* (Stevens, J., concurring) (internal citations omitted).

201. *Id.* at 713.
202. *Id.* at 714.
203. *Id.* at 715 (citation omitted).
204. *Id.*
205. *Id.* at 716.
206. *Id.*

jurisprudence on its head by converting "'an undifferentiated public interest'" into an 'individual right' vindicable in the courts."[207] In *Laidlaw*, "[a] claim of particularized future injury has today been made the vehicle for pursuing generalized penalties for past violations, and a threshold showing of injury in fact has become a lever that will move the world."[208]

Justice Scalia also objects to the Court's uncritical acceptance of Congress' finding that civil penalties deter future conduct. To Justice Scalia, this "deterrent effect is . . . 'speculative as a matter of law.'"[209] Although he agrees that, at a general level, '"all civil penalties have some deterrent effect,'"[210] no prior case has focused on the particular deterrence of a particular penalty on a particular defendant. While the marginal deterrent effect of civil penalties on Laidlaw may be, theoretically greater than zero, to Justice Scalia, "it is entirely speculative whether it will make the difference between these plaintiffs' [sic] suffering injury in the future and these plaintiffs' [sic] going unharmed,"[211] and he rejects Congress' policy findings as determinative — the Court must make its own independent inquiry. He concludes his standing dissent with the frustration that in *Laidlaw* the Court has undone his standing jurisprudence:

> In sum, if this case is, as the Court suggests, within the central core of "deterrence" standing, it is impossible to imagine what the "outer limits" could possibly be. The Court's expressed reluctance to define those "outer limits" serves only to disguise the fact that it has promulgated a revolutionary new doctrine of standing that will permit the entire body of public civil penalties to be handed over to enforcement by private interests.[212]

While he is correct that his standing doctrines have been rejected, they have not been replaced with a "revolutionary new doctrine." Instead, his attempt in *NWF* and *Defenders of Wildlife* to fashion a new

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207. *Id.* at 717 (citing Lujan v. Defenders of Wildlife, 504 U.S. 555, 577 (1992); Steel Co. v. Citizens for a Better Environment, 523 U.S. 83, 106 (1998)).

208. *Id.*

209. *Id.*

210. *Id.* at 718 (quoting the majority opinion at 706, which cites Hudson v. United States, 522 U.S. 93, 102 (1997).

211. *Id.*

212. *Id.* at 719.

doctrine of standing has not been successful. In *Lujan*, his theoretical view on standing, particularly injury in fact, only garnered a plurality of the Court. But first in *Akins*, and then in *Laidlaw,* his views on the general versus the particular have been rejected. Taken together, *Akins* and *Laidlaw* suggest that within some "outer limits" yet to be defined, Congress has the power to define statutory harm (e.g. information deprived of voters) and redressability for purposes of standing. Moreover, originally defined in *Sierra Club, SCRAP* and *Duke Power*, injury in fact is to be only a minimal hurdle, not a castle wall to be scaled. Thus, standing doctrine is not confined to 19th century conceptions of private law, but is large enough to address modern regulations designed to diminish "probabilistic"[213] harms.

VII. CONCLUSION

Laidlaw is important for several reasons. It acknowledges Congress' power to define injury in fact, causation and redress. It allows those injuries to be probabilistic. It, therefore, reaffirms the central premise in *SCRAP* that "[t]o deny standing to persons who are in fact injured simply because many others are also injured, would mean that the most injurious and widespread government actions could be questioned by nobody."[214] *Laidlaw* also brings the concept of standing into line with basic economic principles. By allowing civil penalties that will prospectively deter illegal behavior, the Court constitutionally recognizes the probabilistic role of costs and incentives in influencing behavior. To the extent that civil penalties make illegal behavior more expensive to a violator than legal conduct would, the violator will not benefit from its violation, but be worse off. By placing violators in a worse position than those in compliance are civil penalties will, on average, change behavior and abate the threatened injury.[215]

In the context of climate change, *Laidlaw* will open up the courts to citizens. Under Justice Scalia's standing theory, because increases in CO_2 concentration affect changes in the climate globally, everyone is harmed so no one could complain. Moreover, because the consequences of incremental increases in CO_2 concentrations are slow to be appreciated, and hard to identify in the specific instance,

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213. CASS SUNSTEIN, AFTER THE RIGHTS REVOLUTION: RECONCEIVING THE REGULATORY STATE 215 (1990).

214. SCRAP, 412 U.S. at 687-88.

215. *See* Hodas, *supra* note 12, at 1604-1615.

(they can only be observed as statistical phenomena) no one could claim direct injury.

However, from the perspective of classic economics, the external costs of CO_2 emissions are greater than $0.0, and therefore the emitters are imposing a cost on all others.[216] Although the precise valuation of these environmental costs is subject to ongoing debate, the environmental harms are real and the costs greater than zero.[217] *Laidlaw* permits Congress constitutionally to designate these costs as real, to be harm for purposes of standing, and to have policy instruments that respond to the problem to be redress.

Allowing standing to review governmental decisions and to allow citizen suit enforcement is a good thing. Enhanced transparency and accountability leads to improved and more legitimate government decisions. Promoting citizen participation enhances the democratic process. In the context of climate change, improved quality control is essential because of the danger of sham credits, "hot air," and the myriad of other ways that emission can be reduced on paper but not in fact. Because compliance requires the oversight of far flung projects almost too numerous to count, standing to challenge climate change decisions is vital. *Laidlaw* will allow all of us not only to complain, but do something about the weather.

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216. Efforts to quantify these costs have resulted in a wide spectrum of estimates, but all of them agree that the harms are greater than $0. Most recently the Minnesota Public Service Commission set the environmental costs of CO_2 emissions used to calculate the external costs created by new electricity generation projects; the costs fall in a range from $.030 to $3.10 per ton of CO_2 emissions. *See In re* Quantification of Environmental Costs, 578 N.W. 2d 794 (Minn. App.1998). Currently about half the states take environmental costs into account. *See* ENERGY INFORMATION AGENCY, ELECTRICITY GENERATION AND ENVIRONMENTAL EXTERNALITIES: CASE STUDIES (1998).

217. *See generally,* RICHARD L. OTTINGER, ET AL., ENVIRONMENTAL COSTS OF ELECTRICITY (1990).

CONTRACTUAL ARCHITECTURE FOR THE KYOTO PROTOCOL: FROM SOFT AND HARD LAWS TO CONCRETE COMMITMENTS

IBIBIA L. WORIKA AND THOMAS WÄLDE*

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I. INTRODUCTION

Despite the varying analyses and evaluations of global climate change risks,[1] there is widespread consensus on the importance of international cooperation in efforts to address the problem of greenhouse gas emissions (GHGs). Such concerted international action was evident in the recently concluded Kyoto summit on Climate Change, which culminated in the Kyoto Protocol ("the

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1. On the issue of the greenhouse effect, its evidence, and the long-term consequences of global warming, see Ved P. Nanda, *Global Warming and International Environmental Law – A Preliminary Inquiry*, 30 HARV. INT'L L.J. 375, 378-81 (1989). S*ee also* Durwood Zaelke & James Cameron, *Global Warming and Climate Change – An Overview of the International Legal Process*, 5 AM. U. J. INT'L L. & POL'Y 249, 249-88 (1990).

Protocol").[2] The Protocol affirmed the worthiness of some flexible mechanisms, but left much to the imagination on how to use or implement them.[3]

This paper attempts an innovative contribution to the Kyoto Protocol by shifting the emphasis from mere soft and hard law prescriptions to concrete contractual commitments. It focuses on the contractual strategies and mechanisms which favour international cooperation, rather than on measures with a domestic impact.[4] With the Buenos Aires Action agreement in November 1998,[5] attention is now rapidly turning to the detailed design issues of the flexible mechanisms. These design issues will be of critical importance to the issues raised in this paper.

This paper advocates the view that soft and hard law prescriptions cannot by themselves achieve the overall objective of the global climate change regime without concrete contractual commitments. Concrete contractual commitments attempt to achieve two interrelated but distinct objectives. First, they set to further bind the private and/or legal entities, such as the parties to the Kyoto Protocol, into actuating practical undertakings. Second, they provide the bedrock upon which effective execution of soft and hard law prescriptions under the global climate change regime can

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2. *See Kyoto Protocol to the United Nations Framework Convention on Climate Change* (SEBASTIAN OBERTüR & HERMAN E. OTT, THE KYOTO PROTOCOL: INTERNATIONAL CLIMATE POLICY FOR THE 21ST CENTURY 313, app. (1999)) [hereinafter Protocol]. (The main features of this Protocol are tripodal: (1) It is legally binding. (2) Industrialized countries agreed to limit their GHGs to certain targets by the years 2008-2012. (3) The so called 'flexibility mechanisms' to be adopted by countries in achieving their targets). For a lively legal commentary on the Protocol, see Clare Breidenich et al., *The Kyoto Protocol to the United Nations Framework Convention on Climate Change*, 92 AM. J. INT'L L. 315, 315-31 (1998). *See generally* Peter G. G. Davies, *Global Warming and the Kyoto Protocol*, 47 INT'L & COMP. L.Q. 446, 446-461 (1998); Farhana Yamin, *The Kyoto Protocol: Origins, Assessment and Future Challenges*, 7 REVIEW OF EUROPEAN COMMUNITY & INTERNATIONAL ENVIRONMENTAL LAW [hereinafter RECIEL] 113, 113-127 (1998).

3. *See* Roger A. Sedjo, *Harvesting the Benefits of Carbon "Sinks,"* 133 RESOURCES FOR THE FUTURE 10, 10-13 (Fall, 1998).

4. However this is not to detract from the significance of domestic measures in achieving the overall objective of the global climate change regime. Measures with a domestic impact include regulations, economic instruments and incentives, voluntary agreements and actions, information, education and training, research, development and demonstration. *See* Karen Campbell, *From Rio to Kyoto: The Use of Voluntary Agreements to Implement the Climate Change Convention*, 7 RECIEL 159, 159-169 (1998).

5. *See United Nations Framework Convention on Climate Change, Fourth Meeting*, (UNFCCC) June 4, 1992, S. Treaty Doc. No. 102-38. Oil producing nations expressed deep concerns about the likelihood of their economies being severely damaged by some of the measures envisioned under the Kyoto Protocol. *See Oil producers' concerns must be addressed, OPEC tells COP4*, OPEC BULLETIN, Nov. 1998, at 13; *DCs seek "comprehensive package" of measures from COP4 - Effendi*, OPEC BULLETIN, Nov. 1998, at 14.

be undertaken. The exact nature and scope of such commitments, which constitute the focus of this writing, will be set out in four major sections. Section II provides a theoretical framework. Section III briefly examines the flexible mechanisms. Section IV examines possible contractual precedents for implementing the flexible mechanisms. Section V appraises those contractual precedents. Finally, section VI summarizes the conclusions of this article.

II. A THEORETICAL FRAMEWORK

The following analyses briefly attempt to establish a general contractual architecture for the flexible mechanisms.[6] The phrase "contractual architecture" is used here to mean the conceptual structure and logical organization of a contract. A contract is defined, subject to some qualifications, as "an agreement giving rise to obligations which are enforced or recognized by law."[7]

The question may be asked, what distinguishes "contract" law from "soft" and "hard" laws, considering that they all give rise to obligations? This query is further underscored by the fact that both hard law and contract law give rise to obligations which may be interpreted and enforced by courts or other authoritative tribunals. Here, the term "hard law" is used with reference to legally binding and enforceable international agreements of a multilateral nature between state parties. Arguably, the United Nations Framework Convention on Climate Change (UNFCC) and the supplementary Kyoto Protocol are ready examples. On the other hand, the term "contract law" is used with reference to an agreement between private or public entities participating in the flexible mechanisms envisioned under the Kyoto Protocol.

Much controversy remains regarding the precise nature and scope of soft law obligations.[8] Three circumstances exist in which the term "soft law" has been applied. The first of these relates to emerging norms or principles which may be adopted either formally or as a matter of practice. The second circumstance relates to rules which may not have binding effect or be fully enforceable, but which nevertheless possess some discernible legal status or effect on international law. Third, soft law may also refer to a transitory phase

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6. *See generally* Fanny Missfeldt, *Flexibility Mechanisms: Which Path to Take after Kyoto?*, 7 RECIEL 128, 128-139 (1998).

7. G. H. TREITEL, AN OUTLINE OF THE LAW OF CONTRACT 1 (9th ed. 1995).

8. *See generally* Oscar Schachter, *Twilight Existence of Nonbinding International Agreements*, 71 AM. J. INT'L L. 296, 296-304 (1977).

in the evolution of norms with vague content and imprecise scope.[9] The Rio Declarations on the Environment and Development and Agenda 21 are examples of soft law prescriptions.[10]

III. FLEXIBLE MECHANISMS OF THE KYOTO PROTOCOL : A BRIEF REVIEW

An understanding of the contractual architecture for the Kyoto Protocol requires an appreciation of the flexible mechanisms on which it is based. This section briefly establishes a foundation to make the overall subject matter more intelligible.

A. Joint Implementation (JI)

Annex I Parties can trade (i.e., transfer to, or acquire from, another) among themselves emission reduction units (ERUs) resulting from projects aimed at reducing emissions by sources or enhancing removals by sinks in any sector of the economy.[11] The ERUs can be used to contribute to their emission reduction targets under the Protocol.

B. The Clean Development Mechanism (CDM)

The Clean Development Mechanism was prescribed in the Protocol to assist non-Annex I parties (i.e. developing countries) in achieving sustainable development, contribute to the ultimate objective of the Convention, and assist Annex I parties (i.e. developed countries) in achieving compliance with their emissions reduction targets.[12] Other features of the CDM will be discussed in subsequent sections.

C. Emissions Trading (ET)

Parties are allowed to participate in an emissions trading system, which allows developed countries to buy and sell emission credits to fulfil their commitments under the Protocol.[13] For example, if the United Kingdom (UK) was faced with the exhaustion of its

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9. *See* Steven A. Kennett, *Hard Law, Soft Law and Diplomacy: The Emerging Paradigm for Intergovernmental Cooperation in Environmental Assessment*, 31 ALTA L. REV. 644, 646-7 (1993).

10. *See* 1 PHILIPPE SANDS, PRINCIPLES OF INTERNATIONAL ENVIRONMENTAL LAW 48, 185 (1995).

11. *See* Protocol, *supra* note 2, art. 6.

12. *See id.*, art. 12(2); *Dealing with Carbon Credits After Kyoto*, JOINT IMPLEMENTATION Q., June, 1998, at 6 [hereinafter *Carbon Credits*]; *see also* Jyoti K. Parikh, *Joint Implementation and North-South Cooperation for Climate Change*, 7 INT'L ENVTL. AFF. 22, 22-41 (1995).

13. *See* Protocol, *supra* note 2, art. 16.

quantified emissions limitation reduction (QELR) quota under the Protocol it could buy some or all of the unused quota of Germany or another industrialized country. The UK would then be in a position to use its enlarged credit to increase its total allowable emissions under the Protocol.[14]

A summary of the similarities and differences between these various flexible mechanisms is illustrated in Table 1 below.

IV. CONTRACTUAL ARCHITECTURE FOR THE KYOTO PROTOCOL

This section examines contractual precedents that can extract concrete commitments from the parties. Adherence to such precedents should facilitate the achievement of the overall objective of the Kyoto Protocol.

A. What is the Substance of Contracts for the Flexible Mechanisms?

The substance of any contract for the flexible mechanisms would depend on the type of mechanism in question. Despite the major differences between these various mechanisms (Joint Implementation, Emission Trading, and Clean Development Mechanism) under the Protocol,[15] the following appear to be minimally central to any contract advancing the flexible mechanisms:

> They may be *commercial, quasi-commercial or intergovernmental agreements*.[16]

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14. *See id.*, art. 3(10).

15. *See* Laura B. Campbell, *Emission Trading, Joint Implementation and the Clean Development Mechanism: The Role of the Private Sector and other State Actors in Implementation*, *in* GLOBAL CLIMATE GOVERNANCE: INTERLINKAGES BETWEEN THE KYOTO PROTOCOL AND OTHER MULTILATERAL REGIMES 7-12 (1998).

16. *See* UNITED NATIONS COMMISSION ON INTERNATIONAL TRADE LAW (UNCITRAL) MODEL LAW ON INTERNATIONAL COMMERCIAL ARBITRATION, U.N. GOAR, U.N. Doc. A/4/17 (1985), *reprinted in* HOWARD M. HOLTZMANN & JOSEPH E. NEUHAUS, A GUIDE TO THE UNCITRAL MODEL LAW ON INTERNATIONAL COMMERCIAL ARBITRATION: LEGISLATIVE HISTORY AND COMMENTARY 26 (1989).

The term "commercial" should be given a wide interpretation so as to cover matters arising from all relationships of a commercial nature, whether contractual or not. Relationships of a commercial nature include, but are not limited to, the following transactions: any trade transactions for the supply or exchange of goods or services; distribution agreement; commercial representation or agency; factoring; leasing, construction of works; consulting; engineering; licensing; investment; financing; banking; insurance; exploitation agreement or concession; joint venture and other forms of industrial or business co-operation; carriage of goods or passengers by air, sea, rail or road. *Id.*

Table 1:
Summary of Similarities and Differences Between the Flexible Mechanisms

Criteria	Joint Implementation	Emissions Trading	Clean Development Mechanism (CDM)
Objectives	To reduce Green House Gases (GHS)	To reduce GHG	To reduce GHG and achieve sustainable development
Situation envisaged	Joint implementation of project activities	International trading of emissions	Joint implementation of CDM project activities
Status of parties and participants	Annex I countries, private and or public entities	Annex I countries	Annex I and non-Annex I countries, including private and/or public entities
Method of Certification	Transfer of Emission Reduction Units (ERUS)	'Caps and allowances' or 'Credit and baseline' approach	Certified Emission Reductions (CERs)
Certifying authority	Participating Annex I Countries	Conference of the Parties (COP)	Operational entities to be designated by COP
Remuneration	Certified ERUs	Certified ERUs	Proceeds from certified project activities and CER units
Banking	Banking of ERUs not allowed until 2008	Silent on banking	Banking of CERs allowed from 2000
Interests of the actors	Compliance with quantified emission limitation reduction objectives (QELROs); serves as potential alternative to domestic action	Compliance with QELR commitments; potential alternative to domestic action	Compliance with QELR commitments; could be alternative to domestic action by Annex I countries; avenue for financial flows and transfer of technology to non-Annex I countries
Financial Mechanism	Requires financial outlay for Activities Implemented Jointly/ Joint Implementation (AIJ/JI) projects;* bilateral and multilateral channels	No specific financial outlay required	Requires financial outlay for Clean Development Mechanism (CDM) projects; CDM to assist in arranging funding
Institutional Arrangements	COP serves as meeting of the Parties and secretariat	COP serves as meeting of the Parties and secretariat	Under the supervision of an executive board of the CDM, but COP has authority and guidance

Source: Compiled by authors

* Enables a government or company that contracts with a party in another country to implement an activity that reduces GHS in the other country. *See* AIJ WORLD BANK GROUP STRATEGY (visited Aug. 26, 2000) <http://www-esd.worldbank.org/aij/green.htm>.

They envisage *long-term* arrangements.[17]

Strictly speaking, a commercial agreement would involve private legal entities desirous of making a profit. Where a sponsor and a host government are involved, the introduction of this service element would dilute the commerciality of such agreements into a quasi-commercial status. However, an agreement between two governments for emissions trading, JI, or CDM would quite simply be an intergovernmental agreement. Environmental fundamentalists

> They all possess an *international* element.[18]
>
> The CDM involves the *transfer of appropriate technological know-how and financial resources* to the host (developing) country.[19] JI also involves the mutual transfer of technology and financial resources between the participant countries.
>
> In the CDM, the home country should be able to gain credit by using certified emission reductions (CERs) accruing from such CDM project activities. In the JI projects and emissions trading parties either gain or lose ERUs.[20]

In addition, for both JI and CDM projects, the contract document would need to include a definition of the project. It would also need to include commitments by the donor regarding financial investment, GHGs reductions, project performance, technology cooperation and sustainable development. Further, the contract would require commitments from the host country regarding site and project ownership, and provision of goods and support services necessary for effective project operation and sustainable development.

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would understandably be incensed at the use of the word "commercial" as an attempt to dilute the environmental objectives of the flexible mechanisms. But, the hard fact is, in today's world no private legal entity would undertake any venture associated with these flexible mechanisms without the requisite financial incentives.

17. These are those arrangements "involving the performance of continuing obligations over a lengthy period of time." NAGLA NASSAR, SANCTITY OF CONTRACTS REVISITED: A STUDY IN THE THEORY AND PRACTICE OF LONG-TERM INTERNATIONAL COMMERCIAL TRANSACTIONS 1 (1995). The combined effects of Articles 3(1)-(2), (7) and 12(10) of the Protocol clearly envisage long-term commitments. Indeed by 2005, each Annex I party "shall . . . have made demonstrable progress in achieving its commitments under this Protocol." Protocol, *supra* note 2, art. 3(2).

18. "International" is used to refer to those projects which have a foreign element, as opposed to those based squarely within the domestic or national set up. *See* NASSAR, *supra* note 17, at 1.

19. *See Summary of the Expert Group Meeting on the Clean Development Mechanism and Sustainable Industrial Development: New Partnerships for Industry in Developing Countries* (Vienna, Austria, Oct. 1-2, 1998) (visited Aug. 26, 2000) <http://www.iisd.ca/download/asc/sd/sdvol19no1e.txt>; *Carbon Credits*, *supra* note 12, at 6.

20. CERs and ERUs arising from CDM and AIJ/JI projects should have a cash value which, presumably, makes the project viable from a donor's point of view. Where credits are shared between two or more parties, both will have a clear interest in maximizing, or even overestimating, the number of credits available from the project. Contractual provisions should be very clear on methods for accurately assessing such credits.

Other specific aspects to be covered in any JI and CDM contract should include the following:

> Arrangements for ownership of project site, project, CERs and ERUs arising from project;
>
> Detailed identification and quantification (over full life cycle of project) of GHGs sources and sinks at the site that are included in the emissions baseline, together with assumptions and uncertainties;
>
> A project schedule and timetable, including the period during which emission reductions will take place with year-to-year forecasts of reductions;
>
> Estimated total CO_2-equivalent emission reductions accruing to the donor-investor (and host of credits to be shared) over a specified period;
>
> Emissions monitoring processes and data collection procedures;
>
> Procedures for updating estimates of emission reductions;
>
> Arrangements for independent auditing and external verification and certification;
>
> Assuming no certification takes place before the transfer of credits, enforcement mechanisms will need to be provided in the event of non-compliance by either party or parties; and
>
> Penalty arrangements in the event of non-compliance by either party, particularly in the event of emission reductions being lower than estimated.

Finally, for CDM projects, the contract should explicitly detail the components of "sustainable development" that are expected to be achieved by the non-Annex I countries. The contract should also explain the share of proceeds to be allocated to cover administrative expenses and assistance to parties for adaptation to climate change.

The next issue that necessarily arises is whether it is possible to achieve standardized agreements for these flexible mechanisms.

B. Can there be a Standardized Contract for the Flexible Mechanisms?

Standardization[21] has generated much controversy in the realms of contract law. The arguments against standardized agreements that encompass flexible mechanisms contend that there are basic situational differences that cannot be discountenanced, even in the pursuit of a common goal. None of the flexible mechanisms would be the same in every country in which they are undertaken. Assuming this assumption as true, it would appear that standardization could defeat the premises for flexibility and dynamism in achieving contractual objectives. Again, considering the prevalence of unique socio-economic and political circumstances in different countries, and indeed the differential nature of the various flexible mechanisms, it is difficult not to sympathize with the case-by-case approach. Additionally, it is not uncommon to find that a contracting party or financier has their own contract culture, which would further make fashioning and drafting common contract provisions very difficult, if not impossible.

Nevertheless, it appears that standardization is gradually creeping into long-term international commercial contracts and quasi-commercial contracts, as it lends itself to advantages that the case-by-case approach can not easily match.[22] Some of the advantages of standardization are:

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21. Curiously, the term "standardization" is not easily susceptible to a precise legal definition. It is possible to speak of either international standardization, standardization at the national level, or both. However, considering the international character of the flexibility mechanisms, standardization should be understood in its international context as simply meaning the setting of internationally acceptable contractual terms, rules, or forms for the flexibility mechanism agreements. The critical question regarding standardization is whether the terms, rules or forms must be exactly the same. While this is theoretically possible, in practice standardization does not necessarily preclude peripheral adjustments in order to suit local circumstances.

22. Arguably, standardization is not very common in long-term contracts, but is an instrument for short-term, immediately consumable transactions, typically those of international trade and those traded on exchanges. *See* Thomas W. Wälde, *Modellvertraege und Zwishenstaatliche Kooperationsabkomen: Formen der Verflechtung zwischen Recht und wirtschaft* [*Model Agreements and Intergovernmental Cooperation Agreements*], *in* 1982 JAHRBUCH FUER RECHTSSOZIOLOGIE UND RECHTSTHEORIE [YEARBOOK FOR SOCIOLOGY AND THEORY OF LAW]. However, there is a growing trend in standardizing long-term agreements in the natural resources sector as evidenced by the trend of host countries drawing up similar model contracts to govern such transactions. UNIDO has worked for about 20 years on the BOT and similar contracts. The International Chamber of Commerce (ICC) has some standard terms. The Association of International Petroleum Negotiators (AIPN) has also proposed a standardized Joint Operating Agreement (JOA). Even the World Bank has attempted to

> Standardization facilitates the conduct of commercial/investment transactions, thus saving costs and time;[23]
>
> It facilitates the comparison and evaluation of contractual responsibilities and associated risks, if these are based on the same well-known contractual terms;
>
> Standardization makes financing easier, as financiers would be familiar with the contractual terms;
>
> It enables the parties to plan ahead and to have effective control, monitoring and supervision of projects;
>
> It reduces the private sector's tendency to exploit its financial and technical advantage in the course of negotiations with national or local authorities;
>
> It may facilitate sub-contracting and negotiating of other project-related contracts;
>
> Standardized project agreements are more carefully drafted and, as such, are usually of a higher quality; and
>
> Standardization does not necessarily preclude introducing special conditions if needed, thus ensuring flexibility and dynamism.[24]

It is important to note that even if standardization were possible, there cannot be one standardized agreement for all three flexible mechanisms. Instead, a standardized agreement would be devised

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standardize procurement of works contracts. *See, e.g.*, THE WORLD BANK, STANDARD BIDDING DOCUMENTS: PROCUREMENT OF WORKS (May, 1993); THE WORLD BANK, STANDARD BIDDING DOCUMENTS: PROCUREMENT OF WORKS: SMALLER CONTRACTS (May, 1993); *see also* UNCITRAL LEGAL GUIDE ON DRAWING UP INTERNATIONAL CONTRACTS FOR CONSTRUCTION OF INDUSTRIAL WORKS, U.N. Doc A/CN. 9/SER.B/2 (1988).

23. *See* JOHN TILLOTSON, CONTRACT LAW IN PERSPECTIVE 121-22 (1995).

24. *See generally* UNITED NATIONS INDUSTRIAL ORGANIZATION (UNIDO), UNIDO GUIDELINES FOR THE DEVELOPMENT, NEGOTIATION, AND CONTRACTING OF BUILD-OPERATE-TRANSFER (BOT) Projects (1995 pre-print) 240-41 [hereinafter BOT GUIDELINES].

with respect to a single mechanism. In order to know which possible contractual precedents can be adopted, recourse should be made to existing international investment transaction practices.[25]

C. Contractual Precedents for Flexible Mechanisms

There are a number of contracts[26] which would not squarely fit into any particular flexible mechanism as no flexible mechanism was originally contemplated by such contractual arrangements. Considering the substance of these agreements, however, closer analysis should be given to the Inter-governmental Cooperation Agreements, Concession Contracts, BOT Project Contracts, Joint Venture, Risk Service, and Service Contracts because they contain features which make them more amenable to the type of agreements envisioned under the Protocol.

1. Intergovernmental Cooperation Agreements (ICAs)

Intergovernmental Cooperation Agreements are usually entered into between governments for, and on behalf of, their respective sovereign states. They can be of a general nature (framework) or relate to specific Joint Implementation, emissions trading or Clean Development Mechanism Projects. Figures I and II are simplified diagrammatic representations of these sorts of arrangements.[27]

Figure I: Intergovernmental Framework Agreement

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25. It is, perhaps, pertinent to stress that whichever standard contract is eventually adopted, an arbitration clause should be a sine qua non in every such contract. Such contracts should stipulate, inter alia, the place of arbitration, the languages of arbitral proceedings, the number of arbitrators needed to decide the matter, and how the arbitrators are to be constituted. Sometimes, even detailed procedures could be provided to achieve greater efficiency. *See* HOLTZMANN & NEUHAUS, *supra* note 16, at 6.

26. In general commercial transactions, there are the standard procurement contracts; in natural resource investment contracts, there are the production sharing contracts, the traditional and modern concession contracts, the risk and non-risk service agreements, and the joint venture and hybrid contracts. In the engineering and construction fields, contracts include the build, operate, own (BOO); build, operate, transfer, (BOT); build, own, operate and transfer (BOOT); build, rent, or lease and transfer (BRL)/(BLT); build and transfer immediately (BT); build, transfer and operate (BTO); design, build, finance and operate (DBFO); design, construct, manage and finance (DCMF); modernize, own, operate and transfer (MOOT); rehabilitate, own and operate (ROO); and rehabilitate, own and transfer (ROT). All these various engineering and construction contracts are herein together referred to as "BOT Contracts". *See generally* BOT GUIDELINES, *supra* note 24, at 3. For a discussion of these and various other agreements, see Piero Bernardini, *Development Agreements with Host Governments*, *in* ECONOMIC DEVELOPMENT, FOREIGN INVESTMENT AND THE LAW: ISSUES IN PRIVATE SECTOR INVOLVEMENT AND THE RULE OF LAW IN A NEW ERA 161-174 (R. Pritchard ed. 1996).

27. *See Swiss AIJ Pilot Program--SWAPP Information Network* (visited on Aug. 26, 2000) <http://www.admin.ch/swissaij>.

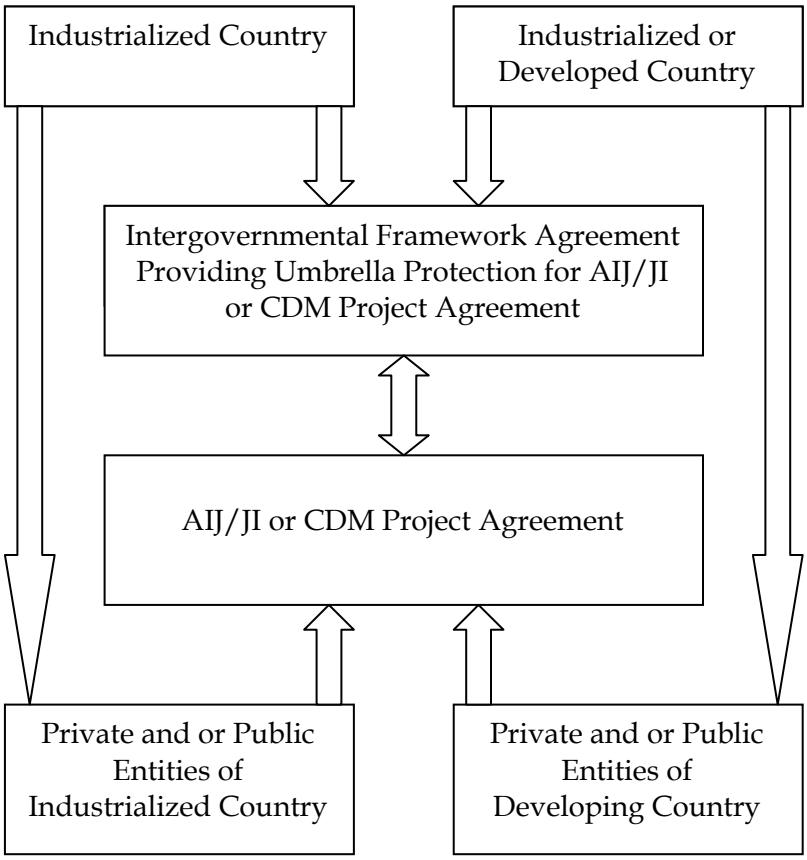
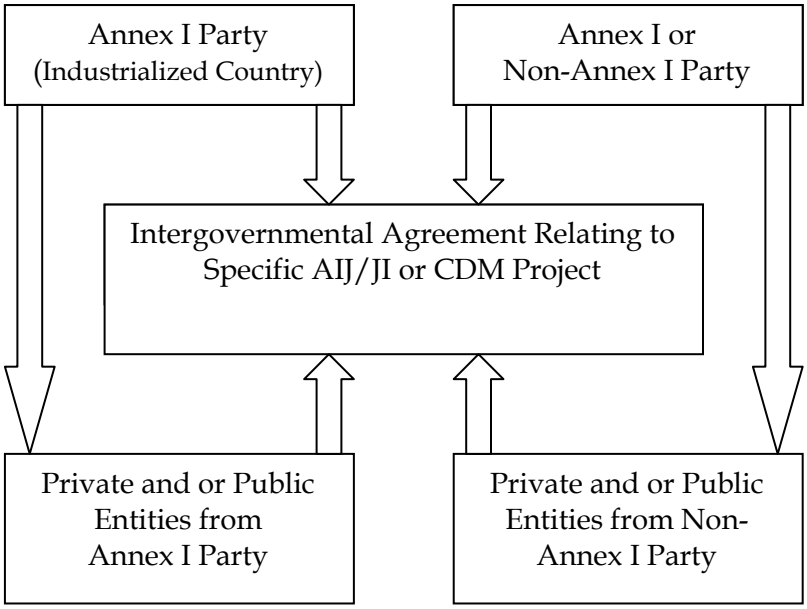

Industrialized Country
Industrialized or Developed Country
Intergovernmental Framework Agreement Providing Umbrella Protection for AIJ/JI or CDM Project Agreement
AIJ/JI or CDM Project Agreement
Private and or Public Entities of Industrialized Country
Private and or Public Entities of Developing Country

Figure II: Intergovernmental Agreement Relating to Specific AIJ/CDM Project



ICAs usually provide, inter alia, "procedures and joint institutions for co-operation programming, for project preparation and evaluation as well as for implementing projects and monitoring their performance."[28] This effort can be complemented by the COP under the Protocol. Intergovernmental agreements relating to specific JI or CDM Projects could contain provisions relating to:

> The partial or full assumption of the risk of non-performance of such projects by their respective home countries, depending on whether projects are initiated by the home states' private or public entities;[29]

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28. Thomas Wälde, *Methods and Mechanisms for International Industrial Enterprise Co-operation*, *in* UNIDO, *Industry 2000 - New Perspectives Collected Background Papers*, Vol. 2, UNIDO/IOD.325, Dec. 1979, at 40.

29. It is suggested that where projects are initiated by the private sector, home states should bear partial assumption of risk. However, home states should bear full assumption of risk for their public sector initiated projects in accordance with the maxim: *qui facit per alum facit per se.*

> Provisions regarding financing and market access conditions to enable the proper and effective implementation of the JI or CDM project;
>
> Host state guarantees regarding the stability of the enabling regulatory regime, including the terms of the JI or CDM agreement; and
>
> Host state guarantees relating to the uninterrupted supply of energy and natural resources, where these are applicable to the AIJ/JI or CDM Project.

Some of the advantages of intergovernmental cooperation agreements include the following:

> This type of agreement seeks to link "project contracts with international law through home state commitments to assume performance responsibility;"[30]
>
> It provides a convenient framework for project agreements on the enterprise level by shielding such enterprises from the vagueness and vicissitudes of host country regulatory regimes;
>
> The reduced number of participants allows commitments to be more concrete and precise in terms of specific sustainable development goals and strategies or quantified emission limitation and reduction objectives (QELROs);
>
> Since they can take a variety of forms, these agreements are flexible in reflecting the degree of state intervention needed in concrete cases of cooperation at the project level; and

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30. Thomas Wälde, *North/South Economic Cooperation and International Economic Development Law: Legal Process and Institutional Considerations*, 23 GERMAN Y.B. INT'L L. 59, 79 (1980).

> The rules or terms of the agreement may be bilaterally negotiated, allowing innovative solutions and a gradual evolution of the entire process.[31]

The main disadvantage of these types of agreements stems from the assumption of equal bargaining power, which is usually not the case even among Annex I parties in JI projects. Indeed, it is likely that unequal bargaining power and the inadequacy or absence of experience on the part of developing countries will result in an AIJ/JI or CDM agreement that reflects this lopsided relationship. The solution lies in drafting such agreements to meet the differing legitimate expectations of the parties.[32]

2. Concession Contract [33]

The term "concession" connotes "ownership," or what common law systems describe as a "freehold interest."[34] Concession is "an arrangement whereby the private sector is granted the right to develop a public infrastructure project."[35] The concession system has become transformed in light of the exigencies of modern international commercial transactions. The following are some of the features of the modern concession contract:

> It gives exclusive right to the concessionaire to undertake its operations in a given area, including other ancillary operations within a certain duration with the possibility of renewal;

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31. *See generally* Wälde, *supra* note 28, at 33.

32. This would imply inter alia that:

They should not be exclusively reflective of the defensive interest of the investment-exporting countries;

They should equally reflect elements of developing countries' collective interests and action such as technology transfer, financial resources and respect for sovereignty over natural wealth and resources;

They should contain concrete commitments from the parties aimed at creating a package of mutually beneficial interdependence. *See id.* at 34.

33. Some legal scholars may view this phrase as tautologous, since the term "concession" in itself may encompass "contract."

34. It is not, however, the exclusive preserve of the common law system. For example, the French water sector has industrialized through this structure for over one hundred years. *See* Duncan Macnab & Jeremy Connick, *Concession Agreements 100 and BOT Projects*, *in* POWER PROJECT DOCUMENTATION 5 (1997).

35. Id.

> It gives the concessionaire exclusive rights to manage its operations without undue interference from the host government;
>
> The concession contract sets out clear commencement, tasks, and obligations (which may include the filing of work reports);
>
> It employs a simplified tax system that enables the concessionaire to effectively amortize its investments within a reasonable period of time;
>
> Allows the concessionaire to set prices, with government supervision;
>
> It allows dispute settlement, usually by arbitration, and a choice of law clause between the laws of the host country and international law; and
>
> It enables the possibility of revocation in exceptional circumstances.[36]

The concession system has been modified recently to accommodate various other types of projects. The concession contract has brought a considerable reduction in host government participation and control. It is possibly one of the most attractive options for CDM Projects, since it enables the private sector to exercise a free hand in developing and managing the project with minimal interference by the host government. Private sector involvement in the AIJ/JI projects makes the concession contract attractive in those projects as well. Thereafter, an intergovernmental JI agreement can provide an umbrella cover for any concession granted by any of the Annex I parties. Innovative contractual clauses can be drafted to synchronize with the objectives of the clean development mechanism and JI as envisioned under the Kyoto Protocol.

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36. These features have been distilled from a comparison of the Traditional and Modern Concession Contracts tabulated by Zhiguo Gao. *See* ZHIGUO GAO, INTERNATIONAL PETROLEUM CONTRACTS: CURRENT TRENDS AND NEW DIRECTIONS 53-54 (1994). They are by no means exhaustive, and are capable of a variety of interpretations. However, they do serve as reference points from which subsequent discussions on contract forms for CDM Projects can be appreciated.

3. BOT Project Contracts[37]

According to the UNCITRAL,

> BOT is conceived as a way to reduce pressure on the use of public funds for project financing and to promote the transfer of technology through the involvement of the private sector in financing, building and operating infrastructure projects. In its most basic form, a BOT project is where the Government grants a concession for a period of time to a consortium for the development of a project. The consortium finances or arranges for financing for the project, constructs the project, and operates and maintains the facility during the life of the concession. Meanwhile, through sale or charge for the use of the facility or its products, the consortium recovers returns on its equity and pays off its debts. At the end of the concession period the project is transferred to the Government.[38]

The potential advantages of using the BOT Project contractual approach to both the private and public sector are illustrated in Table 2 below.

BOT Project Agreements may be called modified versions of the concession contract.[39] There can be considerable diversity in their form and content, ranging from "huge, complex contracts, tailor-made for a particular infrastructure project …to straightforward and to some extent standardized contracts for each infrastructure sector, as in China's BOT programme."[40]

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37. The Build-Operate-Transfer or Build-Own-Transfer projects are said to be "the new buzz words in project finance." PETER K. NEVITT, PROJECT FINANCING 290 (1989).

38. POSSIBLE FUTURE WORK: BUILD-OPERATE-TRANSFER PROJECTS: NOTE BY THE SECRETARIAT, UNCITRAL, 29th Sess., U.N. Doc. A/CN. 9/424 (1996). The subsequent UNIDO Guidelines have clarified that transferring the project at the end of the concession period need not always be the case. *See* BOT GUIDELINES, *supra* note 24, at 3.

39. For the view that the "BOT structure is normally based on a concession agreement between a government or a government agency, and the vehicle company established by the sponsors to carry out the construction and operation of the project." CLIFFORD CHANCE, PROJECT FINANCE 29 (1991).

40. BOT GUIDELINES, *supra* note 24, at 226.

Table 2:
Potential Advantages to Both the Private and Public Sector of Using the BOT Approach for Infrastructure Development

Private Sector	Public Sector
Gives the private sector a free hand to finance the project, rather than depending on contributions from a host government, which may cripple the project because of the government's other commitments.	Use of private sector financing to provide new sources of capital, which reduces public borrowing and direct spending, and which may improve host government's credit rating.
Ability to accelerate the development of projects that would otherwise have to wait for, and compete for, scarce sovereign resources.	Ability to accelerate the development of projects that would otherwise have to wait for, and compete for, scarce sovereign resources.
Use of private sector initiative and expertise to reduce project construction costs, shorten schedules, and improve operating efficiency.	Use of private sector initiative and expertise to reduce project construction costs, shorten schedules, and improve operating efficiency.
The private sector is responsible for the operation, maintenance and output of the project for an extended period (normally the government would receive protection only for the normal construction and equipment warranty period).	Allocation to the private sector of project risks and burdens that would otherwise have been borne by an already encumbered public sector.
Involvement of private sponsors and experienced commercial lenders, which ensures an in-depth review and provides an additional sign of project feasibility.	Gives government breathing space to source indigenous and skilled manpower comparable to the private sector.
Able to recoup the costs of technology transfer, training of local personnel and the development of national capital markets toward the transfer of the project.	Public gains from technology transfer, the training of local personnel and the development of a national capital market.
The private sector establishes a benchmark against which the efficiency of similar public sector projects can be measured and the associated opportunity to enhance management of infrastructure facilities.	The public sector can measure its efficiency against the benchmark established by the private sector in respect to similar projects and associated opportunities to enhance management of infrastructure facilities.

Source: Adapted from BOT GUIDELINES, *supra* note 24, at 7.

To this extent, they are both flexible and dynamic. Importantly so, in view of the fact that in the construction, implementation and maintenance of most CDM Projects, science, engineering and construction works would play a considerable role. Thus, like their AIJ/JI counterparts,[41] the attractiveness of BOT Project Agreements cannot be overemphasised.[42]

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41. The parties to the UNFCCC established a pilot phase for Activities Implemented Jointly (AIJ) under the Climate Change Convention. Its purpose is to enable governments or companies that contract with parties in another country to implement an activity that reduces GHG in the other country. The main distinction between the AIJ and the CDM is that, whereas the former precedes the latter and involves an investor and host country that may both be industrialized countries, the CDM is very recent, having been formulated under the Kyoto Protocol, and involves only industrialized and developing countries. Also, whereas AIJ pilot phase schemes do not involve the crediting of reductions achieved against industrialized

BOT Project Agreements, however, have to be specially and carefully drafted to fit into the legal systems within which they are to operate. Legal systems that are less supportive of, or less transparent to, the BOT approach, may require far more comprehensive provisions in BOT Agreements than those that are more supportive, specific and transparent.[43] What is being suggested here is that BOT agreements cannot guarantee per se many of its attractions.

4. Joint Venture Agreements (JVA)

A joint venture is "a business arrangement in which two or more parties undertake a specific economic activity together."[44] While there are different varieties of joint ventures (JVs), they are generally a popular way of pooling together scarce financial and technical resources for the purpose of carrying out a commercial undertaking. The JV contract spells out the terms of the joint venture, especially the financial commitments of each partner and the profit-sharing modalities, which need not necessarily be in equal proportion. In the energy sector, host governments view JVs as an effective way of participating in the development of their natural resources with the concomitant prospect of technology transfer.[45]

While the CDM envisions a collaborative arrangement between non-Annex 1 and Annex 1 Parties, the JI requires such collaborative arrangements only between Annex I parties. In both, the relevant parties could use public or private parties to undertake either a JI

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countries' legal abatement obligations, those of the CDM do permit such crediting. *See AIJ World Bank Group Strategy* (visited Mar. 30, 2000) <http://www-esd.worldbank.org/aij/green.htm>.

42. This is not to suggest that some other CDM Projects cannot be in areas of social change, education, training and financing. Even growing more trees has been identified as one way to hold down greenhouse gas build-up. *See* Sedjo, *supra* note 3, at 12.

43. A supportive regulatory framework could contain, for example, a law, regulation or code like the Indiana code 22-3-2-15 Enacted 1929, Amended 1991. *See* IND. ADMIN. CODE tit. 36, article 1, chap. 14.3, section 4 (repealed 1997). It could also contain and publish general project eligibility criteria and national rules, which are not incompatible with the provisions of the Kyoto Protocol, as the Czech Republic already has done for JI development projects. *See JI Project Development in the Czech Republic* (visited Aug. 26, 2000) <http://www.vol.cz/nondek/jicz/websi2.htm>.

44. *The Joint Venture Home Page* (visited Aug. 26, 2000) <http://home.earthlink.net/~fpearce/Jointventure.html>. *See also* BLACK'S LAW DICTIONARY 839 (6th ed. 1990) (defining a joint venture as "a legal entity in the nature of a partnership engaged in the joint undertaking of a particular transaction for mutual profit.) This is possibly the simplest definition of the joint venture. The joint venture agreement is the contract defining the rights and obligations of the parties.

45. *See* Robert Pritchard et al., *The Use of Joint Ventures in FDI*, *in*, ECONOMIC DEVELOPMENT, FOREIGN INVESTMENT AND THE LAW: ISSUES OF PRIVATE SECTOR INVOLVEMENT AND THE RULE OF LAW IN A NEW ERA 175, 177 (R. Pritchard ed., 1996).

joint venture (JIJV) or a CDM joint venture (CDMJV).[46] Clearly, a CDM joint venture agreement (CDMJVA) or JI joint venture agreement (JIJVA) would be the most appropriate framework for defining the commercial and legal relationship of the Parties. A standardized JIJVA or CDMJVA can be adapted to take care of the special requirements or substance of the JI or CDM, depending on the circumstances. Table 3 is a summary of some common advantages and disadvantages of the JVA.

Table 3:
Some Common Advantages and Disadvantages of the JVA

Project Developer's View Point	Host Government's View Point
Advantages	
Molding a project into a form that is Compatible with government policies	Maximizing national sovereignty
Minimizing political risk	Receiving subsidized or risk-free participation
Improving predictability and stability of operational conditions	Sharing in the rewards of value-added
Providing a communication channel to the government	Influencing training, education, labor recruitment and labor policies
Availability of tax or other investment incentives	Influencing decisions on sourcing and pricing of plant, equipment, production inputs and services
	Influencing destination and pricing of products
	Minimizing any perceived adverse effects of FDI
Disadvantages	
"Soft" value of host country's capital contributions	Need to contribute capital or other assets
Less efficient decision-making and financing structures	Need to offer tax incentives
Exposure to risk of loss of confidential commercial information and expertise	Exposure to business risks
Exposure to risk of incompatibility with government bureaucrats	Exposure to risk of incompatibility with foreign partner
Higher transaction cost due to less unified and single-purpose management structure and relative absence of shared values.	Higher transaction cost due to less unified and single purpose management structure and relative absence of shared values.

Source: Pritchard et al., *supra* note 45, at 178.

Two observations should be made. The first relates to the varying objectives of the joint venture partners; while the host government would be more interested in attaining sustainable development, including technology transfer for the benefit of the

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46. This is because, under Article 12(9) of the Protocol, "Participation under the clean development mechanism, including activities mentioned in paragraph 3(a) above and in the acquisition of certified emission reductions, may involve private and/or public entities …." Protocol, *supra* note 2, art. 12(9).

national economy, the investor is more interested in making a profitable return on his investment. The second observation is regarding the host government's ability to meet its cash-call obligations,[47] as a cash-strapped non-Annex I countries can hardly be expected to meet their financial commitments under the JVA.

In no contractual arrangement, however, is an investor's objective identical with those of the host government. Furthermore, fears about the host government's inability to meet its cash-call obligations under the CDMJVA would seem to have been arrested by Article 12(6) of the Protocol.[48] In any event, these arguments should not apply to the JIJVA, which involves two Annex I parties. Moreover, even if the CDMJVA is not a preferred option due to developing host-government involvement, it is nonetheless a preferred option for legal entities willing and able to pool their resources together to undertake a JI Project.

5. Risk Service Contracts (RSC) and Service Agreements

The RSC is usually a camouflaged concession, BOT or JV arrangement in which the services of an investor, who assumes the legal status of "contractor," is hired by the sponsoring state.[49] In the case of a CDM arrangement, the tasks of the contractor would be the construction, maintenance and implementation of the CDM Project, or the training of personnel for the purposes of managing any such project.[50] After successful execution of the contract, the contractor is reimbursed for its costs and investments and paid for its services by the sponsoring state. Although he is executing a service contract, the contractor bears the entire financial risks of the undertaking and recovers its investment after successful execution.[51] This explains

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47. In practice, it is usually the responsibility of the appointed government agency or public enterprise.

48. *See* Protocol, *supra* note 2, 12(6) (providing that "[t]he clean development mechanism shall assist in arranging funding of certified project activities as necessary.").

49. *See* KEITH W. BLINN ET AL., INTERNATIONAL PETROLEUM EXPLORATION AND EXPLOITATION AGREEMENTS: LEGAL, ECONOMIC AND POLICY ASPECTS 83 (1986). In the energy sector, the sponsoring or hiring state is usually the host country. But in the CDM Project, it has to be the industrialized or Annex I country.

50. In the European Community (EC) for example, a distinction is made between works and services contracts in relation to certain specialized/utility operations. Consequently, a contract to be awarded can only be either a works or services contract but, not both, with concomitant legal implications. *See* Anthony Woolich & Karima Hudson, *Public Procurement and Brown Field Sites: UKCS Dimensions*, 7 OIL & GAS L. & TAX'N. REV. 280, 282 (1998).

51. The contract may include provisions for certain up-front or mobilization fees to assist in the effective start-up of the project. But this can not be more than a certain specified percentage of the overall total value of the contract.

why it is sometimes referred to as "Risk Service Contract". While in theory, JI envisages 'joint implementation' of project activities, nothing prevents one or both parties from hiring the services of an independent contractor to implement JI projects under a risk service agreement. Details about how to credit or debit ERUs can be determined in the main contract document, or in an appendix.

The distinction between the RSC and the joint venture or sole-investor arrangement is that, in the RSC, the contractor provides a service and receives payment from the client only after successful execution of the project. In the latter, the investor puts up risk capital and receives a return from an expected flow of profits from the venture (usually shared in the case of the joint venture).

A further distinction should be made between a RSC and a real or proper *service agreement.* The RSC is a contradiction in name as it pretends to be a service contract in which there is full client control. The client only pays after successful execution of the contract in the RSC, but in the real service contract the client pays irrespective of the success of the undertaking. In this latter contract, the client bears the risks and has management and control powers, which are inevitably correlated with payment and risk taking. Such a situation may arise where a home country or international agency, for example, hires the services of an independent contractor (service contractor) to perform certain services for the benefit of a third party beneficiary host country. In this situation, there is no contractual relationship (privity of contract) between the host country and the service contractor as such; the service contractor receives payment from the sponsoring home state or international agency (Client).[52] Figure III is illustrative of the real service contract. Examples of the real service contract would be the Phare and the Tacis multi-country Programs.[53] In the Phare Program for instance,

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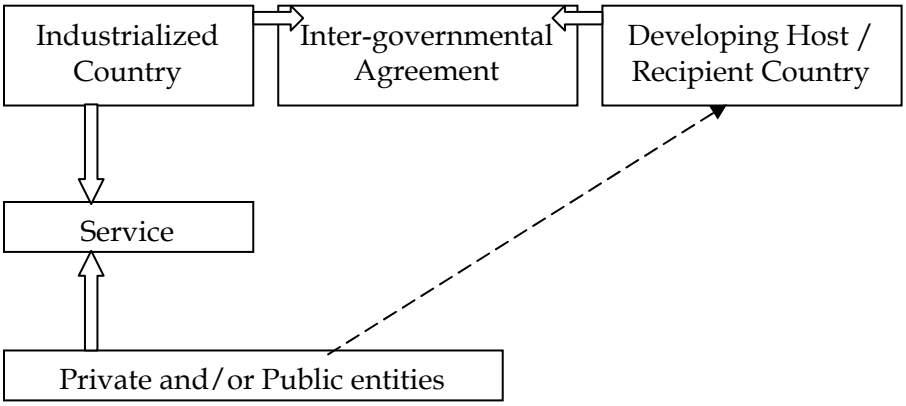
52. Exceptionally, there could be a sub-contract between the service contractor and the host country for the rendering of the particular service it has been hired to perform, even when the sponsor is not the host country. In this latter situation, the service contractor gets paid by the sponsoring agency or home state rather than the host country.

53 "Phare" is an acronym for the program's original name: "Poland and Hungary: Action for the Reconstruction of the Economy." The European Union has expanded the program and Phare now encompasses fourteen Eastern and Central European partner countries. *See The Phare Program* (visited Aug. 26, 2000)
<http://europa.eu.int/comm/enlargement/pas/phare/wip/>.

The Tacis Program incompasses the EU's partnership involvement with nations outside of Europe. *See External Relations – The European Commission* (visited Aug. 26, 2000) <http://europa.eu.int/comm/external_relations/index.htm>. *See also* The Energy Charter Treaty, (visited Aug. 26, 2000) the text of this treaty involving multinational contractual relationships is available at <http://www.encharter.org/English/index.html>.

Figure III:
Real Service Contract Between Industrialized Country and Service Contractor for the Benefit of Third Party Beneficiary (Developing Host/Recipient Country) within the Framework of an Intergovernmental Agreement[54]



the contracting authority - the European Union (EU) - hires a service contractor to provide, among other tasks, training to selected key personnel of each Phare partner country in order to bring their legislation in line with ECT requirements and harmonize their legal, policy and institutional framework with the EU. As the Client, the EU bears the risk and is accordingly vested with control and management powers over the contractor. The Contractor does not get paid by the beneficiary countries, Central and Eastern European Countries (CEEC), but by the EU as the contracting authority. Additionally, such payment is not dependent upon the success of the undertaking.

Similarly, under the Kyoto Protocol, the COP could, in addition to arranging for funding for CDM Projects, potentially hire a Private or Public entity of an Annex I country as a service contractor to construct and implement a CDM project in a non-Annex I country. While this would be with the consent of the parties, the service contractor would receive payment from COP and not the host country. Details regarding quantification and allocation of credits can be worked out within the framework of the service contract.

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54. In this type of contract as depicted above, no contractual relationship (privity of contract) exist between the service contractor (Private and/or Public entities) or the International Development Agency. The real service contract is between the industrialized country and the Private and/or Public entity. Accordingly, the service contractor gets paid not by the host country but by the industrialized country party.

Alternatively, one or both Annex I countries could hire the services of a public and or private entity within its domain to construct, maintain, and manage a JI project in the other Annex I country. In this case, the service contractor gets its remuneration from the hiring home state rather than from the host Annex I state. Again, the specific details of ERUs can be determined under the contract. Admittedly, this latter arrangement blurs the distinction between the RSC and the service agreement.

As in other contractual relationships, the potential for conflicts always exists in the service contract. Due to its peculiar arrangement, this potential for conflict is inherent in the service contract. Under the service agreement, the real service contractor may be bound not to indulge corrupt officials of the host country or to abide by certain standards. This may pose practical difficulties, as the host country may set its own agenda in the "national interest," including the imposition of import duties and the levying of taxes. These are no doubt very thorny issues in practice, since beneficiary governments cannot easily refrain from either levying taxes, imposing duties on imports, or even attempting to influence the project in their favor. If these difficulties are not anticipated and an amicable resolution properly provided for, the effective execution of the real service contract is bound to be prejudiced.

6. A Contractual Precedent for Emissions Trading

The contract form for emissions trading should be simpler than those for the CDM and JI, as there is already a precedent for implementing emissions trading.[55] With emissions, a simple standardized contract for the buying and selling of 'permits,' 'allowances,' or 'emissions reductions' can be drafted in which one Party agrees to sell and the other agrees to buy such tradable commodity. However, considering that emission reduction targets (ERT) are envisioned to be sold between countries under Article 3 of the Protocol, an international emissions trading contract (IETC) within an umbrella-framework intergovernmental agreement is possible.

V. APPRAISAL AND RECOMMENDATIONS

From the foregoing, it seems reasonable to suggest that an intergovernmental agreement would be a necessary starting point for

55. The US sulphur dioxide emissions trading scheme.

all three flexible mechanisms. Also, with the exception of emissions trading, the Concession Contract, the BOT Project Contracts, the Joint Venture Agreement (JVA), and the Service Contract are all suitable for the JI and CDM because of their inherent flexibility and adaptability in advancing the objectives of these particular mechanisms. A summary ranking of the suitability of the possible contract forms is juxtaposed against each of the flexible mechanisms in Table 4.

Table 4:
Summary Ranking of Possible Contract Types against Flexible Mechanisms

Possible Contract Forms	Joint Implementation	Clean Development Mechanism	Emissions Trading
Intergovernmental Cooperation Agreement	3	3	3
Intergovernmental Agreement for Specific Project	3	3	0
Concession Contract	2	3	0
BOT Project Contract	2	3	0
Joint Venture Agreement	3	2	0
Risk Service Agreement	2	3	0
Service Agreement	2	3	0
International Emissions Trading Agreement	0	0	3

Ranking: 0 = very poorly adaptable; 2 = adaptable; 3 = excellently adaptable
Source: compiled by authors

In practice though, it is the substance of the agreement rather than the form that matters most in terms of effectiveness. It is also necessary to note that all these distinct forms can be used in perhaps three broad scenarios: (1) An intergovernmental framework between two or more Annex I countries for emission trading, which may be accompanied by a specific IETC; (2) An intergovernmental agreement between two or more Annex I countries, which may be followed by a specific Concession, BOT, JVA or Service Contract in respect of a JI Project; (3) An intergovernmental agreement between an Annex I and a non-Annex I country followed by a specific Concession, BOT, JVA, or Service Contract in respect to a CDM project in a non-Annex I country.

However, certain general principles are fundamental for any contract to be effective both as between the parties to the agreement and in terms of achieving the general contract objectives. These include, but are not limited to, the following principles:

> Equity, fairness and transparency in apportioning rights and obligations between the parties. This may involve "affirmative action" to counteract unequal development and compensate for the structural weaknesses of a developing country party;[56]
>
> Cost effectiveness in the pursuit of contract objectives. An unambiguous statement of contract terms, which should include *modus operandi* for implementation and enforcement, financial mechanism, dispute settlement, liability and compensation for damages or the failure of the undertaking; and
>
> The principle of both host and home state co-responsibility for international economic and environmental cooperation.[57]

In the final analysis, whatever contract form is employed, (as between the intergovernmental agreements, concession, BOT agreement, JVA, Risk Service Contract, or Service Contracts) the substance of such agreement should state very clearly, inter alia:

> How to establish a baseline for projects in the calculation of real emissions reductions;
>
> How to monitor, verify, and certify real emissions reductions;
>
> How to scale down the administrative and transaction costs of the project; and
>
> How to guarantee uninterrupted project tenure and facilitate repatriation of profits (proceeds from the project).

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56. *See* Wälde, *supra* note 30, at 76.
57. *See id.* at 77.

VI. CONCLUSION

This paper has presented a contractual architecture for the flexible mechanisms envisioned under the Kyoto Protocol. In the final analysis, the substance rather than the form of the contract is what counts. However, all such contracts must be properly drafted to ensure that they synchronise with the overall objective of the Kyoto Protocol, taking into consideration the socio-economic and legal conditions in the participant countries.

With the 'Buenos Aires Action Plan' establishing deadlines and advances on a number of significant issues: financial mechanisms to assist developing countries respond adequately to climate change challenges; further work on policies and measures; development and transfer of technologies; rules governing the Kyoto Mechanisms with emphasis on the CDM; and an undertaking to discuss supplementarity, ceilings, long term convergence and equity, the stage is now set for implementing soft and hard law prescriptions into actual contractual commitments.