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Climage Change: The Next Dimension

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CLIMATE CHANGE: THE NEXT DIMENSION

LAKSHMAN GURUSWAMY*

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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

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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.

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 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

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.

> 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 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).

Consequently, the next decade may be spent quibbling over these demanding short-term commitments while ignoring more important century-scale solutions.[13]

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.

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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. & 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 ecosystems 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

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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.

balance hitherto maintained by atmospheric gases that blanket the 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]

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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.

Moreover, atmospheric general circulation models still exhibit inconsistencies when their results are matched with climatic data of 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

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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).

increases such as those now predicted to occur over the next century, however, may cause a different result.

B. The Yea-Sayers

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]

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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

According to the IPCC second assessment report in 1995, the most pronounced impacts will be related to water resources.[50] Rising 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.

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 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.

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, 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

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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.

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.

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 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

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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 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).

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 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

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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.*

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.*

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

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]

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81. *See id.*

82. *See id.*

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.

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 incorporates 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.

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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 in* 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").

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.

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 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,

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97. IPCC CLIMATE CHANGE 1995, *supra* note 23, at 4.

98. *See* Cooper, *supra* note 43, at 412.

99. *Id.*

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.

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 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

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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).

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.

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, 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

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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 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.

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 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

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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).

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.

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]

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

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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

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.

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 perspective 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

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133. *Conceptual Framework, supra* note 114.
134. *Id.* at 1.
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.

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 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,

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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.

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.

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 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]

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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.
151. *See id.*
152. *See id.*
153. *See id.*
154. *See id.* at 407.
155. *See id.*
156. *See id.*

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 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

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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).

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.

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 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

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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).

165. *See id.*

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

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

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.

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

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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.

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.

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 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]

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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).

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.

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 equipment 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

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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.

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.*

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 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]

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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.*

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,

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 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 develop-

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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.*

196. *See id.*

197. Id.

198. *See id.* at 70

199. See id.

ing 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 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,

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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.

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.*

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 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

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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.

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.

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 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

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213. *See* id.

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

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.

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 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

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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).

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;

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 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

(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*].

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.

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 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

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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 Environment*, 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 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.

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 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

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

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 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.

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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).

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

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 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

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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).

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).

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 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

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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.

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

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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).