Global Warming: Integrating United States and International Law

Lakshman D. Guruswamy
University of Colorado Law School
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I. INTRODUCTION

It is an amazing, yet disconcerting, moment in human history. Today, while the West composes epitaphs to Soviet communism and exults in the demise of the Soviet threat, we overlook a comparable, possibly more ominous threat to security: the endangered state of our planetary system.¹

For the first time in history, human action is dramatically altering the physiology of the entire planet.² The crisis confronting humankind today concerns massive and widespread global assaults on our planetary system rather than just containable pockets of high pollution. These environmental problems are not peripheral issues of concern only to environmentalists. The global economy, health, and modern civilization as we know it depends on these planetary systems. Anything seriously threatening them also threatens the human prospect.

The most menacing global peril arises from a massive increase of trace gases, such as carbon dioxide, methane, nitrous oxides and chlorofluorocarbons. The increase in these gases has changed the atmosphere's chemical composition resulting in global warming. In global warming we confront a truly planetary environmental peril that cannot be controlled by national regulation alone.

There is no doubt that global warming cannot be arrested by the actions of individual states acting unilaterally. Only global norms and international standards that are universally accepted will suffice. Such standards alone can provide for the reduction of trace gases that are causing global warming. Unfortunately, existing international law possesses neither the substantive law, standards and remedies, nor the institutions, to confront the current planetary environmental peril. What is required, therefore, is a new global treaty creating standards accepted by all nations. The community of nations envisages such a treaty which is scheduled to be negotiated at a world conference in 1992.

Recent attempts at international lawmaking have taught us some salutary lessons. The world's nations, through fifteen years of protracted negotiations, developed the United Nations Convention of the Law of the Sea (UNCLOS), a constitution for the oceans.³ Unfortunately, this major historic global treaty is


². Apart from global warming there are a host of problems of which three merit mention: ozone depletion, destruction of bio-diversity, and the cycling of toxic chemical through the environment. See infra note 194.

rejected by the United States, West Germany, the United Kingdom and other European nations because it does not accord with their national laws and policies. The saga of the United Nations Convention on the Law of the Sea contains a fundamental lesson for those seeking action on global warming: international lawmaking cannot be divorced from national lawmaking. Indeed, changes in national laws and policies may well constitute a vital step in the creation of international laws and standards dealing with global warming.

Because international law is a consensual law it cannot be created or applied without the help of powerful industrial nations. This is more poignantly so in the case of international environmental law which can only be upheld or effectively implemented with the support of the powerful economies of the world. In fact, the most productive developments in international environmental law have arisen out of domestic pressures within nations, and domestic laws and policies have become the building blocks of international law. If this country, the leading emitter of carbon dioxide in the world, could formulate and adopt effective policies adaptable to the rest of the international community, it would in fact provide a cure for the deficiencies of both national and international law. In short United States environmental laws addressing global warming, by integrating national, comparative and international approaches, could offer globally rational and compelling legal responses to a planetary peril. Conversely, United States reluctance to take steps to cut down on the use of carbon dioxide will obstruct international accord. More


4. For example, the environmental consequences of acid rain were made known to the Swedish public by Swedish scientists in the 1960's. Public pressure prompted the Swedish government to take action on acid rain within Sweden. Thereafter the government submitted a case study on the environmental aspects of sulphur dioxide to the UN Conference on the Human Environment 1972 (The Stockholm Conference). Wetstone, A History of the Acid Rain Issue, in SCIENCE FOR PUBLIC POLICY 165-66 (H. Brooks and G. Cooper eds. 1987). See also B. BOLIN, AIR POLLUTION ACROSS BOUNDARIES: THE ON THE ENVIRONMENT OF SULPHUR IN AIR AND PRECIPITATION, SWEDEN'S CASE STUDY FOR THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT IN STOCKHOLM (1972).

West Germany the third largest producer of sulphur dioxide in Western Europe was originally unconcerned about international air pollution. This attitude of indifference soon changed when experts revealed to the Federal Government that fully 500,000 hectares or nearly eight percent of Germany's forest area had been damaged by acid rain. G. WETSTONE & A. ROSECRANS, ACID RAIN IN EUROPE AND NORTH AMERICA: NATIONAL RESPONSES TO AN INTERNATIONAL PROBLEM 79-80 (1983). West Germany soon became the chief protagonist within the European Common Market for controls on acid rain and in the enactment of the European Common Market directive controlling air pollution from industrial plants. 84/360 EEC OJ L188, 16-7-86.

The United States was one of the prime movers in the Montreal Protocol which regulated chlorofluorocarbons (CFC's) more seriously. See Doolittle, Underestimating Ozone Depletion: The Meandering Road to the Montreal Protocol and Beyond, 16 ECOLOGY L.Q. 407, 421-22 (1989); Mintz, Keeping Pandora's Box Shut: A Critical Assessment of the Montreal Protocol on Substances that Deplete the Ozone Layer, 20 U. MIAMI INTER-AM. L. REV. 565, 575 n.58 (1989). The United States was one of the first nations to have introduced legislation to curb CFC's. See also Clean Air Act Amendments of 1977, 42 U.S.C. §§ 745-749.

5. The United States is the largest producer of carbon dioxide in the world. C. FLAVIN, SLOWING GLOBAL WARMING: A WORLDWIDE STRATEGY 8 (1989). It is responsible for 25% of the world's carbon dioxide emissions.
strikingly, even if a global treaty places limits on the emission of carbon dioxide, there is no guarantee that the United States will sign it. To avoid a repetition of UNCLOS the laws against global warming should reflect national thinking. The glaring lacuna in the law caused by problems that have outstripped and outgrown the existing capacity of both national and international legal systems can only be overcome by a new generation of environmental laws that seek to integrate national and international law and policy.

Encouragingly, a number of Bills now before Congress undertake the urgent and compelling task of providing answers to global warming. Unfortunately, the underlying premises of these Bills have lacked coherence and cogency. The rationales this article advocates are intended to provide powerful, hitherto insufficiently articulated, jurisprudential and political foundations supporting the vital objectives of these Bills, and to rebut a number of objections that have been raised to the United States taking the vanguard in fashioning global legal responses.

Part II will first explore a set of objections straddling both United States and international law and policy. They are based upon the scientific uncertainties surrounding the existence, the effects, the consequences and the implications of global warming. After disentangling the differing strands of uncertainty giving rise to the objections, and assessing their validity, this articles conclusion is unequivocal. Despite uncertainties, decisions cannot be postponed until conclusive scientific proof is available. It might then be too late to act. Scientific consensus indicates that global warming presents a real, irreversible threat requiring immediate attention. We should use law to attend to it.

Part II justifies the preceding conclusion by addressing the acceptability of risks that are thought likely by most experts. It argues that there are deep flaws in the science of risk assessment which misconceives of the nature of risk and is used to minimize the dangers of global warming and to vindicate inaction. Decisions about the acceptability of risks should not be reached purely on the basis of statistical risk that is only concerned about technical estimates of fatalities. There is a need to include, in risk analysis, the public perception of risk (perceived risk) which encompasses a richer, more complex version of risk. Risk assessment, by focusing upon human deaths, has largely ignored the damage caused to nature, ecological systems, welfare and intangible or non-utilitarian values. In the result, global warming which constitutes the greatest of the identifiable, irreversible and irremediable threats to nature and ecological systems, but is not seen as a great risk to human health, tends to be glossed over as unimportant.

6. See infra note 258.

7. EPA, Unfinished Business: A Comparative Assessment of Environmental Problems, Overview Report, 5-7 (1987) [hereinafter Unfinished Business]. Ecological effects are defined as effects on natural ecosystems caused by habitat modification and environmental pollution on the fauna and flora of aquatic, and terrestrial environment systems. Welfare effects include damage to agriculture, forestry and fisheries, recreation, and buildings to which a monetary value can often be assigned.

8. Id. at 48, 55.

9. Id. at 34, 42.
Resolving that the effects of global warming are unacceptable, the article then offers three broad rationales under which the protection of nature could be subsumed. First, a utilitarian rationale dictates that it is in the self-interest of men and women that nature should be protected. Secondly, altruistic rationales provide for ethics-based obligations. Nature centered ethics, which justify the protection of nature in its own right, independent of humans, provides a third rationale. Either singly, or in combination, these rationales seek to give nature its rightful place in the assessment of environmental risks.

Part II concludes by dismissing a view held by some influential Bush cabinet members and economists who argue that the United States should focus on reducing the effects of global warming rather than addressing its source. A problem as monumental as global warming calls for permanent solutions and permanent solutions can only be achieved when causes are found and dealt with.

Part III addresses the political difficulties of integrating United States and international law. Part III(A) first explores the case for integration in the light of the national security risk presented by global warming. It demonstrates the need for integrating global and national efforts, and advocates a new generation of United States laws that are focussed on integration. Part III(B) continues to deal with the political context of United States responses to global warming and argues that a propitious climate for integrated law-making has arisen. This part sketches a theoretical framework for lawmaking which demonstrates the timeliness and feasibility of integration and supports a premier role for the United States in controlling global warming. Rejecting public choice theories as too cynical, the article instead adopts a republican theory of government and supports this choice with empirical evidence. The article also adopts a "garbage can" model of organizational choice to show why and how the United States should play a leadership role in this area. The enactment of law is possible when the convergence of three streams: problem recognition, politics and policy proposals occurs, and an entrepreneur emerges to guide the passage of law.

"Problem recognition" has occurred because global warming is perceived as a serious problem requiring action. There now is convincing evidence and scientific consensus that a serious problem exists. "Politics" refers to the state of public opinion, which is also currently strongly in favor of immediate, effective environmental action to prevent global warming. "Policy proposals" exist, and are offered in this article based on four areas of converging United States and international concerns. The four areas consist of: (a) the need for more research into the causes and effects of global warming; (b) a redefinition of the atmosphere as a global commons or as the common heritage of mankind; (c) institutionalizing obligations to posterity; and (d) protecting nature for its own sake. These United States and international concerns lead to the conclusion that carbon dioxide emissions should be cut by twenty percent by the year 2000.

10. The "garbage can" depicts "organized anarchy" in the political system where no predictable theory or scientific process can identify problems or find solutions. Rather, salient problems, possible solutions, and legislative opportunities will coexist as separate "streams" in the "garbage can" (the system). Laws emerge where a problem becomes salient at the same time as solutions become well regarded and legislative "entrepreneurs" favoring the solution are able to control the legislative process for that end. See generally J. KINGDON, AGENDAS, ALTERNATIVES, AND PUBLIC POLICIES (1984).
The only remaining element for lawmaking is an "entrepreneur." Part II(C) argues that there is a need for United States entrepreneurship because of the inherent weaknesses in international law, and the likelihood that such law will not develop on its own. United States leadership is shown to be a necessary catalyst in the formation of effective international law. Moreover, part III(D) upholds and justifies the need for wise United States leadership and rebuts political objections to such an United States role. It argues that, at an international level, there is overwhelming evidence of an international commitment to a 1992 treaty on global warming. To the extent that international regulations will need to be implemented in this country it is in the self-interest of the United States to determine and formulate policies and principles, acceptable to itself, that could become international law. Furthermore, in light of evidence that global warming is a national as well as international problem which can seriously affect the United States, political objections to finding global solutions through United States law become even less weighty.

Finally, there are critical areas of law and policy in which the integration of United States and international law is both politically and legally feasible. Part III(E) of this article will deal with four of them: (a) the need for more research into the causes and effects of global warming; (b) a redefinition of the atmosphere as a global commons or as the common heritage of mankind; (c) institutionalizing obligations to posterity; and (d) protecting nature for its own sake.

In traversing the issues, the article will deal specifically with global warming. It is evident, however, that we wrestle with generic questions that could arise in many other areas of global concern. The present case study of global warming could serve as a fruitful model, even a paradigm, for addressing other second generation global problems.

II. SCIENCE AND POLICY

There are four fundamental and interlocking questions dealing with the environmental perils surrounding global warming. The first relates to the likelihood and causes of global warming. The second concerns the probable effects of global warming. The third inquires as to the action that should be taken, and the fourth asks if we should concentrate on dealing with the effects rather than address the causes. Unfortunately, these four interlocking questions have become coagulated in the exposition and explanations about global warming and other environmental questions. These are interlocking issues, but clarity is better served by disentangling them and accentuating their differences.

These four different but interlocking questions, are supposed to be answered by applying rational scientific principles to objective data -- good science. In the United States, as well as the international community, lawmakers have assumed that environmental laws should be based upon good science. Good science is perceived as offering impartial conclusions based upon objective evidence. It is important at the outset to point to two implications arising from the dependence on science.

GLOBAL WARMING

The first underscores the strong reliance both United States and international lawmaking place upon science. This mutual reliance renders the United States more able and willing to explore the scientific likelihood of global warming than a Western European state. Unlike Western European countries, the United States accords science a unique pre-eminence. Here, the objectivity of science has been grasped as a substitute for authoritative hierarchical decisionmaking. In the light of the fragmented, pluralistic nature of United States politics, lawmakers and regulators need some objective basis on which to make, justify, and defend their decisions. Such an objective assessment is offered by good science.

The status of "science in policy" in the United States is mirrored if not accentuated in international lawmaking. The international legal system is still at an embryonic stage of development and possesses no hierarchical authority. International law is horizontal in nature, and lacks universal lawmaking, law enforcing, or law interpreting agencies. The law can only arise with the consent of states which, therefore, would need to be persuaded of the necessity for law. In these circumstances the findings of science have become critical to international decision making.

To the extent that reliance is placed on science and scientific findings, it may be assumed that science offers conclusive and determinative answers to the questions asked of it. This brings up the second implication which can be simply stated. It is that global warming cannot conclusively be proved by scientific evidence. Popular assumptions about science as an objective

12. R. Brickman, S. Jasanoff & T. Ilgen, Controlling Chemicals 185-86 (1985). The authors suggest that as a rule Europeans rely more on the traditional authority of the state and on the inclusion of affected interests in decision making. Science is used to support rather than displace these as a source of authority. For historical and institutional reasons, American regulators are deprived of the legitimizing advantages of unquestioned hierarchical authority, while the co-optation of those affected is inconsistent with the adversarial nature of environmental decision making. They therefore turn to scientific argumentation and other forms of analysis that allow them to defend their decisions. Support for this thesis could also be drawn from Vogel, who suggests that there is a mistrust of hierarchical decision making in the United States. See D. Vogel, National Styles of Regulation 280 (1986).


14. It has been suggested that there has been some loss of confidence in science. See Coggin, Introduction. Governing Science and Technology Democratically: A Conceptual Framework, in Governing Science and Technology in a Democracy 13-14 (M. Coggin ed. 1986). The suggestion does not imply a crisis of confidence. Rather, it is a slipping from the very high levels of respect in which scientists were held. Indeed, it has been observed in this context that "regulators longingly seek the assurance from scientists regarding proper extrapolation in risk assessment." F. Cross, Environmentally Induced Cancer and the Law 57 (1989).


16. Hahn & Richards, The Internationalization of Environmental Regulation, 30 Harv. Int'l L.J. 421, 433 (1989). In the absence of other controlling forces, there is an almost canonical belief that science can instruct decisionmakers not only about the nature of the risk but also about what ought to be done about it. See also E. Haas, M. Williams & D. Babai, Scientists and World Order 18-33 (1977).

cognitive activity that produces unimpeachable conclusions on which policy and law are structured have never really been subscribed to by lawmakers. The "scientific facts" might rhetorically be presented as if they represented objective data. That often is not the case. Almost every legislative or regulatory action governing environmental perils, in the United States or internationally, has been beset with uncertainty. It is well known by law-makers that the endeavors of scientists, and the conclusions offered by science (what will be described as science in policy, or science for policy), is a goulash made up of many uncertainties. Uncertainties surround the scientific modeling on which the likelihood, the causes and the effects of global warming have been predicted. We now turn to the facts and the uncertainties surrounding global warming.

A. The Likelihood

The earth's temperature rests on a delicate heat balance.\textsuperscript{18} Solar radiation passes into the earth through the mass of gases found in the atmosphere and is reflected back through the same gases. A complex system of ocean and air currents, evaporation and precipitation, surface and cloud reflection, and absorption form a involved feedback system for keeping the global energy balance nearly constant. The fragility of this balance makes it extremely important to assess the possibility and significance of climatic changes. While our climate is the result of a gigantic and complicated system that humans cannot control or direct, it is possible for human activities to damage critical leverage points in the climatic system. In light of this possibility, many fear whether such intervention in the form of increased atmospheric concentration of "greenhouse" gases might affect the fragility of the heat balance,\textsuperscript{19} and lead to global warming. Greenhouse gases are trace gases\textsuperscript{20} such as carbon dioxide (CO\textsubscript{2}), methane (CH\textsubscript{4}), nitrous oxides (NO\textsubscript{2}),...
chlorofluorocarbons (CFC), and tropospheric ozone ($O_3$) which allow solar radiation into the earth but prevent heat radiated by the earth from being reflected back. Carbon dioxide is the most voluminous of the trace gases, amounting to 0.03 percent of the atmosphere by volume, and illustrates the dangers of the greenhouse effect.

For nearly one hundred years we have known that carbon dioxide traps heat in the atmosphere.\textsuperscript{21} It does so because $CO_2$ is transparent to, and allows in, solar radiation (sunlight) that falls on the earth and heats it. The heated earth returns or reflects radiation back to the atmosphere at longer wavelengths than incoming solar radiation. $CO_2$ is, however, relatively opaque to such longer wavelengths and reflects or absorbs and re-emits that radiation back, rather than letting it pass back to space, thus leading to the warming of the earth and atmosphere.\textsuperscript{22} Glass too is transparent to solar radiation but not to the longer wavelengths. When used in greenhouses glass traps heat giving rise to the terms "greenhouse gas" and "greenhouse effects."\textsuperscript{23}

In the unperturbed atmosphere, carbon dioxide is circulated naturally between the atmosphere, the oceans, and biosphere by physical and biological processes. Human additions of great quantities of carbon dioxide into the atmosphere may have disturbed the natural cycling of carbon dioxide.\textsuperscript{24} Half of the carbon dioxide emitted into the air by the burning of fossil fuels remains in the atmosphere, the other half is apportioned between the oceans and the biosphere (plants, animals, and living things).\textsuperscript{25}

There is no doubt that the $CO_2$ concentration in the atmosphere is growing. The pre-industrial concentration of atmospheric carbon dioxide was

Moreover, because of the great attention that carbon dioxide has received as a greenhouse gas, the remaining "trace gases" are also referred to as "other greenhouse gases" in literature that is primarily focussed on carbon dioxide. See Bolle, Seiler & Bolin, Other Greenhouse Gases and Aerosols, in \textit{THE GREENHOUSE EFFECT}, supra note 17, at 157.


22. Most of the sun’s radiation is visible light with a wavelength of 0.4 to 0.7 microns. The earth's atmosphere (including the greenhouse gases) is transparent to radiation of this wavelength. However, when the sun’s radiation strikes the earth, the radiation is absorbed and then re-emitted at a longer wavelength (because the earth is much cooler than the sun). This radiation with a longer wavelength (greater than 0.7 microns) is known as infrared radiation (heat). The greenhouse gases reflect or absorb and then re-emit the radiation back towards the earth thus leading to a warming of the lower atmosphere. See generally J.R. GRIBIN, \textit{FUTURE WEATHER: CARBON DIOXIDE CLIMATE AND THE GREENHOUSE EFFECT} 1170-73 (1983) [hereinafter \textit{FUTURE WEATHER}].

23. Compared with the earth, Mars has lower concentrations and Venus higher concentrations of carbon dioxide and other greenhouse gases. Temperature differences between these planets may well be explained by the greenhouse effect and not merely by their distance from the sun. For example, without the greenhouse effect, the temperature in Venus would be about the same as earth. The atmosphere of Venus consists mostly of carbon dioxide that traps heat over one hundred times more effectively than the earth's atmosphere. Venus is 40°C. Hansen, Johnson, Lacis, Lebedeff, Lee, Rind & Russell, \textit{Climate Impact of Increasing Atmospheric Carbon Dioxide}, 213 SCI. 957, 957-66 (1981); Titus & Barth, \textit{An Overview of the Causes and Effects of Sea Level Rise}, in \textit{GREENHOUSE EFFECT AND SEA LEVEL RISE}, supra note 17, at 12.

24. E. EL-HINNAWI & H. HASHMI, supra note 17, at 18.

25. \textit{STUDY OF CRITICAL ENVIRONMENTAL PROBLEMS, MAN'S IMPACT ON TERRESTRIAL AND OCEANIC ECOSYSTEMS} 175 (W. Matthews, F. Smith & E. Goldberg eds. 1971) [hereinafter \textit{MAN'S IMPACT ON ECOSYSTEMS}]; E. EL-HINNAWI & H. HASHMI, supra note 17, at 18.
about 280 parts of carbon dioxide per million parts of air by volume (ppm). It reached 316 ppm in 1959, 338 ppm in 1980, and 343 ppm in 1984 and is expected to increase to 560 by the middle and end of the next century if the present annual increases of 1-2 percent continue. There is broad agreement that the increase of CO_2 will result in the raising of temperatures in the lower atmosphere and the earth’s surface.

Other trace gases such as NO_2, CFC, O_3 and CH_4 are also increasing and compound the problem posed by carbon dioxide. Some experts suggest that a doubling of these trace gases would have the same consequences as the doubling of CO_2. Others estimate that, if present trends continue, the combined concentration of CO_2 and other greenhouse gases would effectively add up to a doubling of CO_2 as early as 2030.

1. Uncertainty or Chaos?

There is, however, some disagreement regarding: (a) the critical role of CO_2 and other greenhouse gases in producing global warming and climatic change; (b) the magnitude of such increases; and (c) the effects of global warming. Along with the disagreements on the scientific account of the greenhouse effect, there have also been disagreements on policy responses to this scientific uncertainty. In mid-October 1983, two separate investigations were simultaneously completed and publicized. One report, undertaken by the EPA, was designed to shed light on the CO_2 debate by evaluating the usefulness of various strategies for slowing or limiting global warming. The other report, by the NAS (United States National Academy of Sciences), was designed as a sustained attempt to assess the CO_2 issue. The public policy thrust of each report was substantially different. The EPA called for a robust policy response within the next few years, while the NAS concluded that the need for a public policy response was still decades away. In response to these conflicting reports, George Keyworth, the presidential science advisor agreed with the NAS report.

26. E. EL-HINNAWI & H. HASHMI, supra note 17, at 18; ROYAL COMMISSION REPORT, supra note 17, at 156.

27. WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, OUR COMMON FUTURE 175 (1987) [hereinafter OUR COMMON FUTURE]; UNEP/ICSU/WMO REPORT, supra note 17. Other estimates vary from 370 ppm to 2100 ppm in the year 2100. E. EL-HINNAWI & H. HASHMI, supra note 17, at 19.

28. The uncertainty on other matters is considerable, but there is almost unanimous agreement that a substantial warming would occur. Bolin, Jäger, Döös, *A Synthesis of Present Knowledge, in 'The Greenhouse Effect*', supra note 17, at 27.


31. OUR COMMON FUTURE, supra note 27, at 175.

32. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, CAN WE DELAY A GREENHOUSE WARMING? ii (1983).

33. CARBON DIOXIDE ASSESSMENT COMMITTEE, CHANGING CLIMATE xiv (1983).
and dismissed the EPA's findings as "unwarranted and unnecessarily alarmist."\textsuperscript{34}

The fact that an increase of $\text{CO}_2$ will theoretically lead to higher temperatures has been confirmed in experimental conditions, and there is "virtually no controversy" about the greenhouse effect itself as a bio-physical phenomenon.\textsuperscript{35} However, the pattern of factors that determine climate is extremely complex, and there is some dissent as to whether global warming and climatic changes are actually taking place.\textsuperscript{36} To begin with, $\text{CO}_2$ from fossil fuels is only a small part of the natural $\text{CO}_2$ that is constantly exchanged between atmosphere and oceans and atmosphere and the forests. Second, there is no certainty about how the carbon dioxide going into oceans and biosphere are divided between these two reservoirs.\textsuperscript{37} There is also considerable uncertainty about the role of the oceans in absorbing $\text{CO}_2$ and mediating temperatures.\textsuperscript{38} Oceanographers are about to embark on a ten year global survey of the oceans to sketch a worldwide picture of its gyres, eddies, and currents. Their hope is that the survey will aid scientists to understand how much heat the oceans move around the planet and how much atmospheric gases the oceans absorb.\textsuperscript{40} It could well be argued that any major policy action

\begin{itemize}
\item \textsuperscript{34} Cooper, The $\text{CO}_2$ Challenge, in \textit{Science for Public Policy} 204 (H. Brooks, C. Cooper eds. 1987) [hereinafter \textit{Science for Public Policy}].
\item \textsuperscript{35} \textit{Climate Surprises: Hearings before the Subcomm. on Science, Technology and Space of the Senate Comm. on Commerce, Science and Transportation}, 101st Cong., 1st Sess. 7 (1989) (statement of Dr. S. Schneider, Section Head Interdisciplinary Climate Systems, National Center for Atmospheric Research) [hereinafter Schneider].
\item \textsuperscript{36} This debate focuses on the question of whether the buildup of greenhouse gases is significantly contributing to the present climate change, or if this change is simply a result of natural climate variability relatively unaffected by increasing atmospheric concentrations of greenhouse gases. The skepticism, in part, is due to the poor understanding of the causes of past climatic change and the uncertainty involved in using past climatic patterns as analogs for predicting future climate trends. See Wigley, Jones & Kelly, \textit{Empirical Climate Studies, in The Greenhouse Effect}, supra note 17, at 287. Skeptics argue that changes in atmospheric carbon dioxide concentrations have a relatively small effect on climatic change. See, e.g., Idso, \textit{Carbon Dioxide: An Alternative View}, 92 \textit{New Sci.} 444 (1981); Newell & Doplick, \textit{Questions Concerning the Possible Influence of Anthropogenic CO$_2$ on Atmospheric Temperature}, 18 J. \textit{Appl. Meteorol.} 822 (1979).
\item \textsuperscript{37} See E. El-Hinnawi & H. Hashmi, supra note 17, at 18; \textit{Man's Impact on Global Environment}, supra note 25, at 11.
\item \textsuperscript{38} Scientific research has suggested that the effects of increasing concentrations of atmospheric carbon dioxide caused by anthropogenic (man-made) emissions may be mitigated by an oceanic response that absorbs atmospheric carbon dioxide. The chemical concept of equilibrium explains how absorption occurs. When the relative concentration of atmospheric carbon dioxide increases, the oceans respond by absorbing more gaseous carbon dioxide from the atmosphere to the point that the two medium (air and water) are in equilibrium. However, the extent to which this phenomenon would mitigate the buildup of atmospheric carbon dioxide is uncertain mainly due to the poor understanding of the rate at which surface ocean water is mixed into deeper layers of ocean. The amount of carbon dioxide that can be absorbed depends on the rate at which the layers mix and the depth at which mixing can take place. For a detailed discussion of oceanic absorption of carbon dioxide, see Bolin, \textit{How Much CO$_2$ Will Remain in the Atmosphere?}, in \textit{The Greenhouse Effect}, supra note 17, at 113-18.
\item \textsuperscript{39} The ability of the upper ocean to absorb heat from the atmosphere is potentially great enough to delay for several decades the establishment of a higher atmospheric equilibrium temperature associated with the increase of greenhouse gases. \textit{National Research Council (United States), CO$_2$/Climate Review Panel: Carbon Dioxide and Climate, A Second Assessment} 2 (1982) [hereinafter \textit{Carbon Dioxide and Climate}].
\item \textsuperscript{40} The Chronicle of Higher Education, August 16, 1989, at A6-A8.
\end{itemize}
should await a fuller understanding of the oceanic role. Furthermore, volcanic and solar activities also account for increases in temperature.  

Third, the evidence offered about rising temperatures is somewhat equivocal. Periodical natural fluctuations of global mean temperatures are well documented by geological evidence. Moreover, global mean temperatures increased about 0.4 degrees centigrade over the last century though temperatures on the northern biosphere actually decreased by about 0.5 degrees between 1940 and 1970, a period of rapid CO₂ increase. Finally, forecasts of temperature rises of between 1.5 and 4.5°C, with warming becoming more pronounced at higher latitudes during winter than at the equator, utilize models that simplify the complexities of climate and involve many assumptions. Critics question both the simplification and the assumptions, pointing out that many models predict that a global warming of at least 1 degree centigrade should have occurred over the past 100 years in response to increasing levels of

41. During the earth's history, natural fluctuations of the earth's surface temperature have, in part, been caused by volcanic and solar activities. ROYAL COMMISSION REPORT, supra note 17, at 158-59. First, there seems to be a very good correlation between historic ups and downs of temperature and number of sunspots. A high sunspot number means that the sun is more active. Second, large amounts of fine ash and dust from volcanic eruptions which is suspended in the atmosphere is believed to reflect incoming solar radiation. See generally FUTURE WEATHER, supra note 22, at 109-54.

42. The most documented periods of past climates which were much warmer than present are the early Holocene post-glacial epoch, 6000-9000 years ago, with observations indicating local summer temperatures at least 1° to 2°C warmer than present, and the Cretaceous period, about 100 million years ago with temperatures 10° to 20°C warmer. However, it is believed that there was a greater concentration of carbon dioxide in the atmosphere during the Cretaceous period than in the present. Dickinson, How Will Climate Change?, in THE GREENHOUSE EFFECT, supra note 17, at 229-30.

43. ROYAL COMMISSION REPORT, supra note 17, at 158-59. This data illustrates the difficulty of finding quantitative evidence that will relate the concentration of carbon dioxide in the atmosphere and changing climate conditions.

44. Models are mathematical representations of the atmosphere, oceans, and important components of the climate system. They embody our current understanding of the factors that determine the earth's climate. The factors or processes include: solar activity and the earth's orbital characteristics; the composition, radiative properties and circulation of the atmosphere; the chemical, physical and thermodynamical properties of the oceans; precipitation; streamflow, soil moisture content, evaporation, and cloudiness; the spatial distribution of ice and snow cover; the behavior of forests, plankton and other biological populations. Global Climate Change: Hearings Before the House Subcomm. on Oceanography and the Great Lakes of the Comm. on Merchant Marine and Fisheries, 101st Cong., 1st Sess. 128 (1989) (Statement of Dr. Andrew R. Solow) [hereinafter Solow]. They are premised on basic universal physical laws such as the conservation of mass and energy and motion. In other words, instead of actually building a physical analogue of the land-ocean-atmosphere system, mathematical expressions for physical principles, such as energy conservation and Newton's law of motion that govern those systems, are devised. A computer then calculates how the climate will evolve in accordance with those laws. Schneider, supra note 35, at 13. "The justification of such a mathematical construct is solely and precisely that it is expected to work." John von Neuman, cited in J. GLEICK, CHAOS: MAKING A NEW SCIENCE at 273 (1987) [hereinafter CHAOS]. Three-dimensional models, which are the most complex models used, make major assumptions, partly to reduce the computations and partly because the processes are insufficiently understood. The areas of greatest uncertainty concern the roles of the oceans, clouds, and particulates in the atmosphere. ROYAL COMMISSION REPORT, supra note 17. The waxing and waning of glaciers and forests, and the motions of the earth's crust. However, most scientists believe that results from the most recent models are the best estimates in light of current knowledge. These results should not be considered as accurate estimations, but rather as predictions based on particular scenarios. Id.
atmospheric carbon dioxide. What has actually taken place is a warming of half a degree or less.\textsuperscript{45}

The great power of science lies in the ability to relate cause and effect. On the basis of the laws of gravitation, for example, tides are scheduled and eclipses are predicted thousands of years in advance. It should be possible for a computer, applying Newtonian principles and physical laws of the universe, to make predictions as accurate as those relating to eclipses and tides. Such predictions are possible because the movements of the atmosphere obey the laws of physics just as much as the movements of the planets. Until recently there was little reason to doubt that precise predictability could in principle be achieved. It was assumed that it was only necessary to gather and process a sufficient amount of information. Many scientists believed that an approximate knowledge of a system's conditions, and an understanding of the laws of nature, enabled one to calculate the approximate behavior of the system.\textsuperscript{46} Such a belief has been altered by the discovery of randomness.\textsuperscript{47}

Structured upon the randomness of nature's behavior, the theory of chaos places fundamental limits on the ability to make predictions.\textsuperscript{48} This is a more elemental objection than those premised upon the incompleteness of weather modes or the absence of good data. Randomness in nature accounts for the fact that forecasts are still stated in terms of probabilities.\textsuperscript{49} The weather, the flow of a mountain stream, the roll of the dice all have unpredictable aspects. Since there is no clear relation between cause and effect, such phenomena are said to have random elements.

Scientists have long recognized, as a working problem, that measurements can never be perfect. But they assume, on the basis of approximation, that small influences can be neglected because they do not blow up to have arbitrarily large dimensions.\textsuperscript{50} The belief in approximation has been shattered in two ways. To begin with, quantum mechanics has found that there is a fundamental limitation to the accuracy with which the position and velocity of a particle can be measured.\textsuperscript{51} Second, the presence of randomness would result in the exponential amplification of errors, and where there is a pattern of randomness due to chaotic dynamics, the predictions become almost useless. The final result according to chaos scientists is that: "Quantum mechanics implies that initial measurements are always uncertain, and chaos ensures that the uncertainties will quickly overwhelm the ability to make them."\textsuperscript{52}

\textsuperscript{45} Solow, supra note 44, at 24.
\textsuperscript{46} CHAOS, supra note 44, at 15.
\textsuperscript{47} Crutchfield, Farmer, Packard & Shaw, Chaos, Sci. AM. 46-57 (1986) [hereinafter Crutchfield]. The account of chaos theory is heavily dependent on CHAOS. See supra note 44.
\textsuperscript{48} CHAOS, supra note 44, draws on the work of about two hundred scientists to present a eminently readable and intelligible account of the new science. Id. at 318.
\textsuperscript{49} "To most serious meteorologists, forecasting was less than a science. It was a seat-of-the-pants business performed by technicians who needed some intuitive ability to read the next day's weather in the instruments and the clouds." Id. at 13.
\textsuperscript{50} Id. at 15. "A tiny error in fixing the position of Comet Halley in 1910 would only cause a tiny error in predicting its arrival in 1986, and the error would stay small for millions of years to come. Computers rely on the same assumption in guiding spacecraft: approximately accurate input gives approximately accurate output."
\textsuperscript{51} Crutchfield, supra note 47, at 48.
\textsuperscript{52} Id. at 49.
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It is difficult, however, to evaluate what the impact of chaos might be. Chaos scientists believe that chaos, paradoxically, is structured, and has a pattern to it. They continue to use computers to model. When doing so they do not gloss over or ignore randomness in the way of Newtonian physicists, but look for patterns of randomness. Despite chaos, the majority of scientists continue to rely on modeling as a method of forecasting. In the case of global warming, the models they have constructed differ from one another in mathematical detail, in the relative emphasis of the various physical processes included in the model, in the manner in which the atmosphere is represented, and in the results offered. But they "all agree in showing that the continued increase in greenhouse gases in the atmosphere will result in a rapid heating of the earth's surface, and it is this agreement that has led to a broad scientific consensus that the projections of a warmer climate should be taken seriously."

There are impressive reasons that empirically verify and confirm the accuracy of models and strengthen the prevailing scientific consensus. First, mathematical models have been used to explain the evolution of past climates, including those of the ice ages and the Cretaceous period (the final age of the dinosaurs). The ability of models to reproduce the diverse climates of the Mesozoic era and glacial/interglacial cycles lends strong supporting evidence to their ability to predict the future. Second, general-circulation models do remarkably well at mapping the seasonal cycle. The seasonal cycle is a good test because the temperature changes involved are large—several times larger than the change from an ice age to an interglacial period. Scientists view this as an encouraging validation of "fast physics," such as cloudiness change. Third, it is possible to isolate individual physical components of a model and test them against real data from the field, or a high resolution sub-model.

As for long term model based predictions, chaos may not be as destructive of general predictions about global warming as might appear at first glance. Predictions of global warming involve global trends of massive proportions, not exact and accurate predictions and minuscule details. We are not concerned, for example, with models that attempt to predict the precise movement of a splash of water, under a particular rock, below a designated

53. CHAOS, supra note 44, at 76.
54. Id.
56. Schneider, supra note 35, at 14, 19. The geologic record contains a rich storehouse of evidence that could confirm or rebut the model's results. Geologists are able to interpret the evidence from the geologic record to reconstruct a history of climate. For example, ice cores from glaciers preserve records of past temperatures, precipitation, atmospheric dust content and past changes in the atmosphere. Sediment cores from lakes and oceans contain long histories of changing climate. By examining evidence of the same age from many localities, from both terrestrial and marine sites, it is possible to recreate "snapshots" of global conditions in different climatic era. Climate Surprises: Hearings Before the Subcomm. on Science, Technology and Space of the Senate Comm. on Commerce, Science and Transportation, 101st Cong., 1st Sess. 40 (1989) (Statement of D. Peck). These snapshots, of an age at which no climatic records were kept, can offer confirmation or rebuttal of the model's reconstruction of climate.
57. Schneider, supra note 44, at 18. This does not, however, indicate how well a model simulates slow processes such as changes in deep ocean circulation.
58. Id.
bridge, at a specified time. Instead, the comparison is more analogous to an inquiry as to whether a river is changing course. Climatic modeling on global warming does not involve anything as exacting as predicting the weather in Princeton, New Jersey, 182 days from a given date. Instead it is more like predicting that Princeton, New Jersey will have rain within 182 days.

2. Decisionmaking

A serious and controversial question that arises in this context is what decisions, if any, should be made in the face of strong but not conclusive evidence of the likelihood of global warming. In answering this question it behoves to be observed that risk is an inherent condition of modern living. Consequently, the issue of global warming is but a species in the broad genus of risk avoidance, and other analogous cases become instructive.

The history of chemical risks and technology in general reveals the disturbing extent to which their introduction was characterized by ignorance about their eventual consequences. Billions of pounds of dangerous chemicals were produced and used before they were found to be carcinogens. For example, 100 billion pounds of ethylene dichloride and five billion pounds of vinyl chloride a year were produced before tests showed them to cause cancer. The story repeats itself for DDT and a host of other chemicals, where there have been long intervals between the exposure to a chemical and the discovery of symptoms. The dangers posed by the "latency" period, as the devastating time lag has euphemistically been designated, have led inexorably to demands that decisions be made about the risks posed by chemicals despite "pervasive uncertainty."

Similarly, the question whether a substance causes cancer or other adverse health effects assumes an affirmative or negative answer. Yet there are few chemicals on which the human data is unequivocal. Conclusive direct evidence of a threat to human health is rare. Fewer than thirty chemicals are definitely linked with cancer in humans. In contrast, some 1,500 are reportedly carcinogenic in animals. Ethical considerations prevent deliberate human experiments with potentially dangerous chemicals, while the length of the latency period for cancer and other effects complicate epidemiologic studies. Thus, animal models are used to investigate whether exposure to chemicals is related to human health effects. Scientists consider the effects on laboratory animals and extrapolate the results to humans. A positive answer to the question whether a chemical causes cancer in animals is treated as evidence that it may pose a threat to humans. The inference that results from animals are

59. Crutchfield, supra note 47, at 48.
60. CHAOS, supra note 44, at 21.
62. For instance, the British Royal Commission on the Motor Car of 1908 viewed the most serious problem of the automobile to be the dust thrown up from un tarred roads. D. COLLINGRIDGE, THE SOCIAL CONTROL OF TECHNOLOGY 16 (1980).
64. NATIONAL RESEARCH COUNCIL, RISK ASSESSMENT IN THE FEDERAL GOVERNMENT: MANAGING THE PROCESS, 11-12 (1983) [hereinafter RISK ASSESSMENT].
65. Id. at 11.
66. Id. at 12.
67. Id. at 19.
applicable to humans is fundamental to toxicologic research, despite known metabolic differences between animals and humans, and the absence of evidence establishing human carcinogenicity as a scientific fact.

The need for early risk evaluation is a lesson bitterly learned, and the importance of recognizing false negatives in toxic testing has been penetratingly illustrated by Talbot Page. Erroneous tests may indicate that a toxic chemical is not toxic or that a non-toxic chemical is toxic. The latter type of error is called a false alarm in environmental risk assessment but there is no common name for the former. Page designates the former a false negative and the latter a false positive. The part false negatives play is vividly exposed by advances in analytical chemistry.

The case of ethylene dibromide (EDB), a soil, fruit and grain fumigant, illustrates a typical example in which a chemical caused unforeseen harm. Using the technique of risk assessment scientists determined EDB to be toxic at the hazard identification stage, and found that it gave rise to dangerous responses at the stage of dose-response assessment. At the exposure assessment stage, however, scientists determined that there had been “zero” (i.e. non-detectable) amounts of toxic chemicals present in soil, grain, and food. This led to the conclusion that EDB was not harmful to human health because it did not migrate further up the food chain from the nematodes (microscopic root eaters) in the field, fruit flies in citrus crops, and weevils in stored grain at which it had been directed.

The concept of “zero” has been rapidly retreating in the face of advancing analytical chemistry. In the 1970’s, analytical chemistry capabilities advanced to a point where it was possible to detect trace amounts of EDB in fruit, grain and grain products, where previously there had been findings of zero. EDB was clearly found to be advancing up the food chain. Further discoveries revealed that EDB had leached into groundwater. After a close consideration of the costs and benefits of their action, the EPA decided to ban the use of EDB. The same belated recognition of toxicity, after enormous harm had been caused, is true of DDT and many other chemicals.

The consequences of a false negative about one dangerous substance can be serious. The consequences of a false negative concerning the more serious
effects of global warming would be disastrous. There are some who view the fear of false negatives as irrational, and false negatives themselves as phantom dragons. These skeptics ridicule the contention that to wait until we are sure about climatic change may be to wait until it is too late. According to Solow, such an argument, applies equally to an invasion by aliens from space. More seriously, this argument neglects the cost of overreaction. A response that is efficient under a rapid change of large magnitude may be a costly mistake under a slower change of more modest magnitude.

This view fails to recognize the mounting evidence that we face a real dragon. To start, scientists while hopelessly divided on other environmental issues involving cause and effect, are almost unanimous about the very real possibility of global warming. The same measure of certainty about a Martian invasion would clearly provide good cause for action. Second, it may be possible to obtain conclusive proof of global warming in another decade or two. Delaying action for another decade or two will, however, not be cost free if global warming takes place. Assuming an optimistic one degree centigrade increase, we will still need to adapt much faster to the newer changes at greater expense. With an increase of four to five degrees centigrade or more we might find ourselves overtaken by catastrophe. Society is faced with a classic example of the need to make decisions with imperfect information.

Alan Weinberg has given the name transcientific to high policy questions that may be asked of science but are not answerable by science. The question whether global warming is taking place is one such transcientific question. There is an overwhelming consensus that something very disturbing is happening. Decisions may be deferred until conclusive scientific proof is available where we are certain not to be overtaken by the feared peril. But global warming provides no certainty. When we confront irreversible effects the cost of postponement might be too high. Lawmakers have rightly assumed that decisions should be taken despite uncertainty. Postponing action on the basis of a false negative — a wrong finding that something does not pose a risk — could be disastrous. The only way to obtain direct and conclusive evidence is to incur the risk involved. Such a course of action would be foolhardy where the disaster is irreversible.

The scientific evidence points to the likelihood, though not the certainty, of a global threat. The argument of this paper is that such a likelihood of harm warrants the adoption of remedial measures. Despite the fact that action regarding chemicals has been taken on the basis of what might be likely, it could still be argued that the kind of socioeconomic disruption caused by global warming is so enormous that it might be better to defer action until stronger

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76. For example, scientists are often divided about the suitability of the models used in the field of dose-response extrapolation (from high level exposure in animal bioassays to lower level exposure in man) to predict carcinogenicity. See F. Cross, *Environmentally Induced Cancer and the Law* 54-58 (1989).
When faced with a likely new Soviet threat, giving rise to global insecurity in the aftermath of the Second World War, the western powers agreed that a credible defense of Western Europe was necessary. There was less agreement on how to execute that commitment, but on the need for action to avert the threat to security there was no doubt. Despite the easing of tensions, the need for massive expenditure on military preparation to meet a likely threat, has continued to be the conceptual linchpin of defense policy. Those who are convinced of the necessity to incur enormous expenses against an attack that is likely but not certain, can hardly demand a more onerous standard of proof from others seeking action against global warming.

We have arrived at a situation where it is rational to conclude that global warming is likely. But what action should we take? In order to answer this question, it seems prudent and wise to ascertain the consequences of such disturbances. Such an awareness will enable us to make informed decisions as to the nature of the action, if any, arising from our evaluation of the evidence.

B. The Effects

The effects of global temperature rises vary with the extent and rapidity of the increase. Historically, climatic changes have been staggered over many centuries enabling plants and animals to adapt. For example, during the Ice Age 18,000 years ago, temperatures warmed about 5°C (9°F) over thousands of years but rose slowly enough to allow for adaptation. To study the effects of global warming, experts have developed “scenarios” to illustrate the possible effects of certain mean global rises in temperature. In some areas of the world, an increase of 1°C would have helpful effects. A modest warming in the far northern latitudes could carry some advantages for such countries as Canada, China, and the Soviet Union: resources in their arctic regions would become more accessible and more easily exploitable. On the other hand, and increase of 1°C could well be accompanied by non-trivial consequences especially with regard to climate-sensitive localized sectors of national economies. A 1°C temperature increase could shift the corn belt area of the United States by over

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79. This is an almost obvious point. For a historical survey see Schwartz, A Historical Perspective, in ALLIANCE SECURITY: NATO AND THE NO-FIRST-USE QUESTION 5-9 (J. Steinbruner & L. Sigal eds. 1983).
80. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, THE POTENTIAL EFFECTS OF GLOBAL CLIMATE CHANGE ON THE UNITED STATES, EXECUTIVE SUMMARY 8 (1988) [hereinafter UNITED STATES CLIMATIC CHANGE].
81. When experts discuss the global effects of a warming of the atmosphere in terms of a 1°C rise or a 2-4.5°C rise in temperature it is important to keep in mind that these are mean global increases. Temperature increases significantly higher than the projected mean increase with attendant changes in precipitation patterns will occur in latitudes north and south of the equator. Cooper, The CO₂ Challenge, in SCIENCE FOR PUBLIC POLICY, supra note 34, at 207.
82. Some regional areas of the world would be particularly sensitive to increases in temperature. For example, an area that is economically based on agricultural crops that are sensitive to small climatic changes would suffer more than areas that may not be hurt or even benefited by small rises in temperature. See id. at 208.
100 kilometers northward.\textsuperscript{83} Rises of between 2-4.5°C could present much greater problems.

Modeling studies have suggested that increased CO\textsubscript{2} concentrations could slow the atmospheric heat engine that is driven by the differences between equatorial and polar climates. This could change the hydrological cycle and affect rainfall patterns.\textsuperscript{84} Tropics and eastern coasts of continents could become wetter while sub-tropics would become drier and increase in area toward higher latitudes.\textsuperscript{85} Although higher carbon dioxide concentrations per se may increase plant growth\textsuperscript{86} and increase water-use efficiency,\textsuperscript{87} increased temperatures are detrimental to agriculture on the whole.\textsuperscript{88}

Crop impact analyses show that warmer average temperatures of one to four degrees centigrade are detrimental to both wheat and maize yields in the Great Plains and in Western Europe. Average yields may be reduced from between three percent and seventeen percent.\textsuperscript{89} It could also lead to sea level rises ranging between 25 and 140 centimeters.\textsuperscript{90} A rise in the upper range would lead to the invading sea submerging whole cities, agricultural land, fragile ecological coastlands, as well as swamping dump sites and salinating freshwater aquifers.\textsuperscript{91} Such a scenario will lead to socioeconomic and environmental problems of striking magnitude.\textsuperscript{92}

\textsuperscript{83} Id. at 208. This illustrates the possibility that seemingly insignificant average temperature changes could have very real consequences in terms of an increase in the frequency of such low-probability events such as droughts, crop failures, and floods.

\textsuperscript{84} See Manabe, \textit{The Effect of Increasing the CO\textsubscript{2} Concentration on the Climate of a General Circulation Model}, in DEPARTMENT OF ENERGY, CARBON DIOXIDE EFFECTS RESEARCH AND ASSESSMENT PROGRAM: WORKSHOP ON THE GLOBAL EFFECTS OF CARBON DIOXIDE FROM FOSSIL FUELS 100-01 (W. Elliot & L. Machta eds. 1979); see also Dickinson, \textit{How Will Climate Change?}, in THE GREENHOUSE EFFECT, supra note 17, at 249-52; ROYAL COMMISSION REPORT, supra note 17, at 159.

\textsuperscript{85} ROYAL COMMISSION REPORT, supra note 17, at 159.

\textsuperscript{86} Under laboratory conditions, increased atmospheric CO\textsubscript{2} conditions increase the rate of photosynthesis and nitrogen fixation in some plants. Warrick, Gifford, & Parry, \textit{CO\textsubscript{2}, Climatic Change and Agriculture}, in THE GREENHOUSE EFFECT, supra note 17, at 406.

\textsuperscript{87} Stomata (microscopic pores on the leaf surface) allow the inward diffusion of carbon dioxide used in photosynthesis and, at the same time, allow the loss of transpired water. An increase in the atmospheric carbon dioxide concentration could reduce the opening of the stomata required to allow a given amount of carbon dioxide to enter the plant and might thus reduce the loss of water from a plant. \textit{Id}. at 402-05.

\textsuperscript{88} In most regions of the country, climate change alone could reduce site to site dryland yields of corn, wheat, and soybeans, with losses ranging from negligible amounts to 80%. These decreases are primarily the result of higher temperatures, which shorten a crop’s life cycle. UNITED STATES CLIMATIC CHANGE, supra note 80, at 21. See also E. EL-HINNAWI & H. HASHMI, supra note 17, at 23; Warrick, Gifford & Parry, supra note 86, at 425.

\textsuperscript{89} UNEP/ICSU/WHO REPORT, supra note 17; UNEP/IIASA, \textit{CLIMATE IMPACT ON AGRICULTURE} (1986); See also Warrick, Gifford & Parry, supra note 98, at 425; EL-HINNAWI & HASHMI, supra note 27, at 23.

\textsuperscript{90} OUR COMMON FUTURE, supra note 17, at 176; E. EL-HINNAWI & H. HASHMI, supra note 17, at 22. Other predictions range from a sea level rise of 56 cm by the year 2100 to a sea level rise of 345 cm by the year 2100. Titus & Barth, \textit{An Overview of the Causes and Effects of Sea Level Rise}, in GREENHOUSE EFFECT AND SEA LEVEL RISE, supra note 17, at 16; Robin, \textit{Changing the Sea Level}, in THE GREENHOUSE EFFECT, supra note 17, at 355.

\textsuperscript{91} See Titus & Barth, supra note 90, at 19-21.

\textsuperscript{92} Even more dramatic changes have been forecast. It has been suggested that global warming could lead to the melting of the marine west Antarctic ice sheet raising the global sea level by several meters. Mercer, \textit{West Antarctic Ice Sheet and CO\textsubscript{2}}, \textit{Greenhouse Effect: A Threat of Disaster, 271 NATURE} 321-25 (1978). Evidence exists that the West Antarctic Ice Sheet...
I. Climatic Change in the United States

The most comprehensive study on the environmental effects of climate change in the United States has been undertaken by the EPA.93 The EPA study analyzed the potential impact of global climatic change in the United States within seven broad areas: sea level rise; water resources; agriculture; forests; biodiversity; health; and air pollution. It also focused upon four regions presenting climatological, ecological, hydrological and economic diversity where changes might be expected. They were the Southeast, the Great Plains, California, and the Great Lakes.

The study concludes that a rise in sea levels is one of the most certain impacts of climate change.94 Some scientists fear that an estimated rise of between 50 and 200 cm95 will drown coastal wetlands,96 inundate coastal lowlands,97 increase coastal flooding, erode beaches and increase salinity in estuaries and coastal aquifers.98 While rainfall will vary within regions of the continental United States, it is unlikely that current rainfall patterns will remain the same.99 It is certain that higher temperatures will increase evaporation and reduce snowpack. The rainfall in the United States falls more heavily on the east than the west and changes in temperature alone will cause new stresses in water resource management particularly in the west. Even without rainfall decline higher temperatures alone will likely lead to lower riverflow and lake levels.100 In California, for example, decreased water availability and increased demand for irrigation may intensify conflicts between agricultural and urban use.101 Higher temperatures may degrade water quality.102
Agriculture contributed 17.5 percent of the GNP of the United States in 1985. The United States produces nearly fifty percent of the world's corn and nearly sixty percent of its soybeans. The immense productivity of United States farmland has been a major reason why the United States has evolved into a giant economic power. Crop production is sensitive to temperature, precipitation, soils, and irrigation. During the dust bowl years of the 1930's wheat and corn yields dropped by up to fifty percent, and during the drought of 1988, estimates of corn yield showed a decline of thirty-seven percent. Climate change alone could reduce dryland yields of corn, wheat, and soybeans up to eighty percent.

On the other hand higher carbon dioxide concentrations on their own may increase plant growth and water use efficiency. When the combined effects of climate and CO$\text{2}$ are considered, results depend on the severity of climatic change. The situation is better or worse depending on how much hotter it will get. In general, global warming will increase the relative productivity of the northern areas, while decreasing productivity in the southern areas. Consequently, there is an estimated increase of five to seventeen percent of acreage in the northern Great Lakes states, the northern Great Plains, and the Pacific Northwest as compared to a decrease of five to twenty-five percent of acreage in Appalachia, the Southeast, and the southern Great Plains. According to the EPAs economic models, the production capacity of United States agriculture appears adequate to meet domestic needs even under the more extreme climate change scenarios. It must be pointed out that such a sanguine prospect is not shared by the UNEP/ICSU/WHO study. In any event the crops will be produced in different regions, thus leading to a redistribution of agricultural production and resources.

Forests which occupy one-third of the land area of the United States will be significantly affected. The report envisages a reduction of the range of

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104. Id. The United States pre-eminence in world affairs is largely due to its economic strength. For this reason, the United States has a large investment in the status quo, and has more at stake in the global climate battle. Id.
105. UNITED STATES CLIMATIC CHANGE, supra note 80, at 20.
106. Id. at 22. However, see UNEP/ICSU/WHO REPORT, supra note 17.
107. See supra note 17 and accompanying text.
hemlock and sugar maple in the eastern United States. Moreover, climate changes may cause major changes in forest composition and significant reductions in the land area of healthy forest, with such reductions being visible from 30 to 80 years hence. In addressing biodiversity, the EPA report suggests that climatic changes will lead to the extinction of many species just as the ice age did. Like trees, plants and animals may have difficulty in migrating with a rapidly changing climate or adapting to it. The diversity of life found in wetlands will be endangered by the advancing sea.

Air quality is also directly affected by temperature, precipitation patterns, and global circulation. Global temperature increases will increase manmade and natural emissions of hydrocarbons, manmade emissions of sulfur and nitrogen oxides. Temperature increases will speed the chemical reaction among chemicals in the atmosphere, and cause ozone pollution in many areas. The EPA report suggests that long term strategies to reduce ozone and acid rain levels may need to factor in global climate change. Global warming may also lead to increases in morbidity and mortality, particularly for the elderly during the summers.

What emerges is a scenario in which global climatic changes will have a major impact on natural ecosystems. Ecological damage will be very serious. Forests, wetlands, barrier islands and national parks could be severely, even irreversibly, damaged. Apart from impacts on the forest industry, forests provide habitat for animal life. Wetlands are the feeding and breeding ground of fish and other species. Climatic changes will also affect when, where, and how we farm; the availability of water to drink and water to run our factories; how to live in our cities; how we use our beaches for recreation; and how all levels of government and industry function.

C. How Acceptable are the Effects?

1. Risk Assessment

It is clear that the effects of global warming will primarily affect ecology, agriculture, forestry and human habitat. Effects on human health and mortality are relatively small. To what extent should we take steps to protect ourselves against these risks? Here that we encounter the science of risk

108. Climatic changes could move the southern and northern boundary by 400 miles. Since forests have only migrated sixty miles per century the actual range of forests is likely to be reduced. UNITED STATES CLIMATIC CHANGE, supra note 80, at 9.

109. Higher temperatures may reduce soil moisture levels. Trees that need wetter soils may die. In central Michigan, forests now dominated by sugar maple and oak may be replaced by grasslands. Id. at 11. See Shugart, Antonovskv, Jarvis & Sandford, CO₂, Climatic Change and Forest Ecosystems, in THE GREENHOUSE EFFECT, supra note 17, at 475-512.

110. It has to be remembered in this context that apart from climatic changes, the continued depletion of stratospheric ozone, the presence of tropospheric ozone and the acid deposition will also have their toll on forests. UNITED STATES CLIMATIC CHANGE, supra note 80, at 11.

111. Biological diversity can be defined as the variety of species in ecosystems and genetic variability within each species. Id. at 13. See OUR COMMON FUTURE, supra note 27, at 147-54.

112. UNITED STATES CLIMATIC CHANGE, supra note 80, at 30.

113. Id. at 32.

114. See Unfinished Business, supra note 6, at 48 (Table 2-4).

115. UNITED STATES CLIMATIC CHANGE, supra note 80, at 7.
assessment and risk management. Although usually employed in the field of hazardous chemicals these methodologies are applicable to the risks associated with global warming.

The emergence of risk analysis in environmental regulation appears to be a classic paradigm formation as described by Kuhn. With "risk" as the organizing concept and risk assessment as the format for elaboration on it, risk analysis provides an "implicit body of intertwined theoretical and methodological belief that permits selection, evaluation and criticism" in a field where choices need to be made and action prioritized. This article argues that limiting the criteria for assessing the acceptability of risk to statistical risk or harm to human health is unacceptable. Such criteria must be enlarged to include the public perception of risk together with harm to nature and ecological systems.

Statistical risks are usually based on technical estimates of fatalities. Risk assessors assume that public perception of risk (or perceived risk) that does not accord with the statistical mortality rates (statistical risk) is irrational. This is simply untrue. The public perception of risk (perceived risk) is based upon competing or alternate rationalities, embracing a richer more complex version of risk, that are as cogent and persuasive as those of the risk analyst.

Furthermore, risk assessment by and large focuses upon harm to human health and diminishes the damage caused to nature, ecological systems, welfare, and intangible or non-utilitarian values. Consequently, global warming, which constitutes the greatest of the known threats to nature and ecological systems, but does not present a great risk to human health, may well be glossed over as unimportant. Where nature is given its rightful place in environmental protection, however, risk assessment cannot be confined to health risks alone.

116. Risk analysis, which emerged in the 1970's, employs engineering and natural science methodologies in order to measure, predict, and manage events that are presumed to have physical and biological causes. The natural science basis of scientific risk analysis distinguished it from actuarial, economic, or financial risk analysis. In the 1970's, the physical, engineering and biological scientists engaged in this field thought they were studying biophysical reality, or "real risks" that was amenable to objective findings, in contrast to the old actuarial risk analysts who were studying non-natural phenomena. Starr, Rudman & Whipple, Philosophical Basis for Risk Analysis, 1976 ANN. REV. ENERGY 640-42; see also W. ROWE, AN ANATOMY OF RISK (1977); Wilson & Crouch, Risk Assessment and Comparison: An Introduction, 236 SCI. 267 (1987).

117. Risk assessment as presently practised assumes that risk is an omnipresent, mathematically measurable possibility of harm that applies to natural events as well as human actions. "Because the probabilistic concept identifies risk by measuring the probability and value of events, rather than by examining analogies to paradigm cases, risk can be seen as reality that yields its secrets to scientific enquiry." Thompson, Risk Objectivism and Risk Subjectivism: When are Risks Real? 1 RISK 6 (1990).


119. See infra Part 2 text accompanying notes 137-42.

120. UNFINISHED BUSINESS, supra note 6, at 5-7. Ecological effects are defined as effects on natural ecosystems caused by habitat modification and environmental pollution on the fauna and flora of aquatic, and terrestrial environment systems. Welfare effects include damage to agriculture, forestry and fisheries, recreation, and buildings to which a monetary value can often be assigned.

121. Id. at 48, 55.

122. Id. at 34, 42.
While this article does not propose either to embark on a comprehensive exposition of the organizing concept of risk or of the methodologies employed in risk assessment, a sketch of their main features becomes necessary. Such a broad picture is essential to understanding the criticisms levelled against the uncritical acceptance of risk assessment as a method of answering the vital question of what steps should be taken to protect ourselves against the risks of global warming.

The underlying rationale for risk evaluation is both compelling and convincing. Risk of one kind or another is endemic to our situation. These risks are the inevitable consequence of the standard and quality of living we desire. All these risks cannot be eradicated. For example, to close down a electric company because it is unable to meet clean air standards, despite its best efforts, might give cleaner air but would result in much greater risks to health and safety. A risk free environment is simply a chimera. In deciding which risks to eliminate or reduce there clearly is a need for prioritization. Given the limited resources available for the task we need to find out more about the nature of the risk we face and then decide how much of an unacceptable risk should be reduced.

In the face of pervasive and ubiquitous risks of all kinds, the effects of which are typically ringed with some uncertainty, the EPA envisions risk reduction becoming a common objective and measure of all agency action. The risk management approach has two major ends: setting priorities among the risks presented by pollution and choosing the appropriate reduction actions for the risks so selected. In the case of priority setting, risk management would enable the agency as a whole to direct its energies against the worst set of risks susceptible to its control. It is important that the EPA define its priorities.

Despite the differences in approach of its mandating statutes, "EPA programs are part of a single national effort embodied in a single Agency. The Agency in turn must respond to a basic requirement of good public policy: to establish the connection between some expenditure and some recognized public good." Agency management needs to know if the resources of the EPA are being directed at the right targets. While the Agency must enforce the statutes as presently written, it needs to select the set of actions that most efficiently reduces environmental risk as a whole. Although advanced in the context of existing environmental regulation, the principles advocated by EPA are clearly applicable to policy decisions about a new risk such as global warming.

The next step lies in applying risk management. In its influential report the National Research Council (NRC) suggested that risk evaluation embraces two distinct and different exercises: risk assessment and risk management. The NRC perceived risk assessment as a use of the factual base to define the

123. Justice Powell, in Union Electric Co. v. EPA, 427 U.S. 246, 272 (1976), noted that "[t]he shutdown of an urban areas electrical system could have even more serious impact on the health of the public than that created by a decline in ambient air quality."
124. 15th REPORT, supra note 71, at 226.
125. Id. at 227.
126. Id. at 231.
127. Id. at 227. "This is a difficult task, but it can be done. Indeed it must be done if one of the primary purposes of EPA's existence is to be achieved — the development of a coherent environmental program out of an array of disparate legislative mandates."
128. RISK ASSESSMENT, supra note 64.
health effects of exposure of individuals or populations to hazardous material and situations. In contrast, risk management was seen as the process of weighing policy alternatives and arriving at policy decisions.\textsuperscript{129}

Professional risk analysts, undertaking risk assessments, aspire to be objective. In doing so, risk analysts try to focus on the consequences of each risk and then on the objectively comparable features of those consequences.\textsuperscript{130} Risk analysts are thus under constant pressure to reduce the many dimensions of each problem to some common measure in terms of which objective comparison seems possible.\textsuperscript{131} They find the objective basis for their assessments in statistics dealing with mortality arising from risk. The statistics they use refer to technical estimates of human mortality or "body counts."\textsuperscript{132}

When experts assess a risk, "they are most concerned with how many people will die from it in an average year."\textsuperscript{133} In accordance with such a view it has been argued that it is irrational to fear nuclear power plants, air transport in jumbo jets, chemical additives, and contaminants in food or recombinant-DNA technology because they are less dangerous than cottage industries, wood stoves, transportation by car, or exposure to natural toxins or pathogens.\textsuperscript{134}

Experts defending such a quantitative approach concede not only that it is systematically and unquestionably biased toward the quantifiable aspects of a decisions, but also that some costs and benefits tend to be ignored because they are more difficult to measure than others.\textsuperscript{135} According to critics of quantitative risk assessment the admission is damning as what is left out altogether might be crucial to a properly informed decision. Others see risk assessment reducing entire problems to terms misstating their underlying structure in order that they may be quantified.\textsuperscript{136}

2. Public Perception of Risks

The views of expert risk analysts\textsuperscript{137} are often at variance, sometimes fundamentally so, with the public's perception of risk. For lay people and the public, riskiness means more that the expected number of fatalities.\textsuperscript{138} While

\begin{itemize}
  \item \textsuperscript{129} Id. at 3.
  \item \textsuperscript{130} Tribe, Policy Science: Analysis or Ideology?, 2 PHIL. & PUB. AFF. 66, 84 (1972).
  \item \textsuperscript{131} Tribe, Ways Not To Think Of Plastic Trees, 83 YALE L.J. 1315, 1319 (1973).
  \item Tribe refers to policy analysts of whom risk analysts are a species.
  \item \textsuperscript{132} Gillette & Krier, supra note 61, at 1072.
  \item \textsuperscript{133} Allman, Staying Alive in the 20th Century, 85 SCI. 31, 35 (1985), cited by Gillette & Krier, supra note 61, at 1073. See also Gillette & Krier, supra note 61, at 1072, where the authors state: "So, for example, when technical experts are asked to rank the risks of various activities and technologies their responses correlate highly with technical estimates of annual fatalities. When experts write about relative risk, they implicitly or explicitly use body counting as the relevant measure. . . . In the view of the experts, then, risk is a one-dimensional phenomenon . . . ."
  \item \textsuperscript{134} Huber, Safety and the Second Best: The Hazards of Public Risk Management in the Courts, 85 COLUM. L. REV. 277, 278 (1985).
  \item \textsuperscript{136} Tribe, supra note 130, at 96-97.
  \item \textsuperscript{137} Most risk experts presume that societal or public risk aversion is a linear function of the average annual probability of fatality associated with a hazard. K. FRECHETTE, RISK ANALYSIS AND SCIENTIFIC METHOD (1985) (see especially chs. 1, 2 & 6).
  \item \textsuperscript{138} Slovic, Fischhoff & Lichtenstein, Regulation of Risk, A Psychological Perspective, in REGULATORY POLICY AND THE SOCIAL SCIENCES 270 (R. Noll ed. 1985) [hereinafter Slovic].
\end{itemize}
fatality is a important factor, the public’s perception of risk is related to other factors such as the catastrophic potential, the threat to future generations and the “dread factor.” Increases in an activity’s dread factor, intensify its perceived risk. This higher risk perception results in more people wanting the risk reduced, together with a greater willingness to employ strict regulation to achieve the desired reduction in risk.139

Unfortunately, risk assessment does not take account of these qualitative and psychological perceptions of risk. This article adopts the cogently argued conclusion that the public’s richer and fuller multidimensional view of risk is fully justifiable on competing and equally valid rationales.140 Attempts to characterize, compare and regulate risks therefore, must be sensitive to this broader concept of risk.141

In global warming the statistical risk of mortality is small. Consequently, competing rationales for assessing risk become of special importance. Conversely, the qualitative fear of interfering with climate is very strong. There is a dread, amounting at times to a taboo, about interfering with the primordial and elemental forces of nature that shape climate. The thought of interfering with these mighty, perhaps almighty, forces that cause the rain to fall and the sun to shine bring dread and trembling to the minds of ordinary people. We stand in awe and fear of a climatic balance which has evolved through the ages to give us the stability of a habitable earth. To interfere with this fragile equilibrium, to destroy something which we cannot create, something which is the expression of millennia of evolution, is to meddle with the unknown. The consequences might be irreversible and horrendous.

Apart from the dread of unseen forces that might be released by global warming, rises in sea level also engenders fear and dread. The ordinary public associates rising seas with disaster. When Christ warned of the last days it was in terms of rising seas.142 Whatever the reality of dikes and levees, the common imagination does not perceive the rising sea as containable or arrestable.

3. Protecting Nature

The consequences of global warming, as we have noticed, are primarily ecological. We are dealing with a phenomenon that will largely affect life support systems rather than mortality. This creates particular problems for the risk analysts who have concentrated on risks to human health and seem impervious to risks that are posed to nature and ecological systems.

Risk analysts do not currently possess a generally applicable methodology for evaluating ecological risk.143 Yet genetic diversity and the ecological integrity of forests, wetlands and agriculture are threatened by global warming. Risk analysis founders in the face of laws that not only seek to enhance the environment’s economic utility but also seek to identify and preserve the intrinsic natural qualities of ecosystems.

139. Id. at 263-65.
140. Gillette & Krier, supra note 61, at 1071-76.
141. Slovic, supra note 138, at 270.
143. Unfinished Business, supra note 7, at 43.
In these laws we encounter a clear intention to preserve nature for its own sake and not because of its market value. For example, NEPA clearly requires consideration of adverse environmental effects on natural areas, and the preservation of the “natural aspects of our national heritage.” Among the goals of the Clean Water Act are the attainment of water quality “which provides for the protection and propagation of fish, shellfish, and wildlife.” The Clean Air Act contains provisions protecting parks and wilderness areas. The Marine Protection, Research and Sanctuaries Act of 1972 commits the nation to preserve the “health of the oceans.” The Endangered Species Act of 1973 finds that various fish, wildlife, and plants in the United States are in danger of extinction, and seeks to provide a means whereby the ecosystems upon which endangered species depend may be conserved. The Act pledges that the United States, as a sovereign state in the international community, will conserve to the extent practicable various species of fish, wildlife and plants facing extinction. The United States Supreme Court has held that section 7 of the Endangered Species Act admitted of no exceptions and required all federal agencies and departments to insure that actions authorized, funded, and carried out by them do not jeopardize the continued existence of any endangered species.

3(i). Utilitarian Rationales

This article does not propose to analyze the competing theories underlying the need to protect nature except to identify three broad rationales under which the protection of nature could be subsumed. The first is a utilitarian or anthropocentric rationale. It argues that nature should be protected because it is in the self interest of men and women to do so.

146. 42 U.S.C. § 7470(c).
148. 16 U.S.C. § 1531(a) & (b).
151. For a captivating introduction to the debate on how to value nature see Ashby, The Search for an Environmental Ethic, in THE TANNER LECTURES ON HUMAN VALUES 1-47 (S.M. McMurrin ed. 1980); see also Stone, Should Trees Have Standing? Towards Legal Rights for Natural Objects, 45 S. CAL. L. REV. 450 (1972); Meyers, An Introduction to Environmental Thought: Some Sources Some Criticisms, 80 IND. L. REV. 426 (1975). A distillation of the arguments, and his own rationale that the “transformative values” of nature offers a basis for its protections is offered by B. NORTON, WHY PRESERVE NATURAL VARIETY (1987). An illuminating and comprehensive survey together with an excellent analysis, the most definitive to date, is found in R. NASH, THE RIGHTS OF NATURE (1989).
152. Utilitarian is being treated here as broadly synonymous with that which is of value to humans, or contributes to human happiness, pleasure or some other substantive good. It is recognized that utilitarianism is a broad church which subscribes to a wide cluster of positions sharing a hedonistic theory of value and a consequentialist method of evaluating courses of action. This means that utilitarianism judges the value of actions according to the degree to which their consequences increase or decrease happiness, pleasure, value, or some other substantive good. M. SAGOFF, THE ECONOMY OF THE EARTH 105 (1988). The wide range of thinking encompassed by utilitarianism might make it too vague and inexact for more precise analysis. B. NORTON, supra note 151, at 7. The term does, however, serve our purposes of identifying and distinguishing broad approaches to the problems we address. See, C. STONE, EARTH AND OTHER ETHICS 115-16 (1987).
Consequently, to undertake species extinction is unwise because "[e]ach species provides a service to the environment; each species is a part of an immensely complicated ecological organization, the stability of which rests on the health of its components."153

Global warming will destroy forests, coastal and estuarine areas, together with the ecosystems they support. The effect of such destruction is that the whole planet's evolutionary heritage — its genetic diversity — will be put in jeopardy. Matthews accurately pointed out that the only reason species loss is not a front page issue is that the majority of species have not yet been discovered. The few conservation biologists who can even guess at the number of species that are vanishing think that twenty percent of all the species now living will be extinct by the year 2000 — without global warming.154

Global warming will dramatically increase this figure. The losses could be economically devastating. Genetic resources are an important source of materials for energy and construction, chemicals for pharmaceuticals and industry, vehicles for health and safety testing, and natural pest controls. Once they are lost, they will be lost forever. Ironically, these resources will be lost at the very moment when biotechnology makes it possible to exploit them for the first time.155 To assume that we could do without them is to make one massive false negative that could have devastating consequences. Increases in the global rate of extinction increases the vulnerability of the human species to extinction.156 Accordingly, human self interest is served by preserving ecological systems and their functioning parts.157

Additionally, ecosystems support natural resources such as fish. If they are destroyed humans will lose a vital source of food. For example, there is a material exchange between salt marshes and coastal waters. The outwellings of nutrients and organic detritus from salt marshes feed large areas of adjacent waters such as estuaries. This enrichment of estuaries helps to support an abundance of animal life and serve as the feeding and breeding ground of fish and bird life.158 A destruction of salt marshes will, therefore, have painful economic consequences. This article's Introduction suggested that the destruction of species constitutes a threat to the life support systems on which we depend. Such an argument is squarely based upon utilitarian reasoning.

3(ii). Altruistic Rationales

Other arguments offer an altruistic and non-utilitarian rationale for protecting nature. A variety of altruistic theories seek to establish reasons for

154. Mathews, supra note 1, at 165.
155. Id.
156. P. EHRLICH & A. EHRLICH, EXTINCTION: THE CAUSES AND CONSEQUENCES OF THE DISAPPEARANCE OF SPECIES (1981). The authors preface their book with a parable called the "Rivet Poppers." A person enters an airplane for a flight but notices a workman prying rivets out of the wings. When questioned the workman explains that the rivets can be sold for two dollars each, thus reducing the price of flying. Asked about the safety of the practice the workman replies that it must be safe as it has been going on for a some time and no wings have yet fallen off even after successive rounds of rivet popping. Id. at xi-xiv.
158. M. SAGOFF, supra note 152, at 6-9, citing such a view in order to criticize it.
protecting nature independent and apart from self interest and utilitarianism. These rationales are based upon deontological theories positing in essence, that nature is to be protected because we have an obligation — an ethical duty beyond self — to do so.\textsuperscript{159} Professor Tribe, for example, argues that “[w]e can be truly free to pursue our ends only if we act out of obligation, the seeming antithesis of freedom.”\textsuperscript{160} To be free is to choose what we shall be. In doing so, we must be able to reason about what to choose and to choose in terms of commitments we have made to bodies of principle that we perceive as external to our choices and by which we feel bound. “Individually or communally defined human interests may often be at odds with the primal ethical impulse — the sense of duty beyond self — that gives passion and impulse to many who see elements of the inviolable in nature.” In such a situation, the ethical duty beyond self becomes the sense of obligation offering a rationale for protecting nature.\textsuperscript{161}

Sagoff, though disagreeing with Tribe on his formulation of a nature centered rationale, belongs to the same altruistic, though anthropocentric, tradition. He argues that “[w]e value the health and integrity of natural ecosystems because they command our love and admiration.”\textsuperscript{162} “Love, reverence and respect are human values but they do not necessarily involve human welfare. Rather, these human values maybe directed to the well being and integrity of the rest of nature.”\textsuperscript{163} What distinguishes these values from utilitarianism is that they are directed toward the good of nature and not the good of humans. Accordingly, wild mountain valleys, bays and marshes are valued for their spiritual, cultural and aesthetic worth.\textsuperscript{164}

In his celebrated \textit{Theory of Justice}, John Rawls explained how contractual arrangements may have occurred at the beginning of any society. Rawls further envisioned that a group of people could draw up what would be acceptable principles of justice and equality provided they worked behind a veil of ignorance unaware of the status and position they would themselves hold in the society to be governed by those principles.\textsuperscript{165} Tribe has proposed adding nature to the contractual arrangements between people. A morally evolving and expanding concept of community, that has included blacks and women, is beginning to incorporate animals, plants, and perhaps canyons, mountains and seashore. In such a situation, Rawls’ principle of maximum liberty (which applied equally to all members of the community) would maximize the benefits for all life not merely human life.\textsuperscript{166}

\textsuperscript{159.} Stone, \textit{supra} note 151, at 115-16; B. NORTON, \textit{supra} note 151, at 7-8; M. SAGOFF, \textit{supra} note 152, at 155-65.
\textsuperscript{160.} Tribe, \textit{supra} note 131, at 1326.
\textsuperscript{161.} \textit{Id.} at 1331.
\textsuperscript{162.} M. SAGOFF, \textit{supra} note 157, at 5.
\textsuperscript{163.} M. SAGOFF, \textit{supra} note 152, at 148.
\textsuperscript{165.} J. RAWLs, \textit{A THEORY OF JUSTICE} 60-65, 136-38 (1971).
In similar vein Eric Ashby creatively suggests that what happens behind John Rawls's veil of ignorance could be applied to the environment. In arriving at a consensus the people would be considering not only their individual self-interests but also the good of the group or community in which they would live. Behind such a veil of ignorance they might well consider Sagoff's problem of the decline of rockfish in Chesapeake Bay caused by pollution. If the rationale for environmental protection is purely utilitarian a possible answer could take the form of converting the Bay into a factory farm for rockfish. If the land could be developed for agriculture, then so could the sea. For example, the Bay could be divided by concrete weirs into neat aquacultural plots. Ecologists could write computer programs to manage the production of crabs, oysters and other finer foods for which there is a market. Genetic engineers might create a new species by recombining genes or they may culture edible tissues in vitro. While this was happening the main channel of the Bay could be utilized efficiently as a sewer and liquid highway.

On the other hand it is equally rational, and more probable, for the decision makers behind the veil of ignorance to arrive at conclusions that seek to preserve the "health" and "integrity" of the Bay, simply because they believe that natural resources should be protected because of cultural, aesthetic and spiritual values independent of human health or consumer demand. According to Mark Sagoff an estuary like Chesapeake Bay may be seen by those who depend on it as a way of life, and viewed as part of a long and proud cultural and historical heritage that should be protected.

Such an argument resonates in international law. Christopher Stone reports that the environmental protection given to the Antarctic by the parties to the Antarctic Treaty of 1959 was not intended to keep the Antarctic preserved so that it could be enjoyed by others. What the negotiants all felt was an awe for the region, "for the fact that of the entire earth, nothing on that scale had remained as little touched by human intervention."

3(iii). Nature Centered Rationales

Finally, other environmentalists, appalled by the human destruction of nature and habitat have attributed intrinsic value to non-human species, arguing that however useful they are for human purposes, their full value is not exhausted by instrumental values. Nature has a right to exist wholly apart from humankind. The value of nature results from qualities it possesses rather than its utility to human purposes. Nature has a right to exist wholly apart from humankind.

167. Ashby, supra note 151, at 32. Ashby invites us to substitute "environment" for justice and equality. He argues that environmental policies are indeed made under a veil of ignorance and that those making policies are displaying welcome prudence. What is being addressed in the text is not the substitution but the addition of environment to other deontological theories.

168. M. SAGOFF, supra note 157, at 4-6.

169. Id. at 5.

170. Id. at 12.

171. C. STONE, supra note 152, at 95-96. He cites his student Professor Steve Burton. However, see Burton, New Stresses on the Antarctic Treaty: Toward International Legal Institutions Governing Antarctic Resources, 65 VA. L. REV. 421, 432 n.67 (1979), where Burton suggests that Sagoff's thesis could be extended to international environmental problems only with considerable attenuation.

172. "The other beings... have just as much right to be in that place as we do, they are their own justification for being, they have inherent value, value completely apart from whatever worth they have for humans." David Foreman quoted in R. NASH, supra note 151, at 4. This
than its usefulness in serving values external to it. These “biocentric”
philosophers assume that all forms of life, including plants and animals, possess
inherently equal value. Proponents of biocentricism see a natural
progression from the freeing of slaves, to the granting of voting rights to
women, to the eventual recognition of the rights of nature. This view runs
counter to the methods that assess the worth of objects on the basis of their
demand value, or their aesthetic, cultural or spiritual value to humans.

Regardless of the exact rationale underlying the protection of nature,
there is little doubt that risk assessment, as presently practiced, does not give
nature its rightful place in the evaluation of environmental risks. Any
assessment of the effects of global warming, therefore, must give full weight to
the awesome impact it will have on nature.

4. Should We Address Effects Rather Than Causes?

Apparently, influential voices in the Bush Administration argue that the
United States should address the effects of global warming rather than its
causes. In their view, even if global warming is proved to be caused by the
burning of fossil fuels, seeking emission limits on carbon dioxide will be too
costly in socioeconomic terms. They argue that it is more sensible and
prudent to counter the effects of global warming rather than the causes.

A State Department position paper prepared for a meeting of the
International Panel on Climate Change, resisted an attempt by some nations to
impose limits on carbon dioxide. The argument appears to be that the costs
of emission limitations on carbon dioxide emissions will be too costly.
Accordingly, any steps against global warming should not aim at “protecting
the climate, per se.” Rather, the objective should be “to protect social,
environmental and economic well-being from the adverse effects likely to result
from global climatic change.”

This line of argument suggests that we can, for example, build sea walls
and levees against the rising sea thereby protecting centers of population, and
design different irrigation and crop procedures adaptable to warmer climates.
Presumably we can exist without the forests and species that will be

is a philosophical trend which emerged in the 1970’s. Feinberg has cogently argued that plants
and species could not possess rights essentially because they lacked “cognitive capacity.” They
are unaware of their treatment and could not, therefore, have an interest in not being harmed.
Without the capacity to assert interests or benefits, nature could not possess rights. Feinberg,
Rights of Animals and Unborn Generations, in PHILOSOPHY AND ENVIRONMENTAL CRISIS
47-51 (W. Blackstone ed. 1974). Legal philosophers played a key role in refuting such an
argument, and making the case that inanimate objects, which are unaware of their treatment
because they lack "cognitive equipment" may still possess rights. See Morris, The Rights and
Duties of Beasts and Trees: A Law Teacher’s Essay for Landscape Architects, 17 J. LEGAL
EDUC. 185, 189-91 (1964); Murphy, Has Nature Any Right to Life? 22 HASTINGS L.J. 467
(1971). The most celebrated of these efforts is, of course, Stone, Should Trees Have Standing?
Toward Legal Rights for Natural Objects, 45 S. CALIF. L. REV. 450 (1972).

174. R. NASH, supra note 151, at 6-7.
178. Id.
irretrievably lost by addressing effects rather than causes. This position is fundamentally flawed for four major reasons.

The first is ethical and has two facets to it. A number of poorer nations obviously cannot afford the cost of these measures. The assumption, therefore, is that entire areas of land such as the Maldive Islands, together with the most fertile food producing areas in the third world, like the Nile delta and parts of Bangladesh, should be surrendered to an advancing sea. The cost in human life and starvation would be tremendous.

It could also be argued that the effects addressing approach is unethical in terms of the toll it would exact on animal life as well as human life. As noted earlier, this argument has three strands. Two of these, the altruistic and biocentric rationales, claim that it is wrong to harm nature. We have seen how an altruistic rationale for protecting nature has given an unprecedented moral dimension to the utilitarian arguments for conservation. Human values of love and reverence are directed toward nature as opposed to the well being of humans. We also noted that some attach intrinsic value to nature, thus recognizing nature’s right to exist. On either of these premises the destruction of nature and ecological systems that will be caused by the building of sea walls is ethically wrong.

The second argument is economic. The effects of global warming on agriculture and the possible depletion of natural resources has already been reviewed. The effects addressing solution assumes a “best case” scenario that assumes temperature rises of little more than one or two degrees centigrade. Higher temperatures would cause economic dislocations that would far outweigh the cost of addressing global warming at its source.

The third reason impairing the effects solution lies in the destruction it will cause to cultural heritage and inheritance. The world is gradually becoming alive to its duties as posterity’s trustee of a common and indivisible architectural and cultural heritage. It would, however, be folly to believe that debt ridden third world countries will have the resources to indulge in projects to preserve historic sites from rising sea levels. A relatively modest effort to save the temples and tombs of ancient Nubia entailed an international effort from 1949-1967 costing over $40 million. This type of project would

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179. Ethics is used here to refer to morality or the science of ethics. THE OXFORD ENGLISH DICTIONARY, vol. V (2d. ed. 1989). Hence the ensuing discussion involves the rightness or wrongness of the effects addressing solution advocated by the State Department insofar as it would affect human and animal life.

180. The cost of relocating entire populations is well documented. See generally A. ZOLBERG, A. SUHRKE & S. AGUAYO, ESCAPE FROM VIOLENCE: CONFLICT AND THE REFUGEE CRISIS IN THE DEVELOPING WORLD (1989), for a discussion of the refugee problem in the third world. Refugees from armed conflicts often end up in as diseased and violent an environment as the one from which they escaped. International relief efforts are just unable to meet this fearful challenge.

181. See supra notes 152-55.

182. See supra notes 163-74 and accompanying text.

183. See supra notes 159-71 and accompanying text.

184. For a striking and costly example of an international effort to preserve a cultural legacy in Nubia—the gateway to Africa—that would have been lost when the Aswan dam was completed see TEMPLES AND TOMBS OF ANCIENT NUBIA (Torgy Säve-Söderberg ed. 1987).

185. Id. at 104. Originally the Nubian temples of Abu Simbel were situated a few meters above the Nile River. The construction of the High Dam at Aswan meant, however, that the water level of the Nile was going to rise year by year from 1964 onward.
be simply impossible for the scores of sites found in the coastal and estuarine areas of the world.

Finally, building concrete structures against an invading sea will afford temporary relief based on a best case scenario. The measures taken to contain effects assume global warming of the kindest and mildest kind. A worst case scenario, or even severe climatic change, is not even contemplated. Wise decisionmaking must surely embrace a fuller concept of risk and aim at a more permanent solution. Such a permanent solution can only arise when we address the causes rather than the effects of climatic change.

The State Department's arguments are insupportable on ethical, economic and cultural grounds. Moreover, they run counter to the position endorsed by the United States at the Paris Communique\(^{186}\) and affirmed by President Bush at the United Nations.\(^{187}\) The position of the State Department should be abandoned and repudiated, and those of the Paris Communique and climatic bills\(^{188}\) restored.

III. THE POLITICAL CONTEXT

A. The Need for Integration

Issues of science and science policy concern only one aspect of global warming. We must also address the problem within a more overtly political framework. In the past, global insecurity was posed by military threats and armed aggression.\(^{189}\) The threat to security as Lester Brown pointed out with percipience and insight, "may now arise less from the relationship of nation to nation and more from the relationship of man to nature."\(^{190}\) In light of such a peril the demand to redefine national security to include environmental dangers is difficult to resist.\(^{191}\) The security problem global warming presents cannot be solved between two superpowers or even by the efforts of the major industrialized countries. Safeguarding the world requires a truly global effort. This effort must include the domain of international law.

Both the United States and the international community face a common foe, and need to arrive at measures that can succeed against it. Recognition that United States policy is addressing a common global problem makes it evident, at both national and international levels, that the fashioning of common policies between the United States and the international community of states presents an eminently sensible and rational way of meeting the challenge. To the extent

\(^{186}\) Supra note 19.

\(^{187}\) Chicago Trib., supra note 177.

\(^{188}\) Supra note 19.

\(^{189}\) We witness the staggering collapse and death throes of an empire that is perceived as the primary cause of insecurity. Security, has usually been viewed as the freedom from danger posed by military threats and armed aggression. National security has, therefore, been thought of as the capacity of the United States to thwart armed aggression by the Soviet Union. Unfortunately, even the removal of the Soviet threat, and the dismantling of the nuclear arsenals, the cause of military insecurity, will not usher in an era of security. See also ARMS CONTROL ASS'N, ARMS CONTROL AND NATIONAL SECURITY 5-15 (1989).


\(^{191}\) The case for an extended definition of security is strengthened by the fact that the concept was expanded in the 1970's to include international economics as it became clear that the United States economy was no longer an independent force and was powerfully affected by economic policies in other countries. Mathews, supra note 1, at 162.
that it is a common problem, we must search for common answers acceptable to all countries and capable of incorporation into both international and national legal systems. If, therefore, the United States can pioneer strategies, policies and laws that could be adopted by the rest of the international community, it would in fact be providing solutions at the levels of both national and international law. Consequently, United States environmental laws dealing with global warming that integrate national, comparative and international approaches, will constitute a rational and compelling legal response to a global peril.

Hitherto environmental problems usually were experienced, detected and interdicted within local or national boundaries.192 National legal systems possessed the jurisdictional power and the capacity to solve them.193 Unfortunately, global warming cannot be solved in this way. It arises because the atmospheric commons, shared by all nations, has been polluted by the very nations that depend on it.194 Unilateral national legislation adopted by the

192. Such an assertion does not in any way seek to underplay the severity or the magnitude of national problems. For example, in the United States rivers burst into flames, water supplies were polluted, coastal zones had become despoiled by oil, and the air was badly fouled. Millions gathered to protest such environmental depredations and violence on Earth Day 1970. N.Y. Times, April 23, 1970, at 1, col. 3. For a summary of the nationwide reporting of these activities, and their impact even on conservative politicians and observers, see J. WHITAKER, STRIKING A BALANCE 2-16 (1976); see also ADVISORY COMMISSION ON INTERGOVERNMENTAL RELATIONS (ACIR), PROTECTING THE ENVIRONMENT: POLITICS, POLLUTION AND FEDERAL POLICY 18 (1981).


194. Although it is the most ominous among the global perils, global warming shares many attributes of other second generation environmental problems. Wetstone, A HISTORY OF THE ACID RAIN ISSUE, in SCIENCE FOR PUBLIC POLICY 163 (H. Brooks & L. Chester eds. 1987). Examples of other second generation problems include: ozone depletion; the destruction of genetic diversity; and the cycling of toxic chemicals through the environment. The massive increase of CFC's has resulted in the depletion of the ozone layer. See infra text accompanying notes 235-66.

The genetic diversity of the species inhabiting the planet has been endangered by massive deforestation and destruction of natural habitat. Tropical forests harbor a disproportionate share of the earth's biological diversity. Each year an area the size of Austria is being deforested from these tropical forests. Biologists estimate that species are being lost at a rate 1,000 to 10,000 times faster than the natural rate of evolution. BIODIVERSITY 3-18 (E. Wilson ed. 1988). As many as twenty percent of all the species now living may disappear by the year 2000. Mathews, supra note 1, argues that the loss will be felt aesthetically, scientifically and, above all, economically. These genetic resources are an important source of food, materials for energy and construction, chemicals for pharmaceuticals and industry, vehicles for health and safety testing, natural pest controls, and dozens of other uses. "The bitter irony is that genetic diversity is disappearing on a grand scale at the very moment when biotechnology makes it possible to exploit fully this resource for the first time." Id at 165. See also Wolf, AVOIDING A MASS EXTINCTION OF SPECIES, in WORLDWATCH INSTITUTE, STATE OF THE WORLD 100 (1988).

The cycling of toxic chemicals through the environment has proved pandemic and assumes the character of a global threat. There are over 5 million known chemical of which about 60,000 to 70,000 are in use. Both conventional and toxic pollutants are cycled through the oceans, the atmosphere, the biosphere and the geosphere. Toxic chemicals moving through
United States, prohibiting such pollution, will not solve the problem when other nations continue to pollute. The United States is only one (though perhaps the most important) among 160 nation states. The problem insists on common and concerted action at both global and national levels.

But this is no occasion to invoke, far less celebrate, existing international law. That law possesses neither the jurisdiction and institutions, nor substantive law and remedies, to deal with the problem. Alas, international law as well as national laws permit the pollution of the global commons. Even in a shrinking, interdependent world, international law is premised upon national sovereignty, and nation states insist upon the sovereignty, supremacy and independence to determine their own course of action. Consequently, when we confront problems that have outstripped and outgrown the existing capacity of both national and international legal systems, we also confront a glaring lacuna in the law.

The legal gap referred to can only be overcome by a new generation of United States environmental laws that seek to integrate international and national policy and law. Integration is an elastic term encompassing a spectrum of meanings ranging from implementation\textsuperscript{195} to unification.\textsuperscript{196} For our purposes integration is synonymous with compositeness rather than unity. It ensures that United States law, by sharing a common core objective with international concerns, will facilitate the adoption of international law. Consequently, United States law will cohere with international law to form an identifiable whole. Integration generates United States and international lawmaking but does not call for the unification or uniformity of such laws. Before we embark on an examination of how this lacuna might be filled by integrating international law into United States law, it is necessary to delineate a rudimentary theory of lawmaking.

\textbf{B. Decision Making Theory}

This article does not purport to offer an all embracing theory explaining the formation and development of United States law or of international agreements in general. Nonetheless, it is useful to offer an embryonic conceptual framework justifying a premier United States role in controlling global warming. The embryonic framework offered is derived from United States law, by sharing a common core objective with international concerns, will facilitate the adoption of international law. Consequently, United States law will cohere with international law to form an identifiable whole. Integration generates United States and international lawmaking but does not call for the unification or uniformity of such laws. Before we embark on an examination of how this lacuna might be filled by integrating international law into United States law, it is necessary to delineate a rudimentary theory of lawmaking.

\begin{itemize}
\item the environment pose a global threat because of their toxicity, persistence and bioaccumulation. They cause death or serious illness in very low concentrations—in the low parts per billion or parts per trillion. As they journey through oceans, the atmosphere and biosphere they leave a trail of sometimes deadly harm that can only satisfactorily be dealt with through international mechanisms. The international magnitude of the problem has resulted in a number of international conventions.
\item Implementation refers to the process of bringing national laws into conformity with international laws and standards.
\end{itemize}
States political theorizing and is extended to the much wider canvas of international relations. 197

The theory of lawmaking begins by rejecting the Kafkaesque public choice theories of democracy, legislative behavior, and regulation, 198 which have been extended by economists to international treaty making. 199 The cognate concept of game theory, 200 which is a method for studying decision making in situations of conflict, is also rejected.

Public choice theories 201 view the democratic sphere as rotten at its core, a domain of unprincipled avarice and brigandary, dominated by selfish, self-seeking, single minded individuals. While it is not proposed to exhaustively argue the case for rejecting such postulations, the bare reasons for so doing can be asserted briefly. To begin with, it simply is not true that all human action is egotistic and self-seeking. While self-interest does play a major role, it is not the sole determinant of human behavior. It has been argued that altruism, like self-interest, has a genetic evolutionary base, 202 and there appears to be substance in such a view. The explanation of human behavior as being altruistic in some situations, and self-interested in others, is not based upon such theories. Instead it is based upon the premise that all judgments and preferences cannot be reduced to a single dimensional quantitative form. 203

James Buchanan, who argues that self-interested behavior in the market place is extended to the public domain, finds it implausible that man should "shift his psychological and moral gears when he moves from the realm of

197. The United States with its federal form of government, and disparate interest groups, offers a close analogy to the international system.

198. These "public choice" theorists apply economic theory to political decision making. "The basic behavioral postulate of public choice, as for economics, is that man is an egotistic, rational utility seeker." D. MUELLER, PUBLIC CHOICE 1 (1979). Politics is understood as the extension of the market in which everyone seeks to further their interests. In a democracy where a majority binds a minority, "to the individual member of the effective majority, the political process provides a means through which he may secure private gain at the expense of other citizens." Buchanan, Politics, Policy and the Pigovian Margins, in THEORY OF PUBLIC CHOICE 174 (J. Buchanan & R. Tollison eds. 1972). Accordingly, they see the political system as designed to serve the self defined private interests of individuals or groups who compete for whatever serves their own self interest. Given a political system where interest groups dominate, the legislative process becomes a microeconomic system in which actual political choices are the result of transactions between reelection minded legislators and self seeking interest groups. See D. MUELLER, PUBLIC CHOICE (1979); J. BUCHANAN & G. TULLOCK, THE CALCULUS OF CONSENT (1962); A. DOWNS, AN ECONOMIC THEORY OF DEMOCRACY (1957); W. RIKER, LIBERALISM AGAINST POPULISM (1982); Landes & Posner, The Independent Judiciary in an Interest Group Perspective, 18 J. L. & ECON. 875 (1975); Easterbrook, Statutes' Domains, 50 U. CHI. L. REV. 533 (1983). For a fuller review of public choice literature, see Farber & Frickey, The Jurisprudence of Public Choice, 65 TEX. L. REV. 873 (1987).


organized market activity to that of organized political activity . . . ." But such a shift of gears or a change of decision criteria is a fact of life. It is something we do almost automatically when extending love, charity, care or sympathy to others. Self interest and altruism may be alternative wellsprings of action. Human conduct is often governed by contrasting motivations. In the result a person may have a number of values or principles which are incommensurable with one another.

If such a view be taken, politics ceases to be the self-serving activity portrayed by public choice theorists. Public decision making could become a search for good or right answers. According to Frank Michelman:

[W]e must be able to imagine ourselves voting for the Endangered Species Act — that is, committing ourselves to the principle of sympathy, or solidarity, or immanence, or whatever principle we think is expressed by the Act — although we would not as individual be willing (or bet that our constituents would be willing) to pay any measurable sums of money for the enactment of that principle; and although no one has offered us anything in exchange for our vote, explicitly or implicitly; and although we know well that we may some day find our own private projects inconvenienced or thwarted by the statute and the principle to which we are now committing ourselves.

This more sanguine explanation of human action is confirmed by empirical evidence. To begin with, such evidence repudiates the public choice view that voters largely seek their own financial benefit when they vote. Voter surveys reveal that perceptions of how government affects the interests of others, rather than their own selfish interest alone, better explain voter reactions to economic downturns. Voters who had themselves been unemployed or seen a decline in their economic fortunes did not tend to vote against incumbents, whereas those who thought incumbents generally incompetent or thought the economy generally weak tended to vote against those in office. Similarly, ideology rather than utilitarian benefit predicted how people responded to the need for a national health insurance. The empirical evidence suggests that it is "simply not the case that self-interest dominates wherever voters would rationally assume that their economic interests can be affected, and that they 'rationally' remain essentially uninterested in all other cases."

204. J. BUCHANAN & G. TULLOCK, supra note 198, at 177.
Secondly, the public choice claims that legislation is simply a series of transactions between reelection-minded legislators and self-seeking private interest groups remains unsubstantiated. Obviously, legislators have a strong desire to be reelected, but this is leavened by other factors such as prestige within the legislature and a desire to constructively contribute to policy debates.\(^\text{211}\) The obverse contention, that the role of interest group pressure on voting by representatives is large, is also repudiated by most empirical studies.\(^\text{212}\) Massive areas of legal policy making, illustrated by the Civil Rights legislation of the 1960’s and the deregulation movement of the 1980’s, seem quite inconsistent with public choice theory. In both these cases many representatives risked the wrath of powerful single interest groups to act on the basis of what they felt was ideologically right.\(^\text{213}\)

The preponderance of social and environmental legislation flies in the face of public choice and its running companion—economic theories of regulation. In protecting the environment legislators did not act as “rent seekers,” neither did they embrace the market model of legislation nor engage in cost-benefit analysis. The primary objective and rationale of legislation was not to serve reelection or conversely, as other economists suggest,\(^\text{214}\) to address problems of competition, correct market failures, or deal with natural monopolies. Legislation was based on moral, aesthetic, and cultural non-market values enmeshed in broad political objectives. The promotion of efficiency was not the primary objective of legislation.\(^\text{215}\)

What Congress did can best be explained on the basis of a republican theory of government which posits that legislators have both the obligation and

\(^{211}\) R. FENNO, JR., CONGRESSMEN IN COMMITTEES (1973); Farber & Frickey, supra note 198, at 888-90.


\(^{214}\) See, e.g., S. BREYER, REGULATION AND ITS REFORM 1-35 (1982).

\(^{215}\) Through efficient means of realizing such objectives were clearly embraced. M. SAGOFF, supra note 152, at 24-49. To the extent that the subjective happiness, satisfaction or utility of people is the objective of legislation, criteria for measuring utility efficiency are unsatisfactory. The science of welfare measurement requires a surrogate (wealth) in order to account for the observer’s inability to measure the real thing (subjective well being). But mistaking the surrogate for the real thing, or worse, passing the surrogate for the original is a different matter. See Hovenkamp, supra note 201, at 81-85. As Hovenkamp points out, surrogates for utility such as those designed by Kaldor-Hicks do not provide a satisfactory measure of such happiness. In situations where interpersonal comparisons of utility are scientifically impossible, Kaldor-Hicks was designed as a substitute test for social utility. It seeks to identify policies that increase the sum total of happiness. A policy is Kaldor-Hicks efficient when those who gain from the policy can fully compensate the losers out of their gains. See R. JUST, D. HEUTH & A. SCHMITZ, APPLIED WELFARE ECONOMICS AND PUBLIC POLICY 34 (1982).
the capacity to identify the public good. Such a view is irreconcilable with "public choice." In so acting, Congress regulates to maximize the well being of the community even though it does not maximize efficiency or wealth. Within the republican view, legislators both discern a public interest and educate their constituencies about the civic good. They do what is right for the body politic and not for a particular interest group they happen to represent.

The framework suggested by this article draws support from the dynamic view of the policy forming process taken by political scientists such as John Kingdon and James Wilson. Kingdon rejects "public choice" theories of legislation, as well as the usual political science preoccupation with pressure and influence. Instead he makes excursions into the world of ideas and politics and recognizes their importance in the form and content of legislation. Kingdon borrows from the "garbage can" model of organizational choice that views the political system as a garbage can in which "streams" exist. The streams consist of "problem recognition," "policy proposals" and "politics." He suggests that the enactment of a law requires the convergence of all three streams, together with the presence of an "entrepreneur" to guide its passage through Congress.

Extrapolating Kingdon's theory to international law and to global warming, this article argues that the streams have converged, making it a propitious time for the enactment of new international law. This analysis offers a preliminary explanation of the evolving form and shape of laws dealing with global warming. "Problem recognition" consists of how global warming is perceived. The scientific evidence dictates that a serious problem exists. There is a convincing consensus among scientists that we face a grave threat. Although there are doubts about the effects and the possible remedies, the gravity of the global problem and the need to address it are not in issue either within the United States or internationally.

222. Id. at 92.
223. See infra text accompanying notes 248-65.
"Politics" refers to the state of public opinion, which is running heavily in favor of fast and effective environmental action to prevent global warming. Although the framework offered in this article differs fundamentally from those based on public choice and game theory, there can be little doubt that domestic politics plays a substantial, perhaps dominant, role in forming and shaping international agreements.\textsuperscript{225} In this context, the findings of the National Opinion Research Center are momentous. For the first time Americans chose the environment as their number one priority for more government spending ahead of crime and health care.\textsuperscript{226} Global warming has become a bipartisan subject in which powerful legislators from both parties have become involved.

The surge of international activity mirrors United States national concerns. The behavior of states, in the face of a public threat to the entire community of nations, could be governed by three broad options. One option is to be a free rider: let everyone else cooperate to stem global warming and accept the benefits without the costs. Another is true altruism; take unilateral action even though other countries do not do so. A third option is reciprocal altruism. Fred Hirsch characterizes it "as if" altruism: to cooperate provided everyone does.\textsuperscript{227} The third option in the one consistent with down to earth, practical national and international politics. All the evidence points to the adoption of such an option. It cultivates the field for the right policy proposals.

The "policy proposals," based on the four themes discussed below, lead to the conclusion that carbon dioxide emissions should be reduced by by twenty percent by the year 2000. The proposals have arisen in response to the perceived environmental crisis. The Dutch government, which will unilaterally cut carbon dioxide emissions without a multilateral treaty, is playing a catalytic role.\textsuperscript{228} Holland is too small a country, however, to shoulder and carry through such an important proposal. A global entrepreneurial role can only be played by a major international force. The United States is still the most important global power and it is argued that the United States should take on this mantle.

C. An Entrepreneur for International Law

United States leadership is the necessary catalyst in the formation of effective international law controlling global warming. International law is still at an early, even primitive, stage of development, and has not matured into a legal system, as that term is ordinarily understood. It is unnecessary to explore the well recognized distinctions between developed national legal systems and the undeveloped state of international law except to point out that international law does not possess a binding law-making agency or international legislature, it has no law interpreting body or court with universal compulsory jurisdiction,

\textsuperscript{224} Even those approaching international agreements from a "public choice" standpoint identify the existence of a scientific consensus as one of the key actors that could lead to an international agreement. Hahn & Richards, supra note 16, at 421, 433 (1989).

\textsuperscript{225} Hahn & Richards, supra note 16, at 422.

\textsuperscript{226} Chicago Trib., Dec. 31, 1989, § 4, at 1, cols. 1-3.

\textsuperscript{227} F. HIRSCH, SOCIAL LIMITS TO GROWTH 146 (1977).

\textsuperscript{228} N.Y. Times, Nov. 7, 1989, at 11, cols. 1-3.
and no law enforcing or policing agencies. Consequently we have yet to witness the development of an international legal system, as distinct from discrete rules of international law. See H. Hart, The Concept of Law 77-97, 208-32 (1961); E. Hoebel, The Law of Primitive Man (1954); Parsons, The Law and Social Control, in Law and Sociology; Exploratory Essays (W. Evans ed. 1962).


231. Harvey Brooks, an eminent writer on science policy, points out that past attempts to use international scientific networks to influence national political decisions have had limited success largely because of a lack of political sensitivity. Proposed measures have to be measured by the pulse of the political process and cannot only be taken on the basis of more scientific information or expertise. Law making is difficult enough in the United States. Those difficulties are multiplied in the
international context. The complications of crossing from cognition to solution are compounded by the fact that the international "legal system" is so much weaker than a national legal system. The international community may agree on what the environmental problems are, and even on what ought to be done about them, but international political and legal processes hardly lends themselves to the expeditious translation of "ought" to "is."

In this situation of cumbersome and sometimes irrational international lawmaking the United States can make a critical contribution to the emerging tapestry of environmental law and policy. The process of working towards the creation of national law will equip and enable the United States to press for the acceptance of a global convention. The intervention of the United States as a superpower and an economic giant in favor of a treaty on global warming will be critical if not decisive. Because the United States is, arguably, still the most important environmental player on the global scene and its internal actions will make a critical contribution to the speedier evolution and creation of new international law.

The recent response to ozone depletion, which is analogous to global warming, is instructive of the way in which the first question concerning the likelihood or certainty of risk evoked similar answers from United States and international lawmakers. Scientists found mounting evidence that chlorine containing substances, more especially fully halogenated chlorofluorocarbons (CFC's), when released into the atmosphere, slowly migrate into the stratosphere and are broken down by solar radiation. The chlorine atoms so produced catalyze a series of reactions that ultimately destroy ozone. Authorities estimated that such a destruction of ozone would admit greater solar UV-B radiation that would lead to increased basal skin cancers and squamous-cell cancers.

Under the auspices of the United Nations Environment Program (UNEP), a global framework convention for the protection of the ozone layer — the "Vienna Convention for the Protection of the Ozone Layer" — was signed in 1985. It was an umbrella convention containing broad obligations lacking specificity. More specific and binding rules were to be elaborated in

and marginal compromise in caucus, in committee, on the floor, and in negotiations with the executive. W. KEEFE & M. OGUL, supra, at 15-16.

234. There is no law-making body or international legislature, no law interpreting body or court with universal jurisdiction, and no law enforcing body either administratively or punitively. Consequently we have yet to witness the development of an international legal system, as distinct from discrete rules of international law. See H. HART, supra note 229, at 77-97; 208-32; E. HOEBEL, supra note 229; Parsons, supra note 229.

235. The atmosphere is divided into the troposphere (9-16 km), stratosphere (16-50 km), and the mesosphere (50-80 km).

236. Ultraviolet (UV-B) radiation has biological effects such as skin cancer, reduced growth of crops, damage to living marine resources, and to commercially important material.


the form of protocols and technical annexes. The lack of agreement on more concrete measures was partly attributable to the absence of scientific proof of CFC damage.\textsuperscript{239} Shortly after the Vienna Convention concluded, scientists discovered a hole in the ozone layer over Antarctica,\textsuperscript{240} and found that there had been a dramatic forty percent decrease of springtime ozone between 1977 and 1984. They realized that the scientific conclusions on which the Vienna Convention relied had seriously underestimated the extent of ozone depletion. The new scientific findings led to a burst of activity,\textsuperscript{241} led by the United States, that culminated in the Montreal Protocol.\textsuperscript{242} It might be pointed out that the ozone hole did not conclusively prove the culpability of CFC's.\textsuperscript{243} Be this as it may a scientific consensus emerged, which the United States argued, warranted international action. Such action was in fact taken. The ozone story illustrates the importance of an entrepreneur capable of employing scientific findings to advance international lawmaking.\textsuperscript{244}

Furthermore, United States law could be adopted or could generate similar laws in other countries. The foreign impact of United States environmental law and policy has been formidable. The National Environmental Policy Act (NEPA) revealed how environmental impact could be ascertained and become part of the broader policy-making framework.\textsuperscript{245} The EPA demonstrated that a centralized pollution inspectorate could become a reality, while citizen suits offered an antidote against administrative apathy. Freedom of information opened the doors to environmental participation.\textsuperscript{246} Even the much maligned, rigorous, combative character of environmental laws dealing with air and water pollution, are now seen as the wave of the future.\textsuperscript{247} International law is a consensual law that arises only if nations agree to its creation. The nations which emulate United States laws will be among the law-makers of international law, and it would be perfectly natural for them to agree to international law that mirrors their own preferences.

**D. Justifying United States Leadership**

At this point we confront the political objections that oppose a premier United States role in integrating domestic and international law. Political misgivings exist about the wisdom of this country taking hasty action that might affect its economic performance, or place it at a competitive disadvantage. It is not a satisfactory answer, to those lodging these objections, to be told that the

\textsuperscript{239} J. BRUNNEE, ACID RAIN AND OZONE LAYER DEPLETION 229, 237 (1988).
\textsuperscript{241} Doolittle, supra note 4, at 421-22 (1989).
\textsuperscript{243} In fact there was no ozone hole, only a large depletion of ozone. Stolarski, supra note 240, at 30.
\textsuperscript{244} For further implications with regard to the role of the United States see infra note 4 and accompanying text.
\textsuperscript{246} This is an impressionistic though widely shared view. For a recent expression see Bonine, A Voice From the Wilderness, Calling Your Name, 6 YALE J. ON REG. 393, 393-95 (1989).
\textsuperscript{247} D. VOGEL, NATIONAL STYLES OF REGULATION 27 (1986).
United States has always led the world in protecting the environment, or that we should demonstrate by the effectiveness of our environmental actions at home our leading role in global environmental protection. Those opposing a pioneer role do not share the assumption that this country should play a leading role in protecting the environment, or be at the vanguard of the international environmental movement, if doing so will affect its economic position.

Paradoxically, arguments from an ecological, as distinct from a political perspective, are premised upon the hopelessness of remedial action by individual nation, including the United States. Such arguments can only be elliptically summarized. From an ecological perspective we live in an interconnected world in which life processes display an immense unity. Where scientific inquiry has revealed the fundamental integrity and globally interrelated nature of the problems in issue, it seems logical to regulate international environmental problems with matching global systems. Individual or particularized responses by states make little sense because global environmental problems should be assessed and remedied within a global context and in a comprehensive manner.

Some scientists argue that the absence of an infrastructure of scientific and technological institutes, with a mandate to study global problems, has resulted in a failure to integrate knowledge with power on behalf of global society. Those adopting such a position apparently contend that such a scientific infrastructure may need to precede the emergence of a global political system that can apply such knowledge without being thwarted or neutralized by claims of national sovereignty.

The ecological argument that individual or particular responses by states make no sense in the absence of pre-existing global institutions must be rejected. While pollution problems do create commonly shared burdens that often call for collective or international answers, international or collective solutions can only be fashioned out of individual responses emerging from within the separate countries affected by, or contributing to, the problems. Global warming, for example, is an international problem because the warming of the earth is caused primarily by the accumulation of atmospheric carbon dioxide caused by the burning of fossil fuels. The consequences of global warming such as climatic change and sea level rises admittedly affect the entire biosphere and demand international solutions. International solutions, however, cannot be forged unless individual nations responsible for the increase of

250. The interrelated consequences of various policies was powerfully illustrated in the Club of Rome's publication THE LIMITS TO GROWTH (D. Meadows ed. 1972). See also P. EHRlich, A. EHRlich & J. HOLDREN, ECOSCIENCE 730-34 (1977).
251. The apocalyptic environmental scenarios presented for example by B. COMMONER, THE CLOSING CIRCLE (1971), and P. EHRlich, THE POPULATION BOMB (1968), could only be dealt with by world government. Richard Falk in his book THIS ENDANGERED PLANET (1971) appears to argue that a world system based upon sovereign states cannot possibly deal effectively with the problems of an endangered planet.
carbon dioxide such as the United States, member states of the European Economic Community and the Soviet Union, agree to take national measures within their countries to reduce CO₂.

This article argues that the United States should lead in the search for international solutions, because there is ample evidence that the community of nations is responding to the challenge of global warming, and that a treaty dealing with it will be signed possibly in 1992.²⁵⁴

In perhaps the most important public declaration on the need for a treaty dealing with global climatic change, the Group of Seven Industrial Nations, issued a communique stating their belief “that the conclusion of a framework or umbrella convention on climate change to set out general principles or guidelines is urgently required.”²⁵⁵ The remarkable extent of international political and scientific consensus demanding such a convention that preceded that communique has been observed.²⁵⁶ It has arisen from scientific bodies, nongovernmental organizations, nations, international organizations, and the United Nations. There are a number of reasons, based upon enlightened self interest, as to why the United States should dominate the law-making process of the forthcoming treaty on global warming. As the largest producer of carbon dioxide in the world, the United States has an obvious stake in a treaty that will regulate how such releases should be controlled. In fact, any international laws setting standards or dealing with steps to be taken to counteract global warming will have to be implemented within the United States. It would be a clear advantage if those areas of international law and policy were to be based on United States law. In such a case the implementation of international law would present no problem.

²⁵³. Brooks, The Role of International Research Institutions, in SCIENCE FOR PUBLIC POLICY 151 (H. Brooks & C. Cooper ed. 1987). Citing such views, not to approve but to refute them.

²⁵⁴. Perhaps the most significant political endorsement is found in the PARIS COMMUNIQUE following the 1989 summit meeting of the Group of Seven. The communique declared that there was a growing awareness of serious threats to the atmosphere that could lead to global climatic change. It strongly advocated efforts to limit the emission of carbon dioxide and other greenhouse gases that threaten to induce climatic change and called for a framework or umbrella convention to control climatic change. See, e.g., N.Y. Times, July 17, 1989, at 5, col. 4. The PARIS COMMUNIQUE was the culmination of numerous earlier proclamations and affirmations to the same effect. See, e.g., INTERGOVERNMENTAL PANEL ON CLIMATIC CHANGE (IPCC) — a panel drawn from 30 countries including the U.S.A., the U.S.S.R., many Western European countries and Japan — which stated after their groundbreaking meeting in November 1988 that “global warming is the most important environmental concern of our day” and pledged to work toward a global warming treaty. Int'l Env't Rep. 644 (Dec. 1988); DECLARATION OF THE HAGUE, March 11, 1989 — a group of 24 countries — describing the dangers of global climatic change as a “vital, urgent and global” problem that jeopardized “the most vital interests of mankind,” and calling for new approaches through the development of new principles of international law. Int'l Env't Rep. 276, 215 (Apr. 1989); EUROPEAN ECONOMIC COMMUNITY, calling for a comprehensive community program to combat global warming in November 1988. Int'l Env't Rep. 645 (Dec. 1988); the meeting of EEC Environment Ministers, in June 1989, assures to combat greenhouse effect. Int'l Env't Rep. 285 (June 1989); UNITED NATIONS ENVIRONMENT PROGRAM (UNEP), calling for a treaty on global climatic change as a top priority in June 1989. Int'l Env't Rep. 279 (June 1989); United Kingdom, calling for a global climatic convention at the United Nations in May 1989. Int'l Env't Rep. 281 (June 1989). The year 1992 has been set as the date for a framework or umbrella treaty by UNEP. Int'l Env't Rep. 279 (June 1989).


²⁵⁶. See supra notes 254 and accompanying text.
It is equally important to recognize that climatic change is also a national problem that can seriously affect the United States. We have noted the quite dramatic impact it could have particularly on agriculture, human habitation, and water supply. Encouragingly, a number of Bills now before Congress undertake the urgent and compelling task of proposing United States legislation that provides answers to global warming. An examination of developments in the two spheres of United States and international law discloses convergent streams of thinking which we shall be examining. Such a convergence gives rise to the need for integrating United States and international environmental law and regulation.

Existing and proposed United States legislation shows a remarkably refreshing awareness of the need, Janus-like though not Janus faced, to look in both directions. The Global Climate Protection Act of 1987 (Climate Protection Act) clearly recognizes the national importance of global climatic change. The premises of the Climate Protection Act, and of much of the legislation introduced in Congress, emphasize how crucial it is for United States law to be developed in answer to global issues as well as to generate international law.

257. See supra notes 93-115 and accompanying text.
258. Bills now before the Senate and House include: S. 169, 101st Cong., 1st Sess. (1989) (to provide a national plan to improve scientific understanding of the earth and the effect of changes to the system on climate and human well being); S. 201, 101st Cong., 1st Sess. (1989) (to respond to global environmental degradation brought about by human activities and to ensure that United States policies provide for the protection of the world environment); S. 324, 101st Cong., 1st Sess. (1989) (to provide for energy conservation and explore policy options that reduce energy use by two to four percent annually; use of nuclear energy and clean coal technologies; reforestation; cut carbon dioxide emissions by 20% by year 2000 in the United States; convening of international convention to reduce carbon dioxide emissions by 20% in year 2000 and 50% in year 2015); S. 333, 101st Cong., 1st Sess. (1989) (to enact the Global Environment Protection Act); S. 491, 101st Cong., 1st Sess. (1989) (to reduce atmospheric pollution to protect stratosphere from ozone depletion; 20% reduction of carbon dioxide emissions by 2005 in the United States; convening of an international convention to do likewise globally; energy research; reforestation); S. 603, 101st Cong., 1st Sess. (1989) (to establish within the Department of State, the Office of Global Warming); S. 676, 101st Cong., 1st Sess. (1989) (global atmospheric and environmental preservation); H.R. 1078, 101st Cong., 1st Sess. (1989) (to establish national policies and support, and encourage international agreements that implement energy conservation strategies to prevent global warming); H.R.J. Res. 207, 101st Cong., 1st Sess. (1989) (to establish that it is the policy of the United States to reduce greenhouse gases).
260. To help identify the effects of climate change, Congress asked the United States Environmental Protection Agency (EPA) to undertake two studies. One of the studies was to focus on potential effects of global climate change on the United States and the other on policy options for stabilizing climate. See supra note 32.
261. See, e.g., H.R. 1078, 101st Cong., 1st Sess. (1989) the Schneider Bill: Global Warming Prevention Act, supra note 258, was supported by 111 cosponsors and has received the endorsement of three dozen nongovernmental organizations including the World Wildlife Fund, the Worldwatch Institute, Environmental Action, the Union of Concerned Scientists and the Sierra Club. Can Congress Cool It?, 74 SIERRA 36 (July/Aug. 1989). The bill directs that carbon dioxide in the United States should be reduced from 1988 levels by at least twenty percent by the year 2000. H.R. 1078, supra note 258, § 3(1). At the same time the bill calls on the United States to actively promote the establishment of an internationally global agreement on the atmosphere by 1992 which shall establish goals for worldwide reduction of carbon dioxide emissions from 1988 levels by at least 20% by the year 2000. Id. at § 3(3). It also calls for a multilateral agreement to reduce nitrogen oxides emissions by 30% by 1998.
President George Bush's historical proposals for amending the Clean Air Act (the Bush Bill) provides an admirable opportunity for integrating United States and international responses. The Bush Bill does not touch on global warming but does address the international implications of acid rain, and could well be extended to global warming. The provisions calling for the reduction of carbon dioxide emissions together with other critical policies dealing with the principles enumerated earlier could be telescoped into the Bush Bill to provide a handsome composite environmental bill.

By taking legal action without waiting for international solutions, the United States actually will be laying the foundation for an integrated solution displaying "effective United States leadership in the international arena." President Bush embraced precisely such a response, promising in his first year of office to summon at the White House a global conference on the environment to discuss ways to control global warming, acid rain, the loss of tropical forests and the saving of the oceans.

E. Intersecting Areas of United States and International Policy

The underlying conclusions, and articulated purposes of the Global Climate Protection Act of 1987 (GCPA), and the bills being examined by Congress emphasize that affirmative action should be taken in the United States, and internationally to address the causes of global warming. The GCPA, for example, after recounting that carbon dioxide and other trace gases "may be producing a long term and substantial increase in the average temperature of the earth . . ." concludes that necessary action must be identified and implemented in time to protect the climate.

We will now discuss four policy areas, of special importance, that demonstrate a confluence of United States and international thinking. The rationales underlying these policy proposals provide a powerful jurisprudential and political foundation for United States legislation integrating United States

S. 324, 101st Cong., 1st Sess. (1989) the Wirth Bill, also calls for a 20% reduction of carbon dioxide emissions by the year 2000 (S. 324, supra note 258, § 3(a)) while directing the United States to convene an international conference in the United States for the purpose of adopting a multilateral global climate protection convention (id. § 1401) no later than 1992 (id. § 1401(b)). The convention would require a 20% reduction of carbon dioxide emissions by the year 2000. It also calls for a multilateral agreement to reduce nitrogen oxides emissions by 30% by 1998.

Similar themes are seen in S. 201, supra note 258; S. 333, supra note 258; S. 491, supra note 258; S. 603, supra note 258; S. 676, supra note 258; and H.R. 2984, supra note 258.


263. Apart from the obvious universality of the problems addressed, there is significance in the fact that the 50% reduction of sulfur dioxide emissions will enable the United States to comply with the Canadian call for a 50% reduction in SO2 emissions. The proposal for a 50% reduction was formally rejected by the Reagan administration in 1982. See Wetstone, The History of the Acid Rain Issue, in SCIENCE FOR PUBLIC POLICY 173 (H. Brooks & C. Cooper eds. 1987).


267. See supra note 258.


269. Id. at § 1102(4).
and International policy. They set the scene for the transformation of United States environmental law. These four proposals are: (1) the need for more research into the causes and effects of global warming; (2) the duty to posterity; (3) the protection of nature; and (4) a re-definition of the atmosphere as a global commons or the common heritage of mankind.

1. Research

The questions of how to minimize the sum of the costs of global warming and the costs of avoiding global warming will require research. GCPA sets the scene by identifying three goals of United States policy. They are: to increase worldwide understanding of the problem; to promote more coordinated international research efforts; and to identify ways of slowing and reducing the concentration of greenhouse gases. The proposals now before Congress build upon this foundation. They provide for development of a National Global Change Research Plan, a Council on World Environmental Policy and for encouraging research on the mechanisms and effects of climate change. These proposals will help to determine more carefully what steps are required. They rightly seek to distinguish between the effects of human activities and the results of natural change, and to coordinate the development of national and international policies to abate, mitigate, and adapt to the impact of global environmental change.

The bills before the Senate and the House share key objectives. One is the reduction of carbon dioxide emissions by twenty percent by the year 2000. Another is the extraordinary consensus on the need for energy conservation and more efficient use of energy. Cutting down on energy is the perfect solution to pollution. It precludes the need for any kind of impact assessment of new technologies which create new problems. Research is required on how this might best be done.

Where a reduction of carbon dioxide necessitates a substitute form of energy, there is a need to consider the environmental impact of the alternatives proposed. The EPA's policy options for reducing greenhouse gases involve the
use of a bundle of measures. They include: a phaseout of CFC; reforestation; improved transport efficiency; promoting natural gas; more stringent NO₂ and CO₂ emission limits; solar technologies; commercialized biomass; and nuclear power. In considering environmental impact the air, land and water should be considered as one environment rather than as separate and discrete parts. Such an approach is based on an integrated approach to pollution control. A preliminary cross-media analysis reveals that some of these, like the use of nuclear power, can present different environmental problems. For example, nuclear power generates spent fuel and high level waste that will remain haz...disposal of radioactive wastes presents an intractable problem. Cross-media transfers of such wastes, e.g., ocean dumping, only shift the burden of pollution from land to the sea. The potential for damage may be even greater.

Disposal in the territories of poorer countries may be considered illegal and cannot be viewed as either ethical or just. Apart from illegality or immorality, self-interest counsels against the disposal of radioactive wastes in other countries where they are the sources of one's own raw material and food. Additionally, where debtor countries are concerned, facing devastating public health problems because of nuclear waste, would make the recovery of debts extremely difficult.

Another of the options for reducing reliance on fossil fuels is greater reliance on hydroelectric power (HEP). In considering such an option, the risks of dam bursts and the severe damage this could cause should be first considered. Second, the environmental impacts of HEP, such as the destruction of ecosystems, uprooting of homesteads, health risks from toxic gases generated by rotting submerged vegetation and soil, from waterborne diseases such as schistomiasis (snail fever), and impediments caused by dams to fish migration, should be assessed against the benefits to be derived from the reduction of carbon dioxide. Such a consideration may lead to the conclusion that HEP is not the most beneficial alternative to the burning of fossil fuels. Another alternative may be nuclear power which does not possess the particular disadvantages of HEP.

The importance of cross-media pollution is being recognized within an international context. To begin with, geographic water areas, such as the North Sea and the Baltic in Europe and the Great Lakes in North America, reveal the

278. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, POLICY OPTIONS FOR STABILIZING GLOBAL CLIMATE (1989).
279. Id. at 34.
280. A fuller argument of the case for integrating pollution regulation is found in Guruswamy, supra note 245, at 463.
281. See N. Y. Times, Dec. 5, 1989, at 19, cols. 1-4 and at 20, cols. 1-5. “When the Department of Energy said last night that it had lost confidence in its latest effort to find a safe place (a deep geologic repository in the Yucca Mountain) to bury nuclear waste, a gnawing question re-surfaced: is the task possible?”
need for a cross-media approach to pollution control. These areas demonstrate the necessity to deal with all sources of pollution. In fact, there is at least implicit recognition of the air as a source of marine pollution in the regional treaties dealing with these areas. While the need to take account of air pollution when dealing with the oceans has not been institutionalized as a global obligation, one detects at least the fons et origo of such an obligation in the United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS obliges states to protect and preserve the marine environment by dealing with all sources of pollution. Referring specifically to toxics, it requires states to minimize toxic pollution from land-based, atmospheric pollution and dumping. This putative integrative obligation is reinforced by the stipulation that states shall not transfer damage or hazards from one area to another or transform one type of pollution into another.

United States policies on the need for more scientific research in these and other areas flow into a larger stream of international policies moving in the same direction. The UNEP/ICSU/WMO and a score of Non-Governmental Organizations (NGOs) are undertaking the same task. It becomes clear that the United States and the international community are addressing the same problem, and that the United States could well integrate its policies with those of the international community. The reduction of carbon dioxide and other greenhouse gases is supported by arguments resonating in United States as well as in international law. They concern the obligations to protect future generations; the duties toward nature; and the need to preserve the global commons. It is to these proposals that we now turn.

2. The Duty to Posterity

We inhabit two worlds. One is the natural world of plants and animals, of soil, air and water which fashioned us as it evolved through the years. The other is the world of social institutions and artifacts we build for ourselves using tools, engines, science and technology. The technological world we inhabit has created an astonishingly good quality of life and offers us an unprecedented standard of living. But there is a cost to pay. The comforts of

283. OUR COMMON FUTURE, supra note 27, at 192 (the Report expresses serious doubts about the advantages of HEP).
285. Convention for the Prevention of Marine Pollution from Land-Based Sources, Paris, Feb. 21, 1974, reprinted in 13 INT. L. MATS. 352 (1974). This convention impliedly, though not explicitly, recognizes air pollution as a source of marine pollution. Article 3(c) has been so interpreted by the Paris Commission which was set up by the Convention. Article 6(2)(d) of this convention refers to the need for an "integrated planning policy."
288. See supra note 17.
modern living that we take for granted arise out of a staggering range of domestic and industrial activities. These activities make high demands on energy and raw materials, and give rise to enormous quantities of wastes, residuals and pollutants. There is an almost unending list of energy use and pollution. Energy is consumed by us for heating and cooling; for moving us rapidly by air, land, and water; chemicals (pesticides, fungicides, and insecticides) are used for producing clean, long lasting food. Add to this the luxurious materials with which we build our houses, furnish our homes, cars, boats and attire ourselves. And so it continues.

The matter and energy used in these activities are neither created nor destroyed but merely transformed. Massive quantities of wastes or residuals are, therefore, the unavoidable by-products of today's living. These residuals or wastes have an impact on the natural world we also inhabit. We create problems for posterity because the disposal of our wastes will affect the uses that future generations can make of the natural environment and the costs that they must bear in doing so. In the case of carbon dioxide and other trace gases, the full devastating effects of the climatic changes we cause may occur several generations in the future.

The difficulty of the dilemma cannot be understated. The material world we have created in the twentieth century is very agreeable. It is a fairly general characteristic of human nature to avoid backbreaking and monotonous work, to seek comfort, to be fascinated by personal possessions, and to enjoy having a good time. For the first time in human history working men and women, not merely the one percent of rich elites, are able to enjoy this handsome standard of living. By any historical assessment, the twentieth century has seen every index of good living such as energy use, the consumption of foodstuffs and raw materials, health standards, housing and transport, taking off for the stratosphere. At the core of the new situation is the interaction of increasing numbers of people, all seeking to make use of more energy and more materials.

The reason why the modern age has seen, in so many countries, the extension of wealth from a traditional elite to the masses is in part political. It

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291. The proof of this basic psychological bias can be seen in the behavior of any wealthy group ever since neolithic man began, through settled agriculture, to build up a surplus of goods above the level of tribal subsistence. See B. WARD & R. DUBOSS, ONLY ONE EARTH 9-10 (1972).

292. Nearly 50 years ago Buckminster Fuller made an estimate of the muscular energy needed to produce the then available supplies of power and suggested that each American had the equivalent of 153 slaves. Today the figure would probably be nearer 500. Machines and gadgets do what slaves traditionally did — lighten domestic work, cook food, carry people, rush with fans and heaters, deliver clothes, finery and ornaments which they have produced in the first place, play continuous music and remove garbage. Energy powered machines also do what slaves could not. Only genies and magic carpets could fly us through the air. Id. at 10.
stems from the emergence of democracy, equality and social justice. But the conclusions of Ward and Dubos are incontrovertible:

wider prosperity is due much more to the extensions of technology; above all, to the enormous increase in supplies of energy. Energy is at the root of the productivity, of the ability to make "more for less" that offers most citizens in a modernized society an inconceivably enlarged range of material choice.\footnote{293}

The problem, of course, is that the burning of fossil fuels, which produces the energy we depend upon, results in increasing releases of carbon dioxide that might irreversibly alter the natural world of the biosphere on which future human survival depends. But in cutting down on fossil fuels, it is feared that we may seriously affect the development, prosperity, and material needs of the whole world, more poignantly of developing countries.

The Australian poet Mary Gilmore starkly summarized the distribution dilemma facing the decision makers who have to make decisions about natural resources today, that have ramifications in the future:

\begin{quote}
All men at God's round table sit,
And all men must be fed.
But this loaf in my hand,
This loaf is my son's bread.\footnote{294}
\end{quote}

Both religious and ethical norms suggest that all nations, rich and poor, have a duty to posterity. Diverse religious traditions have recognized the concept of trusteeship or stewardship for the natural environment. In the Judeo-Christian tradition, God gave the earth to his people to be cared for, husbanded and passed on to succeeding generations. Islamic law obliges man to account to God for the use of natural resources and nature. Each generation is entitled to use the resources but must care for them and pass them to future generations.\footnote{295} The same principle is found in non-theistic traditions of Asia and South Asia, as well as in Hinduism, Buddhism and Jainism.\footnote{296} But what of non-theistic and non-religious ethical norms? And can obligations to future generations be grounded in principles of biological behavior independent even of ethics?

The difficulty of the choice between present and future generations is particularly poignant in the case of poor countries. How can we expect an impoverished country to care about future generations if it cannot even care for its own people today? It is not proposed to enter a discussion of an answer except to point out that it will not be possible without the assistance of the wealthier countries of the world.\footnote{297}

Self-interest and altruism toward those who share our genes is part of our genetically coded human heritage,\footnote{298} that belongs to the "hard core" of our

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\footnote{293}{\textit{Id.}}\footnote{294}{Cited by Ashby, \textit{supra} note 151, at 5.}\footnote{295}{E. BROWN WEISS, \textit{IN FAIRNESS TO FUTURE GENERATIONS; INTERNATIONAL LAW, COMMON PATRIMONY AND INTERGENERATIONAL EQUITY} 18-19 (1989).}\footnote{296}{\textit{Id.} at 20-21.}\footnote{297}{E. BROWN WEISS, \textit{supra} note 295, at 27.}\footnote{298}{Ashby, \textit{supra} note 151, at 9.}
inheritance. The obligation toward posterity is usually limited to a basic genetically coded feature of human nature, which we share with many of the animals: an instinct to leave the environment in a fit state for our children and our grandchildren. This genetically coded feeling of altruism has now been extended by ethical theory beyond the pale of kinship. We refer here to differing strands in environmental philosophy and ethical theory which argues for a duty to avoid endangering future persons regardless of kinship.

What does emerge from this development is the recognition that the duty to posterity and the duty to nature are but two halves of an ethical whole. It is then to the incompletely half of the obligation to posterity, found in the duty to nature, that we now turn.

3. The Duty to Nature

The idea that the treatment of nature should be seen as a moral issue conditioned or restrained by ethics is one of the most extraordinary developments in recent intellectual history, representing "the farthest extension of ethical theory in the history of the universe." It is a movement of ideas that has changed the basis of human responsibility to nature, and led to the "greening" of ethical theory. This environmental philosophy is reflected in legislation protecting animals and nature. We have noted that a large body of legislation preserves nature and protects plants, species and nature from extinction. Such legislation includes the Clean Water Act, NEPA, and the Endangered Species Act.

The Endangered Species Act of 1973 (ESP) is worthy of special mention. The purposes of ESP are inter alia to provide a means whereby the ecosystems upon which endangered species and threatened species depend may

299. Id. at 22.
300. The subject of environmental ethics, in general, includes the following: K. SHRADER-FRECHETTE, ENVIRONMENTAL ETHICS (1981), D. SCHREER & T. ATTIG, ETHICS AND THE ENVIRONMENT (1983), R. ATTIEFIELD, THE ETHICS OF ENVIRONMENTAL CONCERN (1983). With regard to the extension of rights to future generations see J. PASSMORE, MAN'S RESPONSIBILITY FOR NATURE: ECOLOGICAL PROBLEMS AND WESTERN TRADITIONS, 73-100 (1974). Passmore quotes Kant's statement that "human nature is such that it cannot be indifferent even to the most remote epoch which may eventually affect our species, so long as this epoch may be expected with certainty." Id. at 78. See also Bailer, For the Sake of Future Generations, in EARTHBOUND 214-41 (1984); Barry, Justice between Generations, in LAW, MORALITY AND SOCIETY (P. Hacker & J. Rax eds. 1977); R. Manning, Environmental Ethics and John Rawls' Theory of Justice, 3 ENVTL. ETHICS 155-61 (1981).

Others have argued for a kind of moral evolution. See, e.g., L. KOHLBERG, THE PHILOSOPHY OF MORAL DEVELOPMENT (1981). Kohlberg reasoned that moral motivation passes through stages of growth. Beginning with pure self interest at infancy there is a progression in moral responsibility that initially includes mother, father and immediate family and is later extended to town, nation and species. His thinking has been adapted by sociobiologists. See G. KIEFFER, BIOETHICS: A TEXTBOOK OF ISSUES 36 (1974).

301. As Nash points out, ethical duties have progressed from duties toward people to duties toward nature. See R. NASH, supra note 151, at 4-5. Tribe illustrated such a development when he wrote about a "spirit of moral evolution" that has recently spread to include blacks and women and was beginning to incorporate animals, plants, and might, in the distant future, include canyons, mountains or a seashore. Tribe, supra note 141, at 1341-45.

302. R. NASH, supra note 151, at 4-5.
303. Id. at 122.
304. For an excellent survey see id., esp. ch. 5, The Greening of Philosophy, 121-61.
305. See supra text accompanying notes 144-50.
be conserved, and to provide a program for the conservation of such endangered species. The facts of TVA v. Hill in which section 7 of the Act was interpreted are instructive. In that case construction of a $119 million hydroelectric power project was underway when the snail darter — a three inch member of the perch family — was discovered. The Sixth Circuit blocked the completion of the project because it would destroy the only known habitat of the snail darter. The Supreme Court affirmed holding that section 7 required all federal agencies to "insure actions authorized, funded, or carried out by [such agency] do not jeopardize the continued existence of such endangered species and threatened species . . ." admitted of no exception for the dam. By so deciding the Supreme Court confirmed the validity of the Act's nature-based rationale. The corollary of such a rationale is that whenever nature, buildings, or our cultural heritage are protected by legislation, they are also being preserved for future generations.

Joseph Sax and other commentators argue that certain common properties such as rivers, the seashore, and the air are held in trust by the government for the benefit of the public, and that the public possesses inviolable rights in them. Judicial law making has now incorporated the concept into United States law. The doctrine of the public trust was historically concerned with public rights in navigable rivers, such as commerce, navigation and fishing, but has now been extended to environmental, recreational and ecological values in navigable waters. It has even embraced rural parklands, a historic battlefield, wildlife and archaeological remains. One state supreme court went so far as to construe the trust to apply to all natural resources including air and water. Judicial law-making however, has stopped short of extending the public trust doctrine to public lands.

The concepts found in national law are reflected, albeit opaquely on occasion, by international law. The use of national law analogies within other
areas of international law has been demonstrated, and international environmental law is no exception. That law presently protects certain habitats and species, and commentators have sought to extend the concept of the public trust to international law. One such commentator has asserted that each generation receives a natural and cultural legacy in trust from previous generations and holds it in trust for future generations. Support for such an argument, together with a recognition of the danger to future generations, is implicit in the international agreement providing for phased reductions of chlorofluorocarbons and halons.

4. The Global Commons

Global warming constitutes a community problem because the atmosphere or airspace over which nations claim complete and exclusive sovereignty critically affects our climate. The atmosphere or airspace, no less than outer space, is now demonstrably "the province of all mankind." Unfortunately, international law recognizes the complete and exclusive sovereignty of states to the airspace above them. There have been other theories about the status of airspace, but the view that a state has complete and exclusive sovereignty above its territory seems to have been generally accepted.

There are countervailing norms in the form of principles of state responsibility. The most notable of these norms, restated in Principle 21 and

318. E. LAUTERPACHT, PRIVATE LAW SOURCES AND ANALOGIES OF INTERNATIONAL LAW (1927).
320. E. BROWN WEISS, supra note 295. Edith Brown Weiss argues that all people and countries have an obligation to conserve the biological legacy we have inherited for present and future generations. Id. at 194. See also RESPONSIBILITIES TO FUTURE GENERATIONS (E. Partridge ed. 1981); O'Toole & Walton, Intergenerational Equity as it Relates to Conservation and Coal Extraction Standards, 22 NAT'L RESOURCES J. 53 (1982); Weiss, The Planetary Trust: Conservation and Intergenerational Equity, 11 ECOLOGY L.Q. 495 (1984).
321. See supra text accompanying notes 235-244. The Vienna Convention for the Protection of the Ozone Layer "is the first global convention to address an issue that for the time being seems far in the future and is of unknown proportions. . . . Those who could be threatened are the future generations that will have to live in a world that, through errors in judgment or mere short-sightedness, we risk making uninhabitable . . . ." Excerpted from a statement by Dr. Mostafa K. Tolba, Executive Director of UNEP, at the Convention, reproduced in 27 ENV'T 20 (1985).
323. See MCNAIR, THE LAW OF THE AIR 6 (M. Kerr & A. Evans 3d ed. 1964); J. Sweeney, C. Oliver & N. Leech, THE INTERNATIONAL LEGAL SYSTEM 261-82 (3d ed. 1988); Statement of the Meetings of Legal and Policy Experts, art. 3 (Feb. 20-22, 1989); N. Matte, TREATY ON AIR-AERONAUTICAL LAW 132, 605 (1981); Shawcross & Beaumont, AIR LAW (P. Martin, D. McClean, E. Martin & R. Margo eds., 4th ed. 1986). This right is, of course, subject to modification and has been modified by a variety of treaty arrangements dealing
22 of the Stockholm Declaration on the Human Environment, burden states with a responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction.\(^{324}\) Despite the existence of such a general norm the application of the law is still shrouded in uncertainty.

Objection can be raised about attributing to states the conduct of private entities not acting on behalf of the state.\(^{325}\) The better view, is that a state is responsible for the activities of private or public corporations so long as they are under the state’s jurisdiction or control.\(^{326}\) A more substantial theoretical difficulty lies in reconciling the norm controlling environmental harm with another granting to states “the sovereign rights to exploit their own resources pursuant to their own environmental policies.”\(^{327}\) Third, there may also be difficulties of proving causation to the extent that global warming is caused by the combined effect of emissions from many nations.\(^{328}\) Fourth, principles of liability that operate ex post can only be invoked after damage has been inflicted. As we have seen, this may be too late in the case of global warming as the damage could well be irreparable.

Finally, Chernobyl\(^{329}\) demonstrated the lamentable extent to which states refrain from pursuing remedies in international law even where there is serious damage accompanied by an implied acceptance of negligence on the part of the USSR.\(^{330}\) In the result, the extent to which the principles of state responsibility lend themselves to preventing global warming seems dubious. Moreover, the will of nations to exercise guardianship over the global commons, even assuming the existence of customary law, seems minimal.

What is required is a norm modifying the principle of state sovereignty. The concept of the global commons provides for the development of such a norm. The beginnings or fons et origo of the global commons can be detected in the regimes dealing with Antarctica, Outerspace and the Law of the Sea.

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space,\(^{331}\) including the Moon and Other Celestial


327. The Stockholm Conference, supra note 324.


330. Sands, The Environment, Community and International Law, 30 HARV. INT’L L.J. 393 (1989). While pointing out that states have exercised their right to prefer claims arising from transboundary pollution only once in the last 50 years (id. at 406), the author argues that there is no clear and precise rule of customary international law placing an obligation on states to prevent transboundary nuclear pollution (id. at 404-05).

331. The limits of airspace or the atmosphere have not been precisely defined, though there is growing consensus that outerspace begins and sovereign airspace must consequently end
Bodies, Jan. 28, 1967, views outer space as a global commons. It provides in Art. 1 and 11 that:

outer space, including the moon and other celestial bodies shall be free for exploration and use by all the States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

Outer space including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

The Antarctic Treaty of 1959 freezes existing territorial claims to that region but does not declare it a global commons. Because the treaty asserts that no claims to sovereignty can be made while the treaty is in operation, it is possible to argue that this constitutes a significant step in the move toward commons status. The Convention on the Regulation of Antarctic Mineral Resources Activities, 1989 (CRAMRA) is a further step in Antarctica's evolution toward a global commons. It authorizes mineral resource activities only after demonstrating that no significant adverse effects on the environment will result, and imposes strict liability for environmental damage.

The United Nations Convention on the Law of the Sea established an Area (defined as the sea-bed and the ocean floor and subsoil beyond the limits of national jurisdiction) and its resources as the common heritage of mankind. No state is allowed to claim or exercise sovereignty over this Area, and all its resources are vested in mankind as a whole. All activities in the Area shall be carried out on behalf of mankind as a whole by the International Sea-Bed Authority.

A recent resolution of the United Nations General Assembly on the "Protection of Global Climate for Present and Future Generations of Mankind" points toward recognizing the atmosphere as a global commons. Although the resolution makes no mention of the "common heritage" the text

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333. Made by Argentina, Australia, Chile, France, New Zealand, Norway and the United Kingdom. The United States and the U.S.S.R. reserved the right to make claims in the future.
337. Id. Art. 1(1)(1).
338. Id. Art. 136.
339. Id. Art. 137.
340. Id.
refers to "the vital interests of all mankind" affected by climate change and of the need to confront the problem within a global framework.342

In order to be effective, fresh legal policies and concerted legal responses are required from the United States as well as the Soviet Union and Western Europe343 to control the use of the atmosphere344 and prevent it from being treated as a depository or air dump for pollutants. To the extent that international law gives states complete sovereignty over the airspace superjacent to their territory, it is necessary to change the law by means of an international treaty or convention. Such a treaty is a virtual certainty, and it is vital that the United States should provide leadership in treating the atmosphere as a global commons.

V. CONCLUSION

Once it is agreed that action needs to be taken about global warming, the argument that the United States should develop laws and policies that integrate United States and international concerns is difficult to resist. The four themes canvassed above provide the political and jurisprudential rationales for integrating international norms into United States law. The purpose of such integration must be re-emphasized. It is to enable both United States and International law to arrive at a practical answer to the urgent and fundamental question that arises for consideration in any discussion on global warming. That question is: should we make substantial reductions in the emission of carbon dioxide today? The extent of the reduction suggested in the Bills before Congress is a reduction of twenty percent by the year 2000. It is the burden of this article that such a reduction should be undertaken.

In the light of the fact that cheap energy constitutes the foundations of our present material prosperity, the implications of such a step are simply enormous. They touch the deepest roots of the economy and will affect the prosperity and quality of life not only of this country but of the entire community of nations. A decision to substantially cut carbon dioxide emissions can only make sense within the framework of an international agreement. The making of such an agreement falls within the province of international law.

The convergence of United States and international concerns present a promising baseline from which to approach a problem that will surely rank among the greatest in the nineties and the century 2000. The challenge has to be met. This article identifies and offers a theoretical framework and policies that might constitute a starting point from which to attempt the long and arduous task of confronting this truly planetary problem.

342. Id.
343. In 1985, out of a total of 20.5 billion tons of CO₂ emitted, 23% originated in the United States, 19% originated in the USSR, while Western Europe emitted 15%. Wraith, Climate Chaos, 3 FOREIGN POL’Y 6 (1989).
344. Supra note 331.