Global Environmental Accords
Nazli Choucri, editor

Global Accord: Environmental Challenges and International Responses, Nazli Choucri, editor

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Global Accord
Environmental Challenges and International Responses

edited by
Nazli Choucri

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Series Foreword

A new recognition of profound interconnections between social and natural systems is challenging conventional intellectual constructs as well as the policy predispositions informed by them. Our current intellectual challenge is to develop the analytical and theoretical underpinnings crucial to our understanding of the relationships between the two systems. Our policy challenge is to identify and implement effective decision-making approaches to managing the global environment.

The Series on Global Environmental Accords adopts an integrated perspective on national, international, cross-border, and cross-jurisdictional problems, priorities, and purposes. It examines the sources and consequences of social transactions as these relate to environmental conditions and concerns. Our goal is to make a contribution to both the intellectual and the policy endeavors.

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Introduction: Theoretical, Empirical, and Policy Perspectives

Nazli Choucri

The growing scientific consensus that human beings are altering the global environment in potentially significant ways poses important challenges for the study and implementation of national policies and international relations. Despite scientific controversy and continuing uncertainty, there is an increasing recognition that the composition of the earth's atmosphere is changing. This recognition is based on observed trends as well as projected increases of greenhouse gases generated by human activities that are altering atmospheric balances and affecting global climates in new and uncertain ways.

The possibility of such changes raises new questions about the analysis of national and foreign policies throughout the world, as well as the formulation and conduct of such policies. Much of the debate on global change and associated environmental threats—together with the pursuit of global accord on these issues—has been informed by scientific analyses (and controversy) without comparable "scientific" attention to social (human, behavioral) aspects of resource depletion and degradation. The possibility of global change induced by human action, for example, is a relatively new factor in the formulation and implementation of national and international environmental policies. It is now increasingly recognized, however, that human knowledge and skills (technology) interacting with population trends and demands for resources (and derivatives therefrom) have generated environmental problems worldwide. But social science approaches to such issues are only now beginning to come into play.

In the course of intellectual development over recent generations, the social sciences have been predicated on the investigation of motivations,

attitudes, decisions, behaviors, and other phenomena from philosophical, historical, psychological, anthropological, sociological, economic, and political perspectives.[1] Only rarely, however, have these disciplines been systematically directed toward human interventions in nature or to anthropogenic responses to the intended or unintended consequences to nature resulting from human action taken in pursuit of narrowly defined human interests. The tendency has been to abstract humanity from nature and reinforce the separation by withholding formal recognition of our total dependence on the planet and its resources for day-to-day survival.[2] Even the behavioral sciences—identifying, formally quantifying, and analyzing regularities in human behavior—have only in very specialized circumstances combined the "laws" and behaviors of nature and the "laws" and behaviors of people within the same equations. The whole issue of global change lies at the frontier of the social sciences as they are conventionally viewed.[3]

Yet even a cursory purview indicates that interactions between social and natural environments involve issues of economics and politics at the very least. Potential, if not inherent, contradictions between economic growth (and stability) and environmental sustainability immediately come to mind, as do forest preservation, jobs/property rights, and population growth balanced against available resources.[4] In fairness, increasing numbers of economists and other social scientists have taken environmental issues seriously in recent years, especially in terms of international trade, investment, and multinational corporations as mechanisms and agents in the diffusion of polluting technologies and products.[5] But a considerable proportion of the economic literature is concerned with the possible effects of environmental regulation on economies without comparable attention to the effects of economic growth on the environment.

The time-worn problem is that the assumptions, concepts, theories, and methodologies of the various social science disciplines frequently serve as what amount to "protectionist" barriers that shut them off from one another, with the result that findings do not circulate widely in a common marketplace of ideas. In any case, the search for better understanding of the sources and consequences of anthropogenic impacts on the natural environment will by necessity constitute a major challenge to the social sciences.[6] Since the need for policy responses worldwide is

increasingly felt, moreover, the conventional modes of policy deliberation may also be put to the test. Already the possibility of global change has injected scientific evidence, influences, and uncertainties into national and international policy domains.

A major purpose of this book is to develop an integrated conceptual framework linking natural and social systems within which basic (and dynamic) social and natural "actors," behaviors, and interactive processes can be identified and analyzed from some optimal range of disciplinary perspectives. An underlying premise is that the effective management of global environmental change requires coordinated action among sovereign states in the international system and the cooperation of all other relevant actors—at all levels.

The fact that human activities within one jurisdiction can alter environmental conditions in another—and possibly over the planet as a whole—suggests both that there is a new form of politics in the making and that the theoretical foundation for the study of politics among nations must necessarily address a range of interstate and transnational interactions bearing on the management of environmental transformations generated by social activities.

The interdependence among states that had been conceived in economic and political terms is now regarded in environmental terms as well. And environmental conditions do not respect the sanctity of national boundaries. By definition, the very pervasiveness of environmental alteration due to human activities contributes to the globalization of these concerns.

Of the many conceptual challenges posed by possibilities of global environmental change, three are central to the design of this book. First is the *linkage challenge:* the challenge of relating environmental variables and processes to social activities, national characteristics, and international relations. The concerns of this volume bear directly on the intellectual core of the social sciences that have developed over the better part of two centuries as the disciplines designed to improve knowledge of social interactions. None of the social sciences is currently directed to address human interventions in nature or the responses to intended and unintended consequences to nature due to human action. Indeed, the whole issue of global change lies at the frontier of the social sciences as they are conventionally viewed.[7] Understanding the sources and con-

sequences of anthropogenic influence will, of necessity, also constitute a major challenge to the social sciences.[8] Since the necessity for policy response worldwide is becoming increasingly salient, the conventional modes of policy deliberation may also be put to the test. Already the possibility of global change has injected scientific evidence and uncertainties into the policy domain—national and international.[9]

The second conceptual challenge is the *policy challenge:* the challenge of defining appropriate concepts for, and approaches to, decisions about managing the global environment. This challenge emerges from the recognition that the ecological balance of the globe is inadvertently affected by how individuals behave and how institutions, groups, and, most important, countries manage their environments. Such behavior inevitably generates cross-border patterns of effluence that under certain conditions could threaten both the social and the natural environments.

The third conceptual challenge is the *institutional challenge:* the challenge of identifying the appropriate framework for international responses to global environmental alterations due to human action. The international nature of emissions and effluents all but ensures the need for alteration in the behavior of individuals, collectivities, corporations, and nations, and, in all likelihood, for coordinated international response. In these terms bargaining and negotiation become central to the formulation of global environmental policy. At issue is whether the global environmental problems can be reduced to questions of scale (requiring only existing modes of international coordination of environmental processes of planetary proportions) or, alternatively, whether there is something generically different about matters pertaining to the global environment (necessitating adjustments in prevailing international approaches and institutional responses).

The increased visibility of environmental degradation—irrespective of the scale, scope, or uncertainties—politicizes global environmental issues as well as the processes shaping international responses. At issue, then, are the types of responses, their characteristic features, and their prospects for effectiveness. Given the fact that environmental processes do not respect national borders, the international community finds itself in a condition in which countries hold one another hostage: Very little can be effectively done on a unilateral basis, and one nation cannot effectively insulate itself from the actions (and environmental degradations) of others.

The Logic of this Book

According to the underlying premise of this book, effective management of the global environment requires the development of an appropriate intellectual framework within which human-environment interactions affected by, and affecting, global environmental change can be addressed. Given the logic of global processes and the need for coordinated environmental action, it is necessary on both conceptual and empirical grounds to systematically articulate the linkages between natural and social processes and the conditions that generate effective international responses.

This chapter and those that follow are designed to articulate the elements of a framework for the international politics of global environmental management. Together they proceed from the recognition of the three challenges identified above: the ambiguities about the linkages between natural and social systems, the great uncertainties in both causes and effects of global change and about policies and decisions, and the remarkable absence of systematic institutional analysis of linkages between local and global commons, and local and global levels of action.

The contributors to this book have jointly developed an organizational plan to address differences in both dimensions and perspectives. By *dimension* is meant the substantive focus of concern or the problem at issue. By *perspective* is meant the nature and extent of departure from the status quo with respect to political orientation. It is that clue that provides added coherence to our joint effort.

Environmental conditions can no longer be taken for granted. Natural systems can no longer be viewed independently of human action. The contributors to this book tend to believe that growth is environmentally degrading, but the extent of degradation is not inevitable. It is contingent on government policies, on perceptions of the environmental problems, and on the management of environmental variables.[10] Development, if managed effectively and appropriately, can be set on a path that may minimize hazardous consequences. Sustainable development, a new objective of the international community, is intended to be holistic. Later

in this book we will consider the ambiguities inherent in the notion of sustainable development and, based on an analysis of these ambiguities, we will propose a concept of sustainability (and its empirical manifestation) that is more robust than the original formulation of the World Economic Commission in its report, known as the Brundtland Report.

The organizational plan of this book is summarized in table 1.1. The dimensions of inquiry addressed in each chapter bear on intellectual orientations, policy concerns, and institutional responses. In other words, we consider ideas, actions, and organization. The perspectives put forward in the book refer to the political (and ideological) orientations and beliefs of the actors (encompassing individual firms and other collectivities, states, and international groups). Simplifying devices are always necessary to facilitate parsimony; therefore, we consider three modalities of political orientation underlying action. First is the *conservative modality,* which minimizes departure from the status quo. Second is the *reformative modality,* which adopts strategies of gradual departure from current conditions. Third is the *transformative modality,* which is characterized by a substantial break or departure from traditional (status quo) perspectives.

It is this attention to political perspective and resulting policy action (conservative, reformative, or transformative) with reference to dimension of inquiry (intellectual orientation, policy concerns, and institutional responses) that constitutes the organizational plan. There are also some efforts to link environment to contemporary policy priorities. For example, poor countries manage their economic problems and are not willing to impose stronger policies on the use of the environment.

While the nature of political deliberations will continue to be affected by scientific assessments and by interpretation of the evidence—often of a very conflicting nature—it is the bargaining and the negotiation among planetary players and among local groups affecting these players that will shape actions. The political processes—national and international—will marshal concerted strategies for the management of global issues and will ultimately legitimize the responses to evolving scientific evidence and concerns and corresponding policy options. Deliberations around negotiation for a Framework Convention on Climate Change illustrated the dramatic politicization of environmental factors. In this process the

Table 1.1 Dimensions and perspectives of global environmental management: An organizational device[1]

	Political perspective[3]		
Dimension[2] of inquiry	Conservative	Reformative	Transformative
Intellectual orientations	Geopolitical view	Incrementalist view	Society-nature interaction
	Conformist view	Gradualist view	Ecological paradigm (local/global commons)
Policy concerns	Broadening technological options	Developmental alternatives	Legal measures
	Adopting a market solution	Managing growth processes	Judicial resources
Institutional responses	Pragmatic moves	Strategies for international equity	Intergenerational valuation
	Specific institutional adjustments	Institutional bargaining	Novel equity calculations

Notes:
1. This matrix is for organizational purposes. It has been developed jointly by the contributors to this volume. Entries are illustrative only. The theoretical implications and further delineations of the concepts in each box will emerge in the individual chapters.
2. *Dimension* refers to the substantive concerns at issue. *Intellectual orientations* refers to epistemological and theoretical concerns. *Policy concerns* refers to discrete "moves" in the policy context. *Institutional responses* refers to changes in the "rules" of the game within which "moves" are made.
3. By *perspective* is meant the nature and extent of departure from the status quo with respect to political orientation.

roles of science, scientific information, uncertainties, and attendant controversies continue to assume major political proportions.

In due course we might expect bargaining among states to reach agreement on policy across forms of environmental degradation. This could lead to a practice of trade in concessions on behavior modifications designed to reach a more comprehensive accord on global environmental issues.[11]

Levels of Analysis

Central to the intellectual challenges addressed in this book are four interconnected levels of systems, decision, and analysis: (1) individual humans and their decisions; (2) major collectivities and social organizations (states, firms, corporations, nongovernmental institutions, and so forth) and their decisions organized within (3) a competitive international system, with institutional mechanisms for decision making and encompassed by an increasingly (4) global system and (natural and social) components—all interconnected within a complex of dynamic feedback relations (North 1990: 11–20). Ultimately what is needed is a better understanding of interconnections, linkages, and feedback relations both within and across levels as well as their social and environmental implications.

In this connection *globalization* refers to the prehistorical and historical tendency of the human species to grow, develop, and expand (North 1990: 183–85, 212–13). Viewed retrospectively and understood in terms of the intense interactivity and interdependence of human population growth, technological advancement, and pursuit of resources, the globalization of the planet that has proceeded for millennia emerges as a logical and compelling anthropogenic process. Presumably it began with the prehistoric migration of our remote ancestors from their region(s) of origin (Africa?) throughout the other land masses. As the story line unfolds, they gradually learned to use untried resources at hand and, even more gradually, how to obtain resources that for one reason or another were not originally available to them. Their learning rate was exponential, however, as were their numbers and the resources they demanded and "consumed." For hundreds of millennia their population growth, learning, and consumption curves were nearly flat, but over the last dozen generations or so all three have climbed spectacularly. The world is rapidly "filling up" with human beings, along with their organizations, machines, weapons, and other "works."

Superficially the *global system* is easily defined. It consists of the planet, its "envelope," and the totality of its features and processes—continents and all their features, oceans (including depths and floors), the biosphere, ecosystems, flora, fauna, and all the species except for *Homo sapiens*. Admittedly, human beings constitute one of the many mammalian species belonging to the natural environment, but for analytical convenience we treat them, their organizations and institutions, and their works as a distinct social environment. By taking this liberty we divide the global system into two large, complex, and interacting systems—one "natural" (characterized by ecological processes, ecosystems, and geophysical, geochemical, and biogenic processes) and one "social" (characterized by human knowledge and skills, organizations and institutions, technologies, processes of production, and other activities and behaviors). In closely interconnected, interactive ways individuals (together with their families, communities, and others with whom they have essentially face-to-face relationships), states (and firms, corporations, and comparable organizational components), and the international system can be envisaged as fitting into the encompassing global system.

The Individual in Natural and Social Environments

To investigate interactions and relationships between social and natural environments, we need to find ways of identifying and analyzing connections or linkages within and between the two systems. Such a linkage occurs whenever an action on one side of an organizational or other systemic boundary affects conditions in another system, subsystem, or environment (Rosenau 1969). On the side of the natural environment, we accept such systems and subsystems as the scientists make them available, but on the social side we need to make our own definitions reasonably explicit.

The most fundamental unit in all human social systems is the individual human, the dominant thinking, organizing, and deciding actor who, like other living creatures in the natural system, responds to felt needs, wants, and desires by making demands and acting upon natural and

social environments in order to obtain the sustenance without which he/she cannot long survive. In coping with these environments, individuals make demands, reach decisions, and act upon many organizational levels from the family, neighborhood, and community to large corporations, the state, and the international and global systems. This means that each individual—each of us—bears responsibility for and may also suffer from outcomes at all levels of social aggregation and in all parts of the natural environment.

Human decisions yield tight interconnections (direct and indirect) among individual and social actors, activities, and outcomes: Each individual, through his or her central nervous system, translates internally generated needs, wants, and desires into demands, which may or may not be met. Demands combine, in turn, with capabilities to produce decision and action. A decision (and consequent action) represents an application of energy (and other resources) in order to narrow or close a discrepancy or gap between a "fact" (an individual's perception of "what is" and his or her perceptions of "what ought to be") (Boulding 1956: 11, 20–22, 84–85, 99–100; North 1990: 36–38).

An important aspect of decision is feedback, which in effect amounts to the actor's sensitivity, conscious or reflexive, to the consequence of the act that he or she has undertaken. Feedback is an essential element in the ability of a person to learn from experience and to adapt to changes in social and natural environments. Thus, through action and positive and negative feedback processes, each individual "learns" and "adapts" to changing circumstances (including outcomes of his or her own behavior)—and thus contributes to collective learning or sociocultural evolution. To a large extent actions are guided and knowledge and skills (technologies) are "learned" through positive and negative feedback—that is, the perception and interpretation by the actor of the favorable or unfavorable consequences of his or her actions. Here a brief interpretation from prehistory and history may be useful.

Dating from primeval times, human beings—through bargaining, leverage, and coalition building—have maintained, expanded, and developed organizations and institutions of increasing complexity. The earliest human institutions appear to have been hunting and gathering bands (essentially extended families), followed, as a consequence of population growth and the development of more advanced knowledge and skills, by tribes and chiefdoms. Membership in these institutions is thought to have been based on birth and voluntary association. Concepts of authority, governance, and legal sanctions emerged with the first pristine states—either because a stronger tribe conquered and learned to rule over a weaker one or possibly because a number of weaker communities combined to protect themselves against a more powerful neighbor.

From bands and tribes to modern states, organizations have made it possible for individuals to manage their activities in order to obtain what they demanded from the natural environment (and for security against rival communities). All such organizations can be viewed as coalitions (or coalitions of coalitions) resulting from interpersonal (and intergroup) bargaining, leveraging, and other exchanges (Riker 1962). Repetitively, in historical times such interactions within states have given rise to networks of "horizontal" and "vertical" linkages that have been more or less persistent and, not uncommonly, have contributed to new, more complex organizations, institutions, and modes of activities.

The State as "Sovereign" Actor

Organizations and institutions—states included—enable people to accomplish collectively what individuals could never achieve by themselves. Such collectives are often referred to as making decisions and acting. Strictly construed, however, the real decisionmakers and actors are individuals working in concert. This is to say that individuals in organizational or institutional settings reach collective decisions and undertake collective actions by establishing a coalition in support of particular options. This tends to be true even though some "bargainers"—as in a dictatorship—may possess vastly greater power than others (Cyert and March 1963).

Among the many organizations and institutions that constitute social environments, the state is the only one that is accorded "sovereign" power domestically and is franchised to act independently and "legitimately" in the international and global systems. As such, it contributes to, encompasses, and in a sense presides over all the resource expansion and resource depleting and degrading that occurs within its boundaries. In this and succeeding chapters, therefore, the entity and institution of the state requires special attention.

In historical writing and in the formulation of theory, more attention has often been focused on the meaning and exercise of sovereignty than on the driving forces that have contributed to the sociocultural evolution of states and to their undeniable impact upon human life and upon the natural environment. There are, of course, many forces driving the state, but demographic, technological, economic, and political growth and development are surely among the most powerful.

Social functions performed by states (through their institutions) include resource extraction (taxation or some equivalent indispensable for the maintenance of power), resource allocation (a major source of investment and of power as influence), the maintenance of some measure of security (economic, political, and strategic), value formulation and socialization of the young, and the regulation of domestic activities (North 1990). These activities contribute to the growth and development of states, but over time they cannot succeed unless the underlying growth and development processes are functioning in proper balance.

Growth, as we define it, refers to incremental increases (or expansions) in the quantities, sizes, levels, or "prices" of things—numbers of people, aggregates of territory, resources, products bought and sold, and so forth. By *development* we mean quality or qualitative changes, tendencies, or trends. Chapter 3 examines these processes in greater detail.

Growth and development processes are highly interactive, with growth contributing (sometimes, but not always) to development, and development leading (sometimes, but not always) to growth. Included in the concept of development are enhancements of the technological, economic, social, political, and other capacities of a state or other organization (public or private) resulting from the interactions among the growth variables (North 1990: 48–49, 62–63). From this perspective, the three master variables—embedded in a network of human communications and social actions—constitute a dynamic nexus as they interact among themselves and with the many and varied intervening and dependent variables and types of feedback to which they contribute and respond—and by which they themselves are partially shaped.[12]

Constraining these growth and development processes and adding to their complexities are two "natural" laws: According to the first law of thermodynamics, basic energy cannot be "consumed" or destroyed; but according to the second law, no "work" can be performed (no action can be taken) without some measure of energy denigration from more to less usable forms. This means that some form of resource degradation (effluents, emissions, toxics, and other wastes) accompanies all uses of energy and other resources.

The implications of the thermodynamic laws have often been overstated, but all too frequently they have also been prematurely dismissed or wholly ignored. What they reveal is a paradoxical relationship between unrestrained anthropogenic growth and development, on the one hand, and environmental economy and sustainability on the other. It is well known that a certain amount of economic growth and development is necessary for social and political stability—and for a long time that appeared to be all we needed to know. In the latter decades of the industrial age, however, it became increasingly evident that exponential population growth and exponential technological (and economic) development—in combination—were overburdening the natural environment and creating policy dilemmas.

In human affairs, paradoxes—real or perceived—commonly translate into decision and policy dilemmas. In community, national, and international affairs decisionmakers and the public in general, when confronting a policy dilemma, tend to take positions around (or near) one or the other of its horns—the growth and development horn, in this instance, or the environmental sustainability horn. Internalizing both horns, individuals may be immobilized or alternatively deny that any contradiction exists. Much the same can often be said of organizations as collective actors, but there is also a high probability that factions, interest groups, or political parties will rally around one or the other of the horns as a policy position.

Both within and across states, population, technology, and resource access tend to grow and develop unevenly and to interact in ways that are critically relevant to their relative capabilities, dispositions, and impacts upon social and natural environments. To the extent that a country's population growth accelerates more rapidly than its technological development, for example, demands for energy and other resources may be expected to increase, but development will be constrained, and damage to the environment may remain relatively localized and low.

Insofar as technology accelerates in advance of population growth, however, development will be enhanced, resource availabilities will ex-

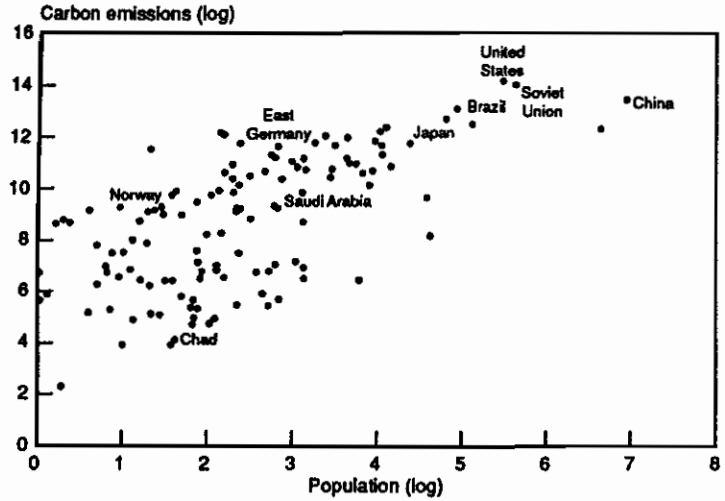

Figure 1.1
Carbon emission and population
Note: Laos (CO_2/cap.: 23 tons) and Côte d'Ivoire (CO_2/cap.: 10 tons) are extreme outliers due to heavy deforestation and are not included.
Sources: Based on data from Marland et al. 1989; World Bank 1988; Central Intelligence Agency (various years).

pand (through exploration, "discovery," and/or trade), and the demand for resources will further accelerate—as will resource depletion, pollution, and other forms of degradation. But new technologies may include the development of machines and the identification of resources that are more resource-efficient and/or "environment-friendly."

There are other implications and qualifications deriving from these propositions, which will be discussed in chapter 3. As a prelude some basic patterns are presented in figure 1.1 (carbon emission and population size) and figure 1.2 relating carbon per capita and GNP per capita.

Limits of State "Sovereignty"

Institutionalized sovereignty does not imply that states are the only (or necessarily the most important) agents or institutions responsible for transforming (depleting or degrading) social and natural environments.[13] Quite the contrary. Emerging from barter exchanges in prehistoric times, markets have provided some of the most powerful driving forces behind the location, transportation, transformation, and redistribution of re-

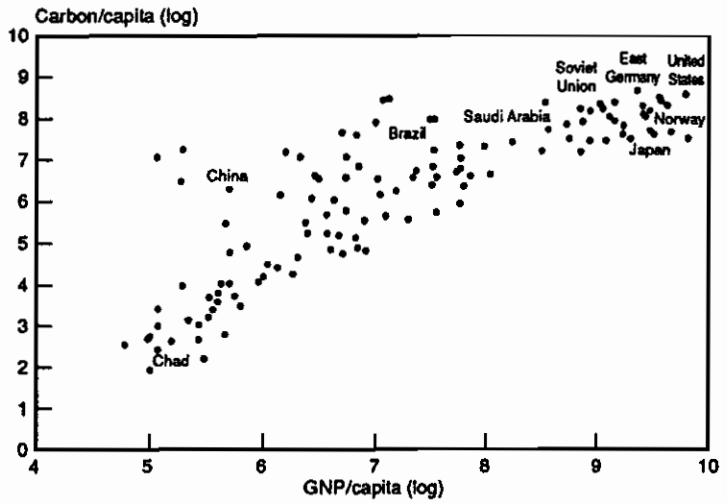

Figure 1.2
Carbon per capita and GNP per capita
Note: Laos (CO_2/cap.: 23 tons) and Côte d'Ivoire (CO_2/cap.: 10 tons) are extreme outliers due to heavy deforestation and are not included.
Sources: Based on data from Marland et al. 1989; World Bank 1988; Central Intelligence Agency (various years).

sources (and manufactured goods) among states and must be recognized, therefore, as playing a major role in determining relationships between natural and social environments. In many respects markets made states possible and contributed to their development into the complex institutions we know today. Closely associated with markets, moreover, are private firms (companies, corporations) servicing them and at the same time benefiting from their ubiquitous functions. Like markets, these organizations and institutions have played historically important roles in technological and economic growth and in development and political stabilization.

Many, if not most, of the more powerful human impacts on the natural environment are exerted by private firms, corporations, and comparable organizations and institutions. In this regard multinational corporations play an increasingly significant role. Because of their uniquely "sovereign" roles in the global system, states are the cognizant and ultimately responsible aggregators and record keepers for their populations, their

economies, their military establishments, their governmental accounts, and increasingly their performances on environmental issues. But markets, firms, and corporations provide mechanisms of production and exchange that are critical to economic stability and the ability of the state to apply leverages domestically and externally and to effectively implement its policies.

Activities Generating Emissions and Effluents

Contemporary anthropogenic activities as diverse as industrial production (i.e., the production of cement, refrigerants, etc.), the burning of fossil fuels, stock raising, rice paddy culture, deforestation, and landfilling generate effluents and emissions that affect the global climate and other aspects of the global system in various ways.[14] In this section of this chapter we are concerned primarily with the sources of such materials, whereas the next section deals with modes of transmission and their implications for state, international, and global environments. In the aggregate the greater the level of production (and associated technological and economic activity), the more rapid will be the expansion of emissions and effluents.[15]

The generation of carbon dioxide (CO_2), a major gas contributing to global effects, is an inescapable consequence of nearly all social processes. Carbon emission is "produced" principally by energy use (74 percent), industry (cement and gas flaring) (3 percent), and deforestation (23 percent) (Marland et al. 1989; Houghton et al. 1987). These estimates are rough at best, given the uncertainties, controversies, and difficulties associated with estimating, let alone computing, indirect effects (see, for example, Stern, Young, and Druckman 1992), as well as interactive effects. By contrast, methane is generated largely by activities in developing regions—the raising of rice (29 percent) and ruminant domestic animals (20 percent), burning of biomass (15 percent), creation of landfills (15 percent), and use of fossil fuels (21 percent)—as well as by the solid industrial wastes of developed societies (25 percent). Methane produced in developing areas is closely tied to subsistence and to activities necessary for the poor to survive day to day.

The chlorofluorocarbons (CFC 11 and CFC 12) are man-made and are used strictly in industrial manufactured products and industrial processes. Although CFCs are currently produced mainly in advanced societies—for refrigeration, cooling, electronics, etc.—the fastest-growing markets for these products are the developing countries. And nearly 80 percent of the world's population resides in developing areas. CFCs contribute significantly to the erosion of the ozone layer, and their residence time is among the longest of the effluents. For these reasons—and others that will be discussed later on in this volume—CFCs have been acknowledged early as crucial outputs. We will show how the international community has been effective in framing a response to this environmental challenge. Relative to the other effluents, the nitrous oxides are the least understood of the greenhouse gases. Such effluents are produced largely by fossil fuel use, biomass burning, fertilizer use, and the contamination of aquifers. Since almost every country in the world uses fossil fuels and fertilizers, the sources of nitrous oxide are distributed globally, as are the activities producing these effluents.

The relevant considerations for subsequent chapters are the major differences in the volume, intensity, and productivity of greenhouse gases—and attendant effluents—across nations and over time.[16] These differences provide important parameters as well as key variables in the formation of strategies for global management. In some cases they may even serve as multipliers, interacting with other social or ecological issues and thereby showing the ubiquity of human-nature interconnections. These differences are created by the differences in distribution of actions and activities worldwide that produce various effluents. Figure 1.3 provides an approximate distribution of effluents by activity. It is approximate because it draws only on first-order consequences at the point of measurement. More than that would be a foolhardy exercise indeed. (See the notes to table 1.2.)

The scope of the global problem is illustrated by the fact that current emission rates of the major greenhouse gases—in conjunction with past emissions—may be in excess of the capacity of the tropospheric, oceanic, and terrestrial sinks to absorb them, creating the ecological imbalances or "deficit." This outcome provides a nearly perfect illustration of the complexities in interactions of social and natural processes. Measurement and observations on these individual gases—carbon dioxide, methane, chlorofluorocarbons, nitrous oxide, and others—vary significantly

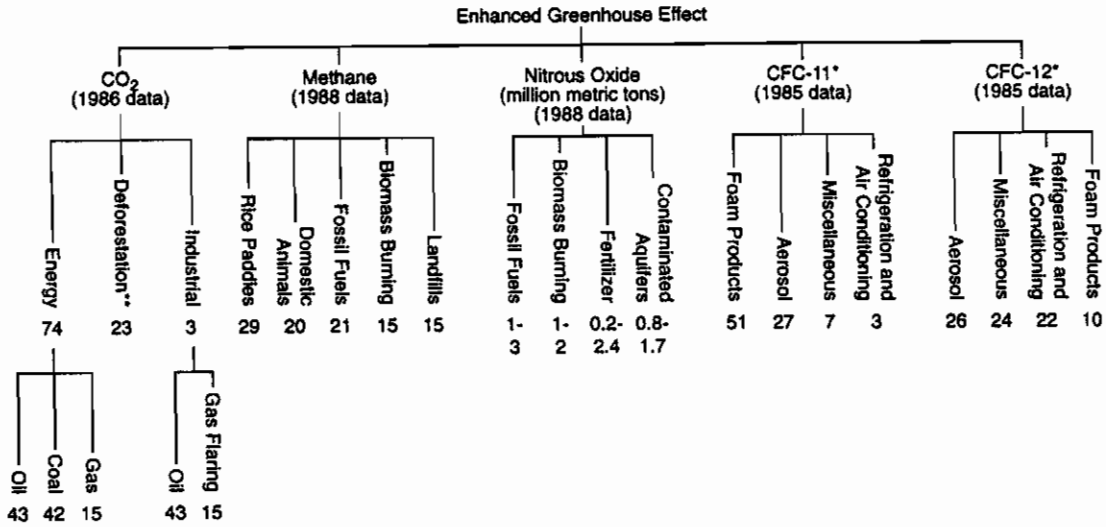

Figure 1.3 Enhanced greenhouse effect: Effluents and activities in terms of approximate percent contribution of various activities to each gas

Notes:
[1]Reporting countries only. For Communist countries CFC 11 is estimated at 12% and CFC 12 is estimated at 18%. An earlier version was presented in Choucri and North 1990.
[2]1980 figure.
Sources: Based on data from the following sources: CO_2: Marland et al. 1989; Houghton et al. 1987. Methane and nitrous oxide: EPA 1989. CFCs: Hammit et al. 1986.

Table 1.2 Properties of major anthropogenic greenhouse gases

Property	CO_2	CH_4	N_2O	CFC-11	CFC-12
Pre-industrial atmospheric concentration	280 ppmv	0.8 ppmv	0.288 ppmv	0	0
Current (1990) atmospheric concentration	353 ppmv	1.72 ppmv	0.310 ppmv	0.000280 ppmv	0.000484 ppmv
Current rate of atmospheric accumulation	1.8 ppmv (0.5%)	0.015 ppmv (0.9%)	0.0008 ppmv (0.25%)	0.0000095 ppmv (4%)	0.000017 ppmv (4%)
Atmospheric lifetime	50–200 yrs (see caption)	10 yrs	150 yrs	65 yrs	130 yrs
Direct global warming potential	1	11	270	3400	7100
Indirect global warming potential	none	positive	uncertain	negative	negative

Notes: CO_2, carbon dioxide; CH_4, methane; N_2O, nitrous oxide; CFC-11, chlorofluorocarbon-11 (CCl_3F); CFC-12, chlorofluorocarbon-12 (CCl_2F_2). Other chlorofluorocarbons are not shown. Several precursors to formation of tropospheric ozone (a strong greenhouse gas) also are not shown; these include carbon monoxide, various hydrocarbons, and oxides of nitrogen. Concentrations are expressed in parts per million by volume (ppmv). Concentration and rate of accumulation data are from globally averaged *in situ* measurement and are well known. Atmospheric lifetimes are computed from observational data and models and are less certain. The "lifetime" of CO_2 reflects a range of model estimates of the rate at which atmospheric CO_2 concentrations would adjust to changes in emissions—CO_2 has no permanent sinks but rather is transferred between atmosphere, ocean and biota through complex and not fully understood processes. The global warming potential (GWP) is an index used to compare the greenhouse effects of sources (and sinks) of different gases in common units (on a mass basis). By definition the GWP of CO_2 is 1. Direct GWPs shown here account only for the direct radiative effects of emissions (or absorption) of these gases. Some greenhouse gases also yield indirect effects, e.g., by altering the chemistry of the atmosphere and thus the concentration of other greenhouse effects. Indirect effects are very uncertain and thus not quantified. Sources: after table 1.1 Houghton et al. (1990) and table 3 of IPCC (1992). (Compiled by David Victor)

in extent and reliability in terms of both quality and quantity; but with allowances for interactions, feedback, and substantial uncertainties, a rough indication of both the sources and the impacts of these effluents can be gauged.

The distributions in table 1.2 show relative contributions of select greenhouse gases to temperature change (global warming), residence time in the atmosphere for the 1980s, and annual growth rate (see Hansen et al. 1988 and Graedel and Crutzen 1989 for slight differences in estimates). While there are many ambiguities, the table shows the differences among the greenhouse gases for each of these factors and provides the basis for propositions about the linkages of these gases to human action.[17] Since these gases are generated by different types of human actions (and hence decisions), we can begin to develop hypotheses about society-ecology linkages.

Differentiating among the greenhouse gases provides an initial entry point into identifying the relative sources of emission and action as aggregated within the institution of the sovereign state. Then, too, differentiating among gases in terms of hypothesized relative contributions to climate alterations—in conjunction with distribution by state source—helps shape assessments of relative impacts on global environmental alterations.

The time element remains critical: The residence time in the atmosphere of the individual greenhouse gases all but ensures that past human effects cannot be eliminated—however effective either present policies or future commitments might be. At issue is modulating present and future effects of present and future actions. In a very real sense, therefore, the broad contours of global accord for environmental management are illustrated by the distribution of the variables in table 1.2, as are the uncertainties and complexities. Because all countries generate these gases, but in different amounts and in different proportions, differences in residence time make it especially difficult to account with any precision for who does what and how much—and whether it matters and how much. To illustrate linkages between human action and types of effluents, in this section we will further highlight the significant connectives between gases and action. Figures 1.4 and 1.5 provide an approximate distribution for CO_2 emissions.

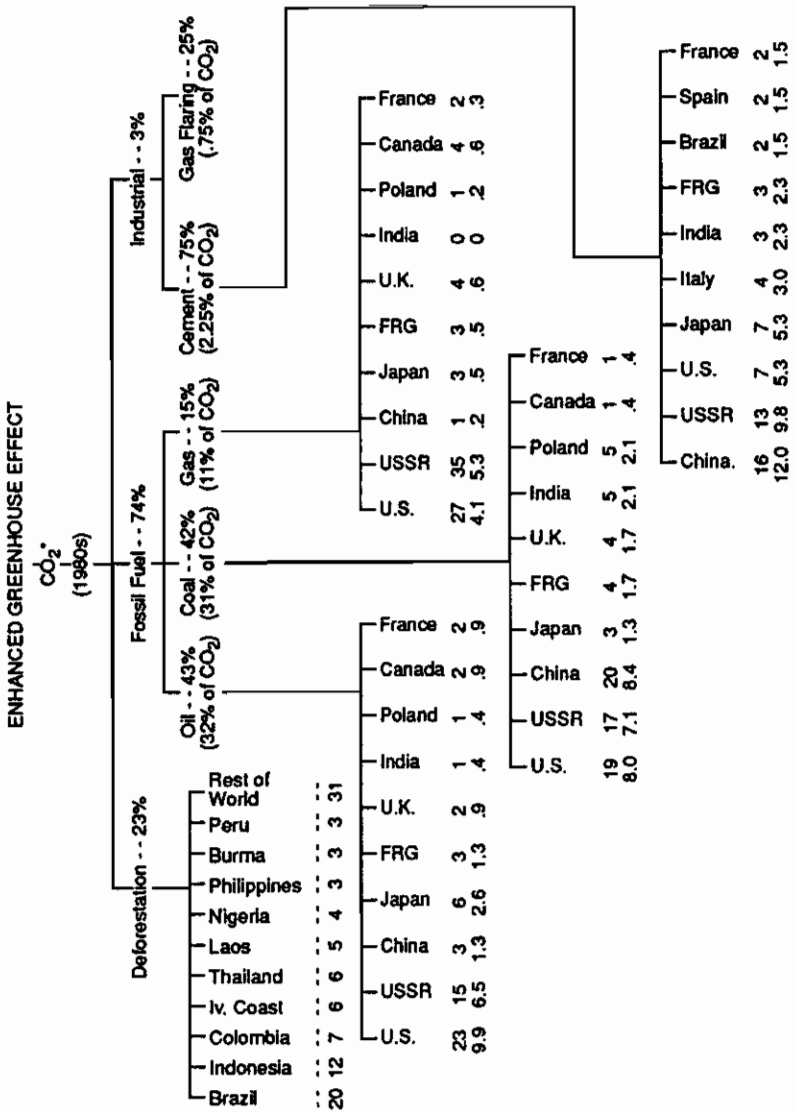

Figure 1.4
States' contributions to activities generating select trace gases
Notes: The first row in each series indicates % contribution of states to uses of oil, coal, gas, and cement, respectively. The second row in each series indicates % contribution of states to deforestation, fossil fuel use, and industrial activity from oil, coal, gas, and cement use.
N.B.: All numbers are in % and have been rounded. Countries listed under each subheading are the top 10 for total contributions to deforestation, fossil fuel use, and industrial activities, respectively.
Source: Based on data from Marland et al. 1989: Houghton et al. 1987.

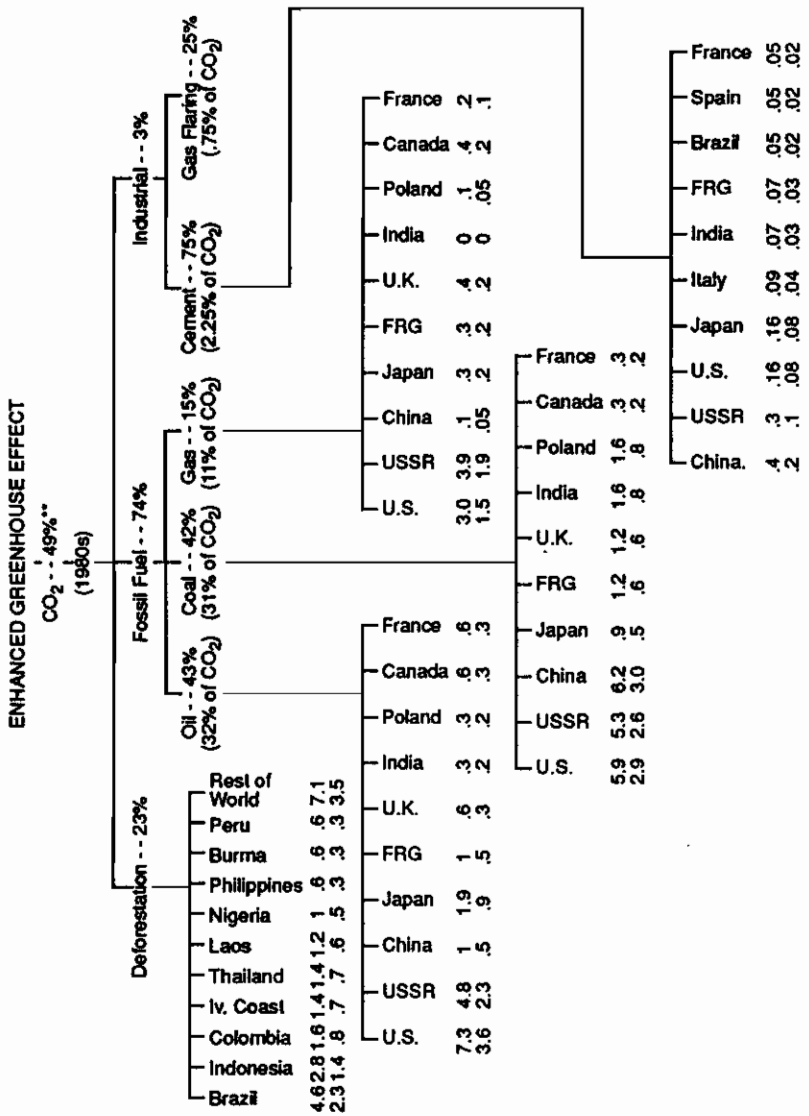

Figure 1.5
State activities and global effects[1]
Notes:
[1]In % and rounded.
[2]Note the inherent statistical inconsistency: 49% of *current* greenhouse effects is the product of all *past* as well as *current* emissions.
The first row in each series indicates % contribution of each state, by activity, to global CO_2 emissions. The second row in each series indicates % contribution of each state, by activity, to enhanced greenhouse effect. Countries listed under each subheading are the top 1 for total contributions to deforestation, fossil fuel use, and industrial activities, respectively.
Source: Based on data from Marland et al. 1989; Houghton et al. 1987.

The fact that human activities within one jurisdiction can alter environmental conditions in another—and possibly for the planet as a whole—suggests both that there is a new form of politics in the making and that the theoretical foundation for the study of politics among nations must necessarily address a range of transnational and interstate interactions bearing on the management of environmental transformations generated by social activities.

With respect to activities and effluents, according to their respective roles and functions, we can view actors in the global system in two broad categories: (1) those that are "full-time" resource depleters and degraders (individuals, firms, corporations, and states) that function as environmentally oriented negotiators and/or regulators in particular circumstances; and (2) those that negotiate and/or regulate environmental and related issues on a more or less sustained basis (agencies of the United Nations, regional or functional regimes, et al.). Beyond that broad differentiation, however, the differences within each group are considerable.

Transmission Mechanisms: Natural Forces and the International System

At this point we turn to two modes of transmission that move emissions and/or effluents—directly or indirectly—from their countries of origin into global space: the natural and the social. The natural modes are illustrated by emissions or effluents that move directly from the site of generation and are "captured," so to speak, by natural forces—updraft, wind, large rivers, ocean currents, and the like—through biogeochemical and related cycles and processes. Among the social modes of transmission are the effluents and degradation materials embedded, moreover, in products that are produced in one country and used in another (automobiles and/or fossil fuels, for example)—from the United States, perhaps, to Germany, Brazil, or possibly Bangladesh. When such transfers are completed, there are almost certain to be at least three mechanisms of social transmission to be accounted for: one at the primary production site in the United States, where emissions or effluents are released into the global environment and moved by natural forces; one accomplished by social means of transport (railway, trucking, maritime shipping, air

freight, pipeline, or whatever); and one associated with product use, where emissions or effluents are again released to natural forces of the global environment.

From the point of view of human societies organized into "sovereign" states in an international system, the interactive effects of natural and social (ecological and anthropogenic) modes of transmission affect—and are affected by—organizational and institutional arrangements of the international system. Shaping both structure and process in the international system are driving forces traceable to uneven growth, development, and competition among the states (and their components)—phenomena of considerable complexity, paradox, and potentials for contention. The discussion here will be limited to the distributional (and essentially competitive) functions of the system, whereas a growing concern among the nations for environmental sustainability—and a measure of global accord—will be considered in the next section. The dynamics of the natural forces of the global system are even more complex (and uncertain), and a more detailed discussion of them is reserved for a subsequent section.

States and their component institutions differ substantially in terms of the levels ("sizes") and rates of change of their populations, technologies (knowledge and skills), and resource availabilities. For this and related reasons their economic, political, and military (strategic) bargaining and leverage capabilities also differ substantially, as do their respective levels and rates of resource depletion and degradation.

Interacting with each other diplomatically, economically, militarily, and otherwise, states constitute the international system. Just as bargaining and leveraging within states contribute to domestic distributions of attributes, resources, capabilities, influence, and agents of environmental depletion and degradation, so bargaining and leverage between states of different profiles (basic structures) and capabilities contribute to the production and distribution of resource-depleting and degrading resources, goods, and technologies across each others' national borders.[18] Through such largely unintended distributions (driven by more or less legitimate economic forces), states create for themselves and for other states conditions of environmental interdependence which none of them intended to impose.

Private and Public Activities

Among the most powerful social distributive mechanisms are the activities (and facts) of production; but once goods are produced, the transport mechanism, the utilization of goods, and their dispersal for intermediate or final use are processes that are generally emission-based. The "normal" practice of international trade best illustrates this simple fact: Effluence is endemic to production; effluence is a necessary corollary of transportation; and effluence is a byproduct of consumption and utilization. As noted below, the complexity of transmission internationally also contributes to significant uncertainties about the sources and consequences of global change and, by extension, to the difficulties of framing appropriate international responses.

Entailing both public and private activities, trade and other commercial and financial exchanges between states can be either binational or multinational within the international system and may involve either state or nonstate actors. In effect, by exporting resources, goods, services, and technologies across national boundaries, countries also export the growth-development/environmental sustainability paradox by the inclusion of depleting, degrading, or polluting actions or agents. The characteristics and outcomes of such transactions are influenced, intentionally or unintentionally, by the profiles of actors on both sides of the relevant border(s).

Additionally, insofar as markets, firms, foreign trade, and other economic ventures (investment, for example) facilitate the production, distribution, and consumption of energy and other resources across state frontiers, these institutionalized transactions often allow the effluents and other residuals to flow back into common property areas of both internal and external environments, thus exacerbating domestically generated pollutants that were domestically distributed and contributing to environmental interdependence (Choucri and North 1990).

Crossing Borders

State borders compound complexities—and derivative uncertainties—because (1) they are man-made and partly protected but also fallible; (2) they delineate jurisdictions of states, indicating where one jurisdiction begins and others end, thereby delineating the legitimate exercise of political authority; (3) and states, in principle, are autonomous in the

exercise of authority within their jurisdictions—even though the impacts may be felt elsewhere. In practice, moreover, (4) states are seldom able to exercise their internal authority over external consequences as effectively as they desire; (5) they are generally unable to control access across their boundaries (of people, goods, and services) entirely—if at all; (6) they cannot regulate flows of environmental effluents across their borders, even if they desire to; and (7) they cannot insulate or protect themselves effectively from actions of states in other jurisdictions (as when deforestation in one state affects carbon balances, and potentially environmental conditions, elsewhere).

Viewed in an international context, it is apparent that no single state can individually control the direction or alter the distributions of effluents, but neither is any one state insulated from the effluents of others. The conjunction of indirect social transmissions of emissions and effluents (through use in one location of products and processes produced in another) and the vagaries of transmission by natural forces give rise to a peculiarly pervasive gridlock of "complex" interdependence[19] wherein all are potentially hostage to all. And the reality of national borders—delineating limits of "sovereign" jurisdiction—is the defining factor of the international system at any point in time.

International Pursuit of Sustainability and Accord

International growth, development, and economic exchange and competition, together with the attendant transmission and diffusion of environmentally degrading agents (including assistance from natural forces) helps to frame the paradoxical relationship between growth and development and environmental sustainability. One horn of the consequent policy dilemma represents economic and political stability, profit, and jobs now (at uncertain environmental cost); the other horn stands for the preservation of environmental assets (at uncertain economic cost) with future generations in mind. The debate is worldwide and is attracting attention at local, national, regional, and international levels.

We view the individual human being as the only true decision- and policymaker in any organization or other collective body—family, community, firm, state, or international or global system. Hence when we assert that any one of these collectives has decided, we mean that through

some kind of bargaining and leveraging process, however equal or unequal and however conscious or unconscious, a coalition of individual human beings has been established in support of some particular option.

We put forward another stipulation: The state is the only organization, institution, or collective actor that is recognized as sovereign or successfully operates in ways that meet the (mythical?) criteria of sovereignty. This means that private firms—including multinational corporations—are not sovereign, nor are any international agencies or the United Nations. There is no world (or global) government. If there were, it would be sovereign by definition, and the status of "sovereign" states would be called into question. This aspect of the sovereignty "myth" helps to explain why there is no world government—down to this day, at least. We cannot conclude, however, that various agencies of the international system, or the United Nations, have little power. On the contrary, they have as much power (which can be considerable), as a sufficient number of powerful or at least influential "sovereign" nations are willing to accord them.

In recent decades numbers of international agencies—and notably the United Nations—have exerted unprecedented power and influence with respect to environmental (as well as security and related) issues. Additionally, several states in the international system, including the United States, have on numerous occasions demonstrated their ability to limit the influence of the United Nations and other international agencies. Such demonstrations remind us that states remain sovereign and are therefore qualified, in effect, to bring as much influence, power, and/or naked force to bear as other nations in the system are willing to allow.

Given these imperatives, how much substance is available in support of the reality that global environment is the encompassing, overarching system on which all social systems and our very existence as a species are irrevocably dependent? Few would deny that the substance is total. At the same time the logic of our status brings us back to our starting point: Only individuals make decisions; only states (for now, at least) are sovereign. And the natural system is the only possible source of everything we need or want. Every action we take has an environmental cost.

We have seen how our power to generate effluents and inflict environmental damage beyond state (and other) borders makes each state

(or other actor) interdependent—almost hostage—to others. Subsequently we will reveal some of the complex ways whereby damage we create in the global (natural) environment is thrown back against us in ways that are likely to remain outside our direct control. Within this complicated (and uncertain) context, bargaining and leveraging define our social relationships, and coalitions determine our "power," influence, and possibilities for pursuing accord.

Viewed within an international (or global) context, clearly no single state can individually alter the global distributions of effluents and none is insulated from the effluents of others. International collaboration is thus a necessary element of effective environmental management both to influence present trends affecting the global environment and to provide both the necessary and the sufficient interventions in prevailing patterns of "individual" and "systemic" human activities.

Because of the long lead time, the complex feedback dynamics within and between social and natural systems, and the irreversibility of many environmental changes, policy interventions set in place now will have impacts only in the longer range. In those terms international coordination becomes a necessary condition for influencing future trends of global environmental deterioration.[20] Although the issue of environmental alteration is relatively new in international forums, there has been a discernable trend toward the regulation of environmental degradation.[21] Already the international community has concluded some 140 environmental treaties.

As indicated in several chapters of this book, the record suggests that accord on the global environment involves a dynamic policy process revolving around bargaining, negotiation, and leveraging among relevant actors. That process begins with recognition of the problem; agreement on goals and principles, identification of specific procedures, and formulation of policy alternatives; and—finally—a decision on policy. Matters of implementation and compliance emerge at a subsequent stage. One of the most important achievements in this entire process is the building of consensus between scientists and policymakers in the development of a flexible framework designed to avoid obsolescence in the face of new scientific evidence.[22]

The basic differences and unevenness among states on either side of the growth-development-sustainability ledger—whether generating patterns of effluence or contributing to their management—help shape the contours of responses to global responses to environmental change. Industrial societies are expressing concern over the developing countries' reluctance to engage in environmental deliberations.[23] And developing states are countering with the charge that since it is the industrial societies that have polluted the environment, they must bear the costs of management. These concerns begin to frame the bargaining dimensions of global accord for environmental management. So, too, while there is an appreciation of the distinctive environmental problems for industrial and developing countries, the common predicaments are not agreed upon, nor is there consensus on the salience of environmental problems—on priorities and policy.

While the nature of political deliberations will continue to be affected by scientific assessments and by interpretation of the evidence—often of a very conflicting nature—it is the bargaining and the negotiation among actors and among local groups affecting these actors that will shape actions. The political processes—national and international—will marshal concerted strategies for the management of global issues and will ultimately legitimize the responses to evolving scientific evidence, concerns, and corresponding policy options. Deliberations around negotiation for a Framework Convention on Climate Change and a Framework Convention for the Preservation of Biodiversity illustrate the dramatic politicization of environmental factors. In this process the role of science, scientific information, uncertainties, and attendant controversies will continue to assume major political proportions.

The Encompassing Global System

The earth and its features might be envisaged as a massive incubator of life—all flora and fauna, including our own human species, and their needed resources—heated by the sun and tempered by winds, clouds, rain, and other natural forces. The whole system—geological, chemical, climatic, biological et al.—has always been undergoing change, but throughout most of the planet's history, such changes have been attributable primarily to the amount of solar radiation reaching the earth's surface and to alterations in the planet's orientation to the sun (Hileman 1989, 40), which is not only the "prime mover of the earth's climate"

but also "the source of its life" (Schneider 1989a; Schneider 1989b, 13). Only during comparatively recent times (no more than a few ticks of nature's clock) have human beings emerged as agents of disruption of the global equilibrium.

From this perspective, if the nested social systems discussed in previous pages are "fitted into" and intensely interact with nature's encompassing system—thus completing the global system as we have defined it—individuals on all levels (all of us) continue to function as the ultimate anthropogenic actors. Like other living things, humans remain sensitive to myriad events in the natural system, which is sensitive in turn to a wide and ever-broadening range of anthropogenic activities. They demand products that contribute to soil erosion, deforestation, and flooding. The fossil fuels we burn generate carbon monoxide, carbon dioxide, sulfur dioxide, and methane. Our refrigerators, aerosol sprays, and foams combine with other effluents to deplete the ozone layer, and on and on. These are all elements of what Westerners have defined as the "good life," one to which people in other parts of the world increasingly aspire.

In guiding us through the formulation of theory and making of policy, an integrated perspective relating social and natural environments to global change is less a luxury than a necessity. Figure 1.6 centers on the interactions of ecological systems and decision-making systems as they are shaped by natural processes (on the environmental side) and by action and decision-making processes (on the social side). It is this connectivity between the two types of processes that defines the essence of global environmental problems, and it is the distinctiveness of the respective processes that enables identification of potential policy alterations or interventions.

Seeking to penetrate what casual observers might perceive as enigmas of the universe, scientists address the top part of figure 1.6. These seeming mysteries emerge from the nature of planetary processes and sources of change within and between ecological systems. Social scientists, by contrast, are concerned with the remaining elements of the diagram—the core interactions between decision-making and ecological systems and the underlying social processes (or process variables). These variables are presented in bold type in the lower part of the diagram. In all their complexity, multidimensionality, and intense interactivity, these

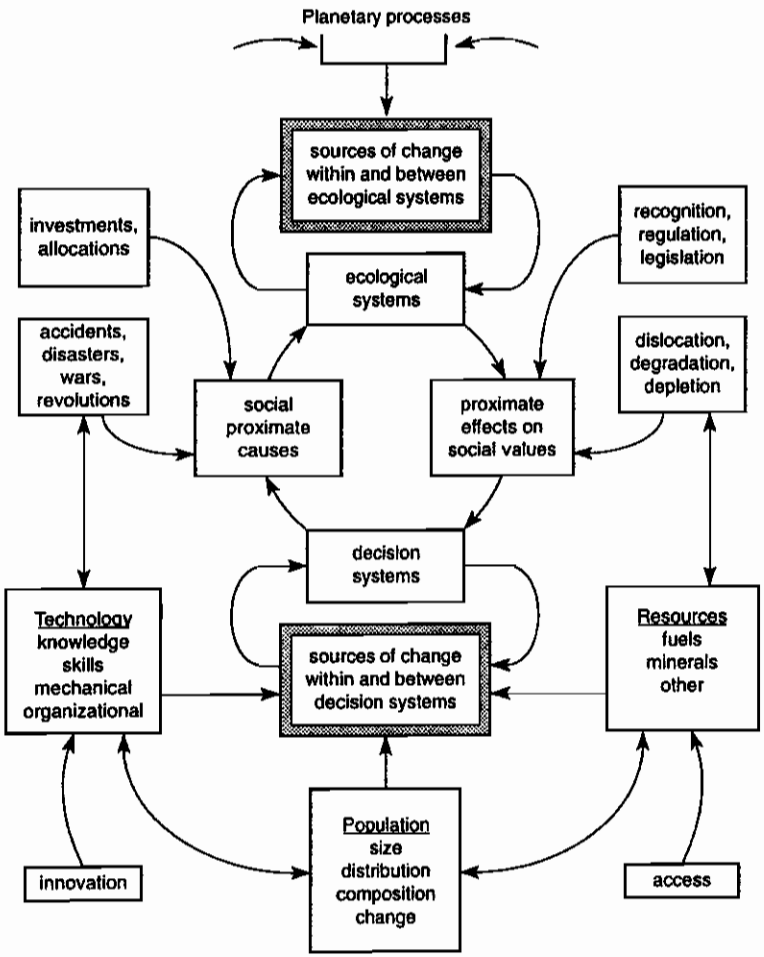

Figure 1.6
Integrated global perspective: social and natural environments
Source: Extended and adapted from Stern, Young, and Drukman 1991.

master variables contribute to the variables of human outcomes and effects on ecological balances.

For scholars of international relations the conception of a global system as distinct from an international system is especially challenging.[24] Conventionally the study of international politics has focused almost exclusively on social interactions across national jurisdictions.[25] It becomes increasingly apparent, however, that the interactions between social and natural forces exert strains on the global system, calling into question the global system's capacities to adjust, accommodate, or absorb dislocations thrust upon it and lies beyond the bounds of the field as traditionally conceived.

The political problem worldwide derives from the consideration that in all societies population demands must be managed and basic needs met. To the extent that such demands are met, managed, postponed, diffused, or mitigated, the essential conditions for ecological security may be met for the short term. But if the demands of a population exceed the carrying capacities of resources, land, and the economy, environmental security is threatened. And if populations, in conjunction with prevailing technologies and social adaptation techniques, place pressures on resources in excess of the prevailing resource base or its capacity to meet or "absorb" pressures, the viability and environmental conditions for social systems may be threatened—in the sovereign state, in the international system, and in the global system.[26]

This means that the individual—each of us—bears responsibility for and may suffer from outcomes that occur at all levels of social aggregation in all parts of the world. Concurrently, to the extent we individuals buy, sell, invest, produce, or otherwise operate through privately owned and managed manufacturing, commercial, or financial institutions, we find many of our internationally and globally oriented activities mediated by our respective firms or corporations and also, directly or indirectly, by governmental agencies in ways that have political and economic as well as environmental implications.

For both analytical and policy purposes figure 1.6 depicts a significant challenge: the need to distinguish among global processes and outcomes in terms of those which for all practical purposes are, and are likely to remain, outside human control (such as cloud formation and solar radiation); those over which human control is partial (such as the buildup

of carbon dioxide levels through fuel use); and those which are entirely under human control. The global processes and outcomes that are entirely under human control are those for which human beings are primarily, even wholly, responsible as "producers" and which, in principle, they distribute globally.

Added purposes of figure 1.6 are to (1) help frame the logic for international action, (2) identify the junction at which policy interventions may be crucial, and (3) highlight the need for consistency on conceptual grounds and for a definition of international policy responses. Figure 1.6 depicts highly complex processes in a highly simplified form. To read the figure as it is intended, one views each component itself as composed of complex nonlinear and highly complicated processes fraught with uncertainty. This mental exercise, applied to the distribution in figure 1.3, should yield a sense among the state entities in the international system with respect to the scale and scope of the dynamics of figure 1.6.

Also embedded in figure 1.6 are the major intervention junctions, i.e., the points at which alterations in human action due to policy changes, different types of interventions, and different types of actors are salient in each phase. Government performance everywhere is shaped to administrative capabilities, political stability, and support of the population, all of which directly bear on its capacity to act. Different governments have different tools and policy preferences for meeting demands.[27]

Complicating the problem from a policy perspective is the fact that from an ecological perspective—at the top center of figure 1.6—there is a generic dilemma that underlies all social processes: Activities undertaken in the pursuit of legitimate ends (i.e., economic growth, industrialization, etc.) can be ecologically dislocating and environmentally threatening. Defining the global predicament, this policy dilemma is by now both recognized and to some extent accepted in industrial societies. But it is especially controversial—and compelling—in those developing countries in which the demands of a rapidly growing population must be met.

In the parlance of dynamic feedback processes, the central proposition of figure 1.6 is the necessity for joint action: The persistence of unconstrained human activities that are degrading to the environment and

unabated patterns of effluence may substantially disturb the interaction and relationship between two complex environments, the natural and the social. The disturbances induced by human activity could exceed nature's adaptive and absorptive abilities. They could also effectively transform conditions for life on earth on an aggregate basis (for example, the prevailing temperature) as well as regionally, if not locally. Central in this connection is the fact that most patterns of environmental degradation are basically due to actions and investments that are viewed as normal and legitimate and are entirely in keeping with the most routinized social processes worldwide. These are the actions we encourage, uphold as valuable, and seek to emulate. And people everywhere have defined these as "growth" and "development."

Clearly there are also sources of environmental degradation that are considered to be not normal and which we would all view as pathological and not always legitimate—such as nuclear warfare—with potentially potent impacts on the global environment. But for the most part it is "normal" human behavior—and its underpinnings of social legitimacy—that emerge as root "causes" of deleterious effluence and environmental degradation.

A wide range of environmental alterations and the increased patterns of environmental interdependence shape the parameters for coordinated institutional responses. Under certain circumstances these pressures may even be articulated as "demands." The obvious fact that environmental effluents do not respect the sanctity of territorial boundaries defines the character of environmental interdependence. The diffusion of effluents across territorial borders and the inability of states to control their diffusion or destination place states in a bargaining stance in which managing effluents—their sources and consequences—is the central issue of deliberations that may shape the choice of targets, of strategies, and of expected outcomes.

In the context of figure 1.6, the outliers in the diagram, on both sides of the figure, represent the intervention points—through normal processes (such as regulation, legislation, allocations, investments, and so forth)—as well as processes considered less normal, or at least socially undesirable (such as war, violence, dislocating conflicts, and the like). Both types of processes are generic features of social practice and of social systems. The policy sector in figure 1.6 points to the problem

inherent in striving for global accord. In the absence of changes in human action, prevailing patterns of human activities may seriously stress the resiliency of ecological systems. Inducing behavior changes could alter current trajectories; without alteration, however, we can envisage greater environmental strains. Therefore, devising approaches to alter behavior amounts to an imperative. And since alterations may be needed in all social contexts, the challenge (originating "locally") is inherently one of individual decision, international politics, and global impact.

Uncertainty, Policy, and Risk

Unavoidably a presumption of pervasive uncertainty accompanies any discussion of resource-depleting or -degrading activity, the generation of emissions or effluents, and possible global consequences. The gross immeasurability of uncertainty on both sides of the ledger—in terms of both ecological systems and social systems—and the unknowns of "cause" and "effect" are nearly overwhelming. In this connection types and sources of uncertainty can be roughly categorized as follows. First, while the basic biogeochemical characteristics of global environmental change are broadly recognized, uncertainties about the *feedback effects* on both the physical and social processes are compelling.

Second, environmental as well as social processes operate in multiple, unequal, and sometimes overlapping *time frames*. Variability in time increments complicates assessments of the underlying processes. Fundamentally the long lead times in both social and environmental processes—and the separation of "cause" and "consequences"—themselves amount to major sources of uncertainty. Third, there are uncounted uncertainties associated with intertemporal effects. In particular, there are *intertemporal and intergenerational impacts* of environmental change whereby future generations incur the environmental costs of the actions of past and present generations, which reflect the complexities associated with long lead times.

Fourth are uncertainties due to *irreversibility*. It may well be that some patterns of environmental alterations cannot be "undone" and that the underlying sources cannot be eliminated either wholly or in part—at least not within the frame of historical rather than geological time.[28] Finally, given a major unevenness in the sources and consequences of

environmental perturbations, the differentials in the determinants of greenhouse gas emissions and in their effects both regionally and worldwide raise crucial issues of *equity* related to intertemporal (over time) and intergenerational (across generations) effects. Not all countries contribute the same way to the global balances, nor are they uniformly affected. Some will benefit from climate alteration.[29] This unevenness may be a significant constraint on the development of international responses.

These features characterize some crucial uncertainties associated with global environmental change. Because human activities are incremental in historical time and therefore minuscule in geological time, they confound assessments of complex feedback, time frames, and differentials in sources and in consequences.[30] Together these factors bear on the political issues and on the policy responses of the international community, as they serve also to frame analyses of the constituent components of the global issue—in terms of both sources and consequences.

The more illusive uncertainties in the natural environment derive from our limited knowledge of climatic and other processes of change affecting human and other forms of life on the planet. Uncertainties in social environments are shaped in considerable part by the fact that whereas individual human beings are the only real decisionmakers on any level of organization, competing states with grossly unequal power and influence are the sole sovereign and legal decisionmakers in the international and global system. And firms, also with unequal capability, scope, and influence, are the major producers and distributors of effluents and agents of environmental degradation. It is the conjunction of these uncertainties in both natural and social systems that confounds a simple policy prescription for environmental management—at any level of decisionmaking.

The climate focus is particularly important as it highlights, par excellence, the salience of uncertainty—in both cause and consequence—and the sensitivity of climate to levels, rates, and perturbations of atmospheric conditions. Because the climate's mechanisms are highly sensitive to a set of trace gases, labelled the "greenhouse gases," the role of humans in "producing" these gases is of critical concern.[31]

The most frequently cited pattern of climate change is the record of global temperature, which shows a distinctly upward slope over the span

of a century. The attendant trend in carbon emissions also shows a notable increase. The concentration of carbon dioxide in the atmosphere today is roughly twenty-five percent higher than a century ago. And it is generally agreed that with increases in carbon concentrations, the temperature of the earth's surface will also rise. In this sense climate serves as a dependent variable to be "explained" by patterns of human activity, and the effluents attained (carbon dioxide in this case) serve as intervening variables to be altered by conscious policy intervention in order to respond to the change in climate.

To the extent that the environmental and ecological systems are perturbed by human action, both the sources and the consequences are fraught with uncertainty.[32] The climate system illustrates some compelling complexities. In physical terms the climate system is a complex process governed by intricate feedback interactions among biota, air, sea, land, and ice components.[33] The system, driven by solar radiation, is "regulated" by natural feedback processes, such as changes in the earth's position in relation to the sun and changes in the gaseous composition of the atmosphere.

Because of the complex interactions among the underlying natural processes—and given uncertainty about the effects of social interactions of the distinctly human element—separating out these effects is exceedingly difficult, if not impossible. The oceans and the biosphere, for example, play major (and highly uncertain) roles in the climate system,[34] and the conclusions we reach depend on how we approach the extensive uncertainties about these interactions.[35] The ubiquity of the underlying sources of global environmental change shapes, in principle, the nature of the interactions depicted in figure 1.6. So, too, figure 1.6 highlights the generic processes of linking "local" and "global."

These and associated imponderables are often put forward as a rationale for political indecision. How can we mount a full-blown program of environmental sustainability when we cannot assess the risks and other probabilities involved? There are two simple answers. First is insurance: If there were no uncertainties and risks in life (no fires, shipwrecks, automobile and aircraft crashes, floods, hurricanes, or earthquakes), there would be no need for insurance companies. Programs of environmental sustainability can be viewed as insurance programs. Second is the logic of local-global linkage: To the extent that global deple-

tions and degradations originate locally (and nearly all of them do), clean, healthy, and reasonably safe local environments will ensure clean, healthy, and reasonably safe global environments—at no additional cost.

Notes

Collaboration with Robert C. North in framing the theoretical issues of this volume, and of this chapter, is especially acknowledged, as are contributions to the logic of this chapter and the joint research that shaped inquiry into underlying analytical and empirical issues. I am grateful to Hayward R. Alker, Jr., Kenneth A. Oye, Thomas Homer-Dixon, Peter Haas, David Victor, and Oran Young for comments on an earlier version, to the members of the Harvard-MIT Seminar on International Institutions and International Cooperation for insightful discussion of the political issues and, especially, to the MIT Faculty Seminar on Global Change: An Interdisciplinary Perspective for a critical review of parts of this chapter.

1. Exceptions to this generalization reflect the increased recognition of the importance of environmental issues and their integration into disciplinary frameworks. See, for example, the development of economic analysis to address environmental issues as a distinct subfield of economics. For an analytic perspective, see Arrow and Fisher 1974.

2. Among the most relevant analyses of this issue is that of Young 1989a. See Krasner 1983 for alternative approaches to the problem of converging expectations and norm development.

3. For valuation of environment and for analysis of pollution, for example, see Dorfman and Dorfman 1972.

4. With relevance to such issues, Paul and Anne Ehrlich have quoted economist Kenneth Boulding to the effect that anyone who believes that exponential population growth "can go on forever in a finite world is either a madman or an economist" (Ehrlich and Ehrlich 1990, 159).

5. See, for example, Rubin and Graham 1983, and Walter 1975.

6. On the role of knowledge and issue linkage in international politics, see, for example, E. B. Haas 1980.

7. For valuation of environment and for analysis of pollution, for example, see Dorfman and Dorfman 1972.

8. On the role of knowledge and issue linkage in international politics, see, for example, E. B. Haas 1980.

9. See Skolnikoff 1990 for a discussion of political obstacles to domestic response to global environmental issues.

10. For a detailed analysis in the context of the Mediterranean region, see P. M. Haas 1990a.

11. The literature on bargaining and negotiation is rich with propositions and directives for cross-issue bargaining. For background and strategic analysis, see especially Raiffa 1982 and Fisher 1981. See also Young 1975. See Oye 1990 for a theoretically important and useful distinction between tactical and substantive cross-issue bargaining. On the issue of self-binding commitments, see Maoz and Felsenthal 1987. For a useful overview of approaches to regime analysis, see Haggard and Simmons 1987. Already there are efforts to articulate a viable transfer of technology to the developing countries in return for their compliance with pollution abatement measures.

12. See the dynamic representation in figure 21.2 in Choucri and Bousfield 1978 (p. 314) for an operational model.

13. In chapter 6 we show the conceptual (and empirical) relationships between expansion of state behavior outside national boundaries and expansion of firm behavior, extending markets, and market share (North 1990; Fligstein 1990).

14. See, for example, Keyfitz 1989, 1990, and 1983.

15. See Keyfitz 1989. See also Mathews 1990.

16. See, for example, Graedel and Crutzen 1989.

17. For a more recent analysis of the residence time issue, see Victor 1990.

18. Somewhat similar outcomes can result when large numbers of migrants move from their own countries into densely populated urban areas of other countries.

19. Peter Haas has suggested a related perspective, namely temporal, spatial, and functional transmission.

20. The alternative hypotheses are (1) that coordination among the most significant actors is sufficient to generate significant outcomes (in terms of imposing the corrective measures in figure 1.2); and/or (2) that spontaneous, uncoordinated action could generate behavior modifications; and/or (3) that effective bilateral exchanges on a generalized scale could generate requisite behavior alterations.

21. See Thatcher 1989 for a brief survey of institutional responses.

22. For examples of technological change and more scientific evidence, see Manzer 1990.

23. With the exception of the United States, the countries of the Organization for Economic Cooperation and Development (OECD) appear to be willing to engage in the search for interventions and policies to induce alterations in human activities and reduce greenhouse gas emissions.

24. North 1990 provides a detailed argument for separating "global" from "international," defining *global* as the Fourth Image, and thus extending the original Waltz formulation (Waltz 1959). See Choucri and North 1990 for an explicit articulation of the environmental linkages at each level/"image."

25. A nascent literature on the global dimension of world politics is emerging. See Pirages 1989 and North 1990. The intellectual debt to Aron 1973; Renouvin and Duroselle 1967; and Sprout and Sprout 1962 must be acknowledged.

26. See Keyfitz 1989 and Mathews 1990.

27. From a methodological perspective, this statement is best illustrated by the way in which different macroeconomic models rely on different types of "closure rules." For a detailed analysis of this issue, see Taylor 1983.

28. For an analytical perspective, see Arrow and Fisher 1974.

29. For example, global warming could alter the Siberian climate, enhancing agricultural prospects.

30. The broad scientific task involves improving understanding of the underlying forces for each of the greenhouse gases as well as interactions with gases that are not themselves greenhouse gases but can significantly alter the chemistry of the atmosphere and hence affect the concentration of greenhouse gases.

31. In the absence in the atmosphere of the greenhouse gases—which absorb heat that radiates from the Earth's surface and emit some of the heat downward, heating the earth—the earth would be about thirty degrees centigrade colder than today. This downward emission is a basic natural process governing the earth's "thermostat." But human activities are not increasing the atmospheric concentration of these gases on a global basis and, therefore, apparently intensifying the greenhouse effect. See IPCC 1992 for a recent synthesis of assessments and a scenario of effects.

32. Most of the hypotheses about climate alterations are derived from atmospheric general circulation models exercised to date largely in terms of exploring the effects of doubling atmospheric carbon dioxide—a fairly dramatic intervention. For a discussion see Schneider and Rosenberg 1989.

33. For a summary of key processes, see Schneider 1989a and Graedel and Crutzen 1989.

34. The ocean's ability to absorb carbon dioxide and heat is a major determinant of the rate and the extent of climate change. The oceans today absorb 45 percent of annual fossil fuel emissions. While the elementary chemistry is well understood, complex ocean/atmosphere feedback is not; further, the effects of the oceans can change as well, (possibly) due to climate change. Thus one of the most important pieces of the global climate puzzle is largely unknown, and it is unlikely that scientific closure could be achieved in the foreseeable future.

35. See, for example, Wunsch 1984.