Global Environmental Accords
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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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Growth, Development, and Environmental Sustainability: Profiles and Paradox

Nazli Choucri and Robert C. North

From an environmental perspective the terms *growth* and *development* are often used interchangeably with reference to advances in a country's technology and/or increasingly productive economy. Conventionally, they are also used interchangeably in typologies of and comparisons across countries. This chapter proposes that this conventional practice, while useful for some purposes, is inherently misleading, both in providing effective comparisons among countries and in yielding predictable indices of environmental degradation. In this chapter an alternative approach is presented that is based on fundamental differences between growth (expansion of size) and development (transformation of structure and processes). As defined here, *growth* refers to incremental increases (or expansions) in the quantities, levels, or sizes of particular variables relevant to the processes, issues, and outcomes under scrutiny. *Development,* by contrast, is construed as qualitative change, adjustment, adaptivity, organizational transformation toward improved quality of life, and, in the long run, sociocultural evolution.

For states in the international system—the focus of this chapter—successive and differential levels and rates of change of any society's population, technology, and resource availabilities tend to play central roles in shaping its profile, that is, its structure, and behavioral relations with other societies—and its impacts (positive and/or negative) upon natural as well as social environments (Choucri and North 1975, 14–16; 1989, 292–94). As indicated in chapter 1, the variables of consequence for the growth and development of states and their environmental relationships are population, technology (applied knowledge and skills, mechanical and organizational), and resources, together with a wide range of "conditioning" (largely derivative) variables such as agriculture and industry, trade, and so forth.

Three propositions summarize the relevance of these variables to environmental issues on all four organizational levels—individual, national, international, and global—as put forward in chapter 1: (1) through time, growth and development tend to be uneven on all four of these levels; (2) these differentials contribute to different manifestations and patterns of resource depletion and degradation; and (3) growth and development differentials also affect social and natural environments—locally and worldwide—in many different and complex ways. The challenge is to identify why these differences occur and how they lead to particular economic, political, strategic, and environmental linkages and outcomes.

Growth and development processes are uneven and highly interactive, growth contributing (sometimes, 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, 48–9, 62–3). 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 feedbacks to which they contribute and respond—and by which they themselves are partially shaped.[1]

Translated into acceleration (growth) and "steering" (development), the three master variables may be expected to interact in ways that are critically relevant to the contradiction between environmental sustainability and technological and economic growth and development: (1) To the extent that population growth accelerates more rapidly than technological advancement, demands for energy and other resources will increase, but development will be constrained, and damage to the environment will remain relatively low and localized; however, (2) insofar as technology accelerates in advance of population growth, development will be enhanced, resource availabilities will expand (through exploration, "discovery," and/or trade), and the demand for energy and other

resources will accelerate—as will resource depletion, pollution, and other forms of degradation.

In the first instance, prevailing qualities of life will remain low and subject to further deterioration. In the second instance, many of the negative qualities of life will be reduced or eradicated. At the same time, moreover, accelerations in technological growth and development will be reflected by alterations in the distributions of resources and benefactions (advantages, general welfare, and the structures of social, economic, and political institutions). And new challenges relative to quality of life may be expected to appear as new technologies emerge. This means that individual or collective policies and actions that change the (normally) uneven rates of growth and/or development among the three master variables (second difference changes in first difference rates) can be conceptualized as steering functions constraining population growth relative to technological advancement and resource availabilities, for example—or, down the line beyond that, constraining energy-inefficient technologies and resources through the "discovery" of more energy-efficient technologies and resources.

Population is viewed here as an aggregate of individuals on any organizational level (local community, state, international, or global). Technology gives people—and derivative organizations, including the state—new resources (and new uses for old resources). Historically, the more advanced the technology, the greater the amount and range of resources in demand and the greater the amount and range of resources that people think they need and increasingly define as necessities. A crucial issue for the future is the extent to which technological change enables increased efficiency in resource extraction, processing, and use. Resources in various forms, including energy, are the sine qua non for human existence and social enterprise. Without access to basic resources (air, water, food, fabrics, and the like) our species obviously could not survive.

In line with the second law of thermodynamics, neither energy nor other resources are entirely consumed or destroyed, but each transformation or application involves a reduction from more usable to less usable form. In general, the larger the amount and the wider the range of resources used, the greater will be the production of such wastes (garbage, trash, junk) and the greater the risk—direct or indirect—of toxic consequences. Additionally, the greater the use of natural resources in any given environment, the greater is the likelihood that costs (local depletions, pollution and/or other degradations) will increase, and the greater will be the inclination to find more affordable substitutes (often requiring new technologies) or to pursue lower-cost resources in other environments.

Regardless of its geographical location, any country may be expected to supplement the domestic resources available with imports from other countries, either to substitute for resources that have not been found (or not yet exploited) at home or because they can be obtained less expensively from abroad. These considerations are accounted for in the profiles by including trade (imports and exports) as a conditioning or qualifying variable (among many such variables) augmenting a country's resource availabilities in major ways. In this connection, when a powerful state interacts intensely with a state that is weaker economically, politically, or strategically, the stronger state is likely to penetrate (and possibly exploit, intentionally or unintentionally) the weaker state economically and politically in terms of new techniques, higher standards of living, energy consumption—and attendant environmental impact. This indicates that states can become hostage to environmental deterioration due to the actions and investments of others. Thus "environmental invasion" is gradually becoming recognized as another mode of invasive interaction.[2]

Profiles and Paths of Growth and Development

Along with natural forces (or as an aspect of them), human beings—both individually and through bargaining, leveraging, and coalition formation—can be envisaged as primary extractors, producers, multipliers, and distributors of resources (including information), goods, services, power, and authority both "vertically" and "horizontally" within their respective local and national societies. All of these activities, in turn, exact costs from the natural environment by means of various types of resource depletion, pollution, and other forms of degradation. Aggregated on a national level, these intensive activities, along with population increases (and decreases), contribute to the structures (or profiles) of individual states.

By drawing on specific interactions among the master variables and a wide range of intervening variables, we hope to bring the capabilities and dynamic characteristics of each country into sharper focus. Such differentiation is needed for policy—as well as analytic—purposes. Unless there are effective "diagnostics," effective strategies for solutions will be obscured.[3] We begin with the following questions: What are the expected outcomes if resources and technology are held constant and population is allowed to spiral indefinitely? What if resources are held constant and population and technology increase exponentially? What if population is constrained and access to resources is systematically developed? In each case, what are likely to be the consequences for social and natural environments?

It goes without saying that number of inhabitants is a key indicator of population. But growth in numbers is not the only indicator, and a host of other demographic factors are often used (and are useful) as indicators of population (Choucri 1974). With respect to growth and development, each state's progress along its path (or at any specific "milestone") is measured by its gross national product (GNP), an indicator of growth, and GNP per capita an indicator of development. Again these are conventional indices, but not the only ones (Choucri, North, and Yamakage 1992).

Measuring access to (or availability of) resources involves a problem that is difficult to resolve. Most analysts assume that a nation's resources are more or less randomly distributed and that the larger a country's territory, the less specialized its resource base is likely to be. Kindleberger (1962, 23) added a qualification to the effect that a nation is likely to have greater resource diversity in its north-to-south territory than in its east-to-west territory, particularly insofar as such a resource base includes territory in both temperate and tropical zones. (Trade—imports and exports—serves as an important conditioning or qualifying variable, among many such variables, augmenting the availability of a country's resources in major ways.) We recognize the limitations of using area as a surrogate for resources. If we use known resource reserves of one type or another, we improve realistic measurement but contaminate conceptual underpinnings in the sense that for reserves to be "known," some technological investments and applications must have been made.

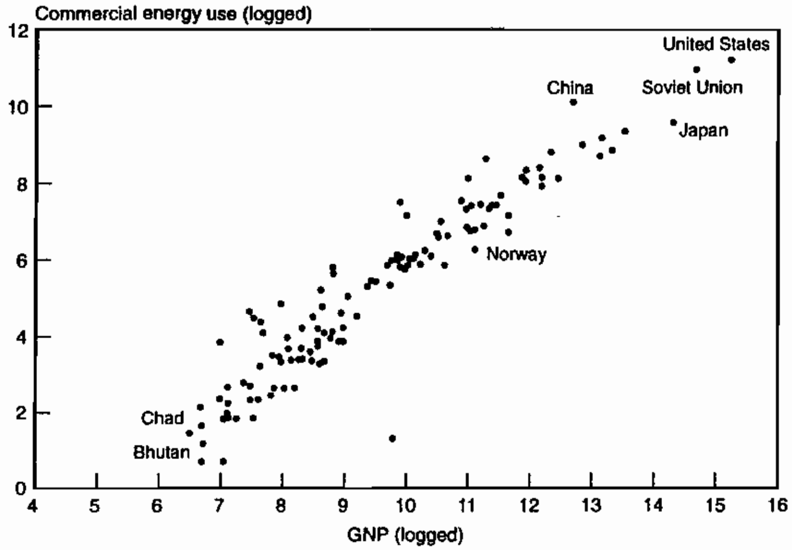


Figure 3.1
GNP and commercial energy use
Source: Based on data from Marland et al. (1989); World Bank (1988); Central Intelligence Agency (various years).

The indicators of technology are especially controversial. Patents, licenses, inventions, innovations, and increases in efficiency are all plausible indices and also plausible indicators of economic performance, such as GNP. Each, however, has some fundamental flaws. Nonetheless, a strong positive relationship can be seen between GNP and energy use (figure 3.1).

A schematic illustration of interactions among the master variables that define the profiles (table 3.1) is presented in figure 3.2 in the form of a three-dimensional space. In principle, all countries within each profile can be located in their relative and appropriate positions in this figure. Although the profile of any given country is determined by the configuration of its population/technology/resource-access indicators, these indicators (and the master variables they represent) are generally conditioned, constrained, or qualified by intervening and/or dependent variables (or feedback linkages therefrom).

The major types of intervening variables—linking the master variables

Table 3.1 Profile definition

Group I:	Resources	> population	> technology
Group II:	Population	> resources	> technology
Group III:	Population	> technology	> resources
Group IV:	Resources	> technology	> population
Group V:	Technology	> resources	> population
Group VI:	Technology	> population	> resources

Note: For operational purposes each group is defined as follows: Each master variable for every country is computed as a share of the global total for that variable. The variables in each group definition are thus framed in proportional relative terms, and the group profiles are in terms of relative shares. This simple method provides information about relative sizes of master variables within states and relative constraints among the master variables within states. The same information is provided across states within each profile and across states and across profiles. With respect to indicators, for illustrative purposes, following Kindleberger (1962), we use area for resources. As an indicator of technology, following Kuznets (1966), we use GNP. See text for further explanation.

in their raw form to their socially meaningful contexts—are the following: (a) Population/area/domestic resource base conditioned by agricultural production, manufacturing activity, energy consumption, and imports and exports, among others. (b) Population density and per capita levels of GNP, agricultural production, manufactures, energy consumption, imports, and exports. Potentially, there are many more intervening variables; their relative importance is an empirical question.

In both the (a) and (b) configurations, it is apparent that the master variables and their combinations are treated as independent variables; all other variables—including agricultural production, manufactures, energy consumption, imports, exports, and so on—are treated as intervening or dependent variables (contingent on the specific questions under investigation). In a fully specified, completely interactive dynamic system, however, the simple independent/dependent variable designation loses its meaning. The real world must be viewed in terms of its inherent complexities, with everything related to everything else. Intensely interactive among themselves, the master variables (and their indicators) "link up" with and are affected by these (and other) intervening and dependent variables. The use of the core or master variables as independent variables in this analysis is undertaken for empirical analysis and conceptual clarity.

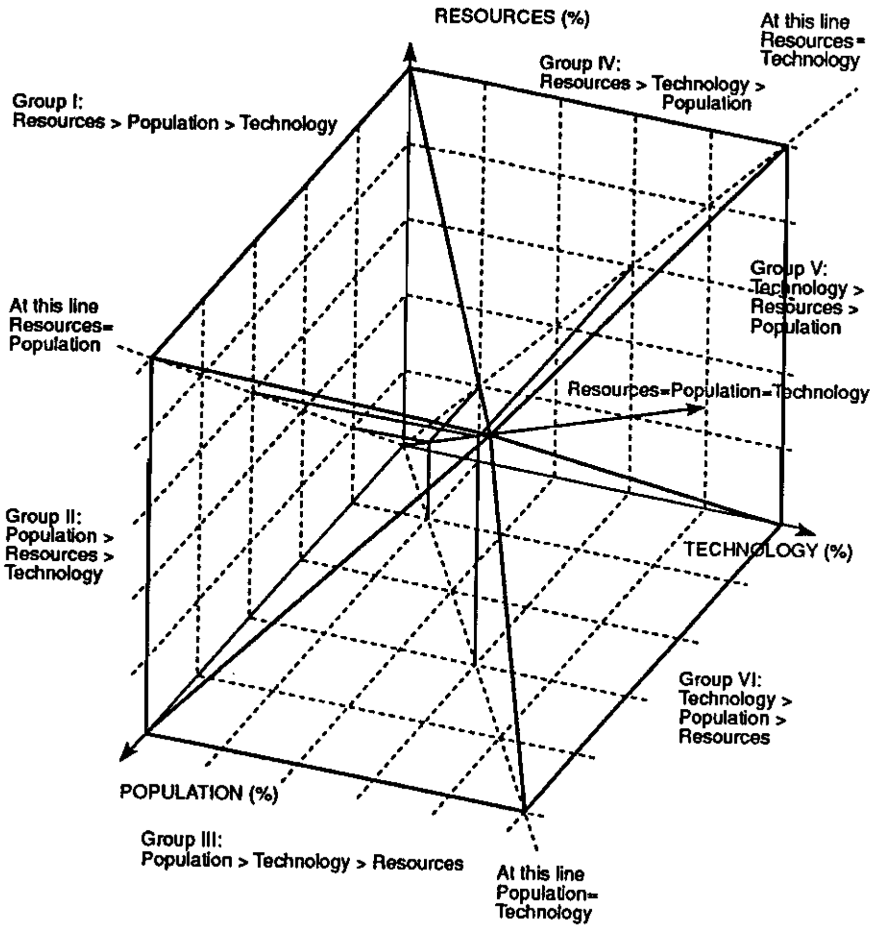


Figure 3.2
Profiles in three dimensions. In this figure we see six profile types in relationship to each other. Each profile type is the set of points contained in the 3-space defined by a triangular pyramid formed by the triangle drawn in bold and the point (0, 0, 0).
Source: MIT Project on Global Environmental Accord, Center for International Studies, prepared by Waleed Hazbun, MIT, Cambridge, Mass., 1992.

At a minimum, each country profile draws upon and includes the five conditioning variables listed under (b). There is nothing magic about the number five, however; other factors are certainly at work. Certainly, the master (or core) variables affect and are themselves conditioned by a host of other variables, some domestic, others external, and by allocations and devices of national governments. These allocations, which involve decisions as to how much money is given to health, how much to education, how much to the military, and how much to basic research, for example, may affect (and be affected by) birth and death rates, the availability of resources (including territorial size and usable land), and the technologies that are favored in principle and in practice.

The central proposition of this chapter is that different patterns of growth and development generate different forms of lateral pressure and that different modes of lateral pressure generate different types of effluence and patterns of environmental degradation. A corollary to the proposition is that there are both qualitative and quantitative differences in the relationship between growth and development, on the one hand, and patterns of lateral pressure and effluence on the other. The next step is empirical measurement and the respecification of these propositions into hypotheses to be submitted to empirical testing.

Determination of Profile Groups

To the extent that the possible variable-size combinations are exhausted, six profile clusters or groups—predicated on master variable-size relationships—emerge. Although we compiled and explored relevant data for nearly all countries of the world (a few are so newly established that adequate data are not yet readily available), we selected a limited number (130) for the initial construction of profiles and profile groups. The data are for one cross section of time only—1986. The larger research program, of which this chapter is only a segment, involves analysis of cross-national state attributes and behavior since 1950. This more inclusive conjunction of intertemporal, cross-national, and interstate approaches to data analysis should provide multidimensional views of international relations through time. Only at that juncture will we observe how the profiles (cross-section snapshots) begin to "move" along their respective paths of growth, development, and possible transformation. And only then will the full measure of the pattern of development become apparent.

Empirical Perspective: Problem and Procedure

The main criterion for selecting the 130 countries was representation—that is, we chose countries which, overall, would be representative of variations in size, levels of development, geographical location, forms of government, and the like. Very small countries are underrepresented, in part because the variables of many of them, expressed in percentages of global totals, required so many decimal places that the tables would have become unwieldy for presentation. Also underrepresented at this time—because of the rapid changes that were occurring among them—are the East European and other former Communist Bloc nations, for which much data from 1986–87 might be misleading for the 1990s. Such uncertainties were already evident with respect to the former USSR, as well as Yugoslavia, both of which are included in this set. In fact, at this writing (early 1992) the current areas, populations, GNPs, resource availabilities, and other critical dimensions of these two countries (and of their constituent components) are beyond calculation. But eventually the countries of Eastern Europe will be included in the time series analysis. The overall quality of data used is notoriously uneven. Our only defense is that we have drawn upon the most acceptable sources available—the World Bank, for example, and the United Nations and more or less comparable publications. In short we, like these institutions and other enterprises, must do the best we can.

Each profile is derived from the relationships between the key indicators, which are presented in descending order by variable size. (The choice of indicators is obviously crucial, as is the mode of measurement.) In terms of the levels and rates of change of its population, technology, and access to resources through time, every country of the world can be located somewhere within one of the six groups. The complexity of the international and global systems thus becomes evident. Neither states nor their encompassing systems stand still: To one degree or another, all are changing all the time, however unevenly; all are interacting, however differentially; and, within its own profile group, each is pursuing its own growth and development path. Viewed from this perspective, every state, every locality, every community, and every individual

is an active component within a global network of intensely dynamic social and natural environmental change. The profile groups are both consequences and determinants of these changes.

The 130 nations were sorted according to the relationships between their respective master variables. The countries in each *A* table are ranked according to their respective GNP levels ("sizes") from "low" (small) at the bottom to "high" (large) at the top. In these terms those countries located at the lower left side of figure 3.1 are less "advanced," engage in less economic activity, generate less effluence, have lower institutional and organizational capabilities, and influence global environmental conditions less than do the "more advanced" countries at the top right side of the diagram.

In each case size is measured in terms of shares relative to the global total. In this way we can bypass some of the difficulties of comparing apples and oranges (people, technology, resources)—and remain consistent with the basic objective of using profile delineations to clarify ranges of interaction among social and natural environments. This suggests that a reading of national GNP values from bottom to top will provide an overview of countries at different locations along the growth pathways that characterize their respective groups, from Chad (or Bhutan) to Brazil in group I, from Lesotho to China in group II, and so on.

The size tables indicate rough positive relationships between GNP levels and levels of carbon dioxide (CO_2) production. (Below we present the correlation coefficients.) But there are notable anomalies that point to the importance of ratio indices, such as density and per capita values. The *B* tables may suggest strong population and/or resource-access influences work in shaping national profiles. The C tables provide added information on variations across and within profiles.

Clearly, such numerical comparisons will not substitute for the rigor of formal statistical or more complex quantitative analysis, but an understanding of what the distributions of relative shares in the tables reveal may provide valuable clues for the design of the most appropriate strategies for analytical and quantitative inquiry. These profiles are broad, ideal types. They are not meant to reflect all conceivable historical possibilities or future prospects; they are designed to guide our understanding of interactions among social and natural environments in different contexts. If GNP is admitted as an indicator of growth and if

GNP per capita is accepted as a rough indicator of development, then even a cursory comparison of the rank orderings in the *A* tables, *B* tables, and *C* tables should empirically reveal some of the reasons for distinguishing between unevennesses in growth and development processes and some of the consequences to be expected within the six growth and development profile groups and along the attendant pathways through process and over time.

But an examination of the tables also reveals some seeming idiosyncracies that casual scanning of the data may not elucidate—or that may even be obscured by complex inquiry. Looking at group II, for example, we see that the People's Republic of China generates a remarkably high GNP (eighth in the world in 1987) and a correspondingly high level of carbon dioxide. But since the country's population is also large (the largest in the world), the Chinese GNP is transformed into a low (typically Third World) GNP per capita (level of development) and its high level of carbon dioxide production into a relatively low (typically Third World) per capita value. Thus, compared with a U.S. resident, an individual in China is not a serious threat to the environment. But in the aggregate China's remarkably high level of carbon emission obscures the per capita differences. What growth and development (or other) variable(s) would need to be altered in order to reduce China's overall carbon emission? Do these differ from what would need to be altered for the U.S. or other states? The tables effectively expose such issues but often fail to clarify them. The high ratio of coal use to total energy use and the extensive decentralization in coal use—down to individual households—partly explain the seeming anomaly of the China case. Therefore, it would be only from a close look at the composition of the master variables and their change over time that one could find additional information.

It will be evident that the levels of carbon emission by some countries are higher (or lower) than their per capita GNP and/or energy consumption values might lead us to expect. As in the case of China, clarification in such instances is likely to require formal analysis in order to uncover the potential influences of intervening variables (such as agricultural production, value added by specific manufactures, imports of polluting agents, and the like) which may condition or qualify the impacts of the master variables on natural and social environments.

Exploring the Logic of Development

The distribution of countries according to relative global share presented in these tables is a useful device for framing hypotheses about developmental trajectories. For example, the tables may suggest that, despite unevenness in the growth among the three master variables, all individual countries appearing in any one of the six groups may be envisaged as proceeding along the same broad path of growth and development. But there may be contending hypotheses. First, there are undoubtedly variables of importance (some of them difficult or impossible to quantify) that may help to explain anomalies in the tables and suggest alternative developmental paths. The quality-of-life indicators of several former colonies, for example, or the levels and other particulars of trade, may vary according to the policies of the former imperial power (England, France, Belgium, Germany, the Netherlands, or whatever) of which these now independent countries were once colonial components.

A second type of hypothesis can be derived from the fact that a given table represents only one cross section of time, thus obscuring a distinctive trend among countries within it. Therefore, within-group differences might be as significant as across-group differences, since variations in rates of change may be shifting countries toward other groups. A third set of hypotheses emerges from a consideration of investment decisions. Investments in certain directions (such as toward advanced technology) may accelerate change and help transform the profile of a country in short order. If the change is both rapid and sharp enough, it may result in a cross-group shift without a country's going through the sequence of within-profile development.

In assessing the dynamics inherent in the (uneven) levels of variables, rates of change (first differences), and changes in rates of change (second differences), formal time series analyses (beyond anything covered in this chapter) will require measurement of the continually changing widths or gaps (through time) between paired master variables (and intervening variables where relevant). Used in conjunction with a body of time series data that are sampled in the *A*, *B*, and *C* tables, these gap measurements should provide information that will be useful for ascertaining the variables within each group that might be "throttled up" in one country or "throttled down" in another in order to maneuver the whole society along a new pathway leading to lower levels of carbon dioxide emissions and other more sustainable environmental outcomes, at the same time adjusting other second differences in order to minimize impediments to economic growth and development. Among intervening variables, we would expect energy-efficient technologies and resources to be essential for environmental sustainability as well as for maintaining a country's position within a profile—given growth in population.

Transgroup clusters emerge to the extent that countries in two or more groups share compelling characteristics that set them apart in distinctive ways. The Middle Eastern oil-producing countries constitute one such cluster. Five Scandinavian nations—Norway, Sweden, Finland, Denmark, and Iceland—form another. And a number of small, low-lying Pacific Island states share the possibility of submergence as a consequence of global warming—a rare, if dubious, distinction.

Toward Profile Measurement

The profile groupings presented here are defined in terms of relative size and relative constraints. In the discussions below we will also consider investment allocation variables and indices of political behavior, namely degree of "political liberty." In each case it is essential to stress the difference between size and profile.

Group I is defined as: $[R > P > T]$,

where R = resources, P = population, and T = technology.

Countries in group I possess more resources relative to their populations and more resources relative to their levels of technology. Resource availability is constrained by the low level of technology. Conditioning and intervening variables include climatic and topographical factors exemplified by the tropical rain forests of Brazil, the slopes and high plateaus of Bolivia, and arid regions in Chad. The less developed among these countries may provide the closest modern approximations to the agrarian-based states of the past. Agriculture, grazing, mining, lumbering, or other forms of exploitation of basic resources may be expected to predominate as compared with manufacturing. Group I countries tend to rely heavily on exports of raw materials in exchange for manufactured products from more developed countries, and a single product

such as coffee, sugar, hemp, tin, timber products, or other resources often predominates.

Among the "bottom" cases in group I is Chad—one of the world's least developed countries with its population density of four persons per square kilometer, a per capita GNP (1986) of $180, and per capita energy consumption of 10 metric tons (oil equivalent). The country is also one of the world's lowest producers of carbon dioxide emissions. Despite significant differences in endowments of known resources, Sudan, like Chad, also ranks low in resource availability. The country has vast known oil reserves but, in large part because of violence in the south and weakness in its infrastructure, these resources are largely unexploited. The compelling tragedy of the "bottom" states of group I is that their low levels of knowledge and skills deprive them of ready access to their territorial resources. Skilled labor is generally in limited supply, the number of specialized professionals falls far short of the critical mass required to stimulate growth or development, and educational possibilities remain extremely limited. Potentials for development also tend to vary according to the proportions of each country's national territory that is arable and the availability of water and other vital resources that can be acquired, processed, and distributed among the populace.

Modes of environmental degradation (natural as well as social) include over-grazing, slash-and-burn agriculture, deforestation, soil erosion, and desertification. The introduction of insecticides, defoliants, internal combustion engines, and comparable products from more developed countries contributes to these processes. Thus, limited by their natural and social environments, the bottom states in group I commonly suffer from famine, and diseases tend to be endemic. However threatened (or constrained) these countries may be by local environmental phenomena, their contribution to carbon emissions and other forms of globally significant effluents and degradation seems almost minuscule. But aggregated with global levels, their low-level resource depletions, pollutions, and other degradations cannot be discounted—especially to the extent that such countries are justifiably encouraged to grow and develop.

Several countries in group I are borderline in population density relative to GNP—that is, the number of inhabitants per square kilometer (20 to 30) as compared with more typical group I densities (from two

Table 3.2A Dimensions of growth: Ranked by GNP
Group I: Area > population > GNP

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
Brazil	2.837	6.469	1.655	2.433	3.298	1.142	1.075	0.716	5.882
Iran	0.935	1.252	0.571			0.573	0.645	0.535	0.472
Argentina	0.635	2.103	0.481	0.752	1.275	0.584	0.329	0.217	0.398
South Africa	0.662	0.928	0.395	0.465	0.461	1.151	0.886	0.598	1.401
Algeria	0.459	1.810	0.383	0.258	1.064	0.309	0.378	0.468	0.234
Venezuela	0.365	0.693	0.343	0.442	0.643	0.652	0.481	0.440	0.400
Colombia	0.594	0.866	0.236	0.233	0.841	0.247	0.245	0.178	2.056
Peru	0.406	0.977	0.143	0.143	0.262	0.115	0.120	0.130	0.769
Chile	0.250	0.575	0.106			0.122	0.203	0.158	0.091
Ecuador	0.197	0.216	0.074	0.099	0.245	0.068	0.105	0.083	0.661
Cameroon	0.215	0.361	0.063	0.040	0.361	0.033	0.099	0.070	0.025
Côte d'Ivoire	0.219	0.245	0.052	0.037	0.380	0.023	0.154	0.093	1.549
Sudan	0.463	1.904	0.048	0.021	0.378	0.016	0.024	0.052	0.014
Kenya	0.434	0.443	0.042	0.026	0.254	0.018	0.058	0.076	0.017
Tanzania	0.471	0.718	0.038	0.016	0.340	0.010	0.016	0.048	0.009
Uruguay	0.061	0.134	0.038		0.088	0.020	0.052	0.038	0.013
Jordan	0.074	0.074	0.037	0.021	0.048	0.041	0.035	0.112	0.037
Zimbabwe	0.178	0.297	0.036	0.055	0.081	0.063	0.062	0.052	0.053
Ethiopia	0.892	0.929	0.034	0.021	0.345	0.009	0.022	0.051	0.009
Panama	0.045	0.059	0.034	0.018	0.069	0.016	0.116	0.136	0.012
Zaire	0.650	1.782	0.034	0.002	0.250	0.023	0.088	0.068	0.545
Angola	0.184	0.948	0.031			0.010	0.086	0.050	0.009
Bolivia	0.135	0.835	0.026	0.034	0.146	0.024	0.027	0.033	0.017

Table 3.2A (continued)

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
Paraguay	0.078	0.309	0.025	0.021	0.139	0.010	0.011	0.027	0.007
Gabon	0.020	0.204	0.020		0.046	0.014	0.050	0.044	0.011
Afghanistan	0.316	0.492	0.020			0.018	0.026	0.065	0.012
Mozambique	0.291	0.609	0.020		0.216	0.005	0.008	0.022	0.005
Senegal	0.139	0.149	0.019	0.020	0.120	0.010	0.030	0.047	0.009
Nicaragua	0.070	0.099	0.018	0.033	0.093	0.011	0.012	0.035	0.009
Papua New Guinea	0.070	0.351	0.016	0.009	0.123	0.011	0.050	0.052	0.009
Madagascar	0.217	0.446	0.016		0.165	0.004	0.016	0.018	0.003
Zambia	0.141	0.572	0.014	0.021	0.026	0.021	0.033	0.033	0.012
Congo	0.041	0.260	0.013	0.005	0.025	0.009	0.032	0.029	0.007
Niger	0.135	0.963	0.011	0.002	0.137	0.004	0.016	0.020	0.003
Guinea	0.129	0.187	0.011	0.002	0.114	0.005	0.021	0.016	0.004
Mongolia	0.041	1.189	0.011			0.036	0.000	0.000	0.034
Somalia	0.113	0.485	0.010	0.006	0.192	0.006	0.004	0.020	0.005
Mali	0.156	0.942	0.009	0.003	0.079	0.002	0.018	0.020	0.002
Burkina Faso	0.166	0.208	0.008		0.061	0.002	0.005	0.015	0.002
Liberia	0.047	0.084	0.007	0.002	0.053	0.004	0.019	0.011	0.003
Yemen, People's Democratic Republic of	0.045	0.253	0.007			0.017	0.000	0.000	0.015
Botswana	0.023	0.456	0.006	0.002	0.006	0.000	0.000	0.000	0.005
Chad	0.105	0.976	0.005			0.001	0.006	0.009	0.001
Central African Republic	0.055	0.473	0.005	0.002	0.053	0.001	0.006	0.010	0.001

Table 3.2A (continued)

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
Mauritania	0.037	0.783	0.005		0.037	0.003	0.020	0.017	0.002
Laos	0.076	0.180	0.004			0.001	0.000	0.000	1.288
Bhutan	0.027	0.036	0.001			0.000	0.000	0.000	0.000

Notes: Data is for 1986, except where otherwise noted.
All percentages are of the global total. The global total is the sum of data for all countries listed.
Within each group countries are listed in descending order in terms of the percentage of the world GNP.
MnVA: Total value added in manufacturing. MnVA data (from World Bank 1988) is for 1985.
AgVA: total value added in agriculture.
CEC: Commercial energy consumption.
Carbon emissions: Carbon dioxide emissions from energy, cement, and deforestation. Deforestation figures are for 1980.
Sources: Population, GNP, area, exports, imports, MnVA, AgVA, exports, and imports: World Bank 1988. For countries with missing data: Central Intelligence Agency (various years).
Commercial energy consumption: World Resources Institute 1989.
Carbon emissions from energy and cement: Marland et al. 1989.
Carbon emissions from deforestation: Houghton et al. 1987.

or three people per square kilometer up to eighteen or nineteen). In some of these countries the level of population is increasing relative to resource access and the rate of technological advancement. Table 3.2B suggests that bottom countries like Afghanistan and Ethiopia will be both economically and environmentally vulnerable to further population growth, thus increasing pressure on available resources, unless the rate of their technological development accelerates faster than the number of their people. Furthermore, *rates* of population growth are often high.

The more developed "top" countries of group I include Brazil, Venezuela, Argentina, and Algeria, with per capita GNPs (1987) of between $1000 and $5000. These countries play significant regional and international roles in terms of their production, energy consumption, exports, imports, and production of carbon and other environmental impacts. In Brazil, especially, intensified deforestation, loss of biodiversity, and effects on global carbon balances have exerted economic, political, and social impacts internationally as well as at home—as have the illegal production and international distribution of illicit materials originating in these countries and elsewhere. To the extent that their populations are allowed to grow faster than their technologies advance, these and other more developed group I countries may be expected to exert increasingly intense pressures on available resources and to generate higher levels of carbon dioxide and other forms of environmental depletion and degradation.

The governments of some (but not all) group I countries allocate larger budgetary shares to military expenditures than to education or health. Chad has followed this pattern, as have North Yemen, Bolivia, Ethiopia, and Mali. Data from Afghanistan have not been available. Tending to correlate with the GNP and energy consumption per capita, quality-of-life indicators such as infant mortality and life expectancy generally leave much to be desired in group I countries—as do political rights and civil liberties.

Compared with highly industrialized societies, most group I countries produce relatively low levels of pollutants, but contributions to local resource depletion and global effluents (carbon emissions and other gases and effluents) by some of the top states of group I are substantial. In response to population growth, early stages of industrialization, and intensifying urbanization, Brazil, for example, has tended to squander a

Table 3.2B Dimensions of development: Ranked by GNP per capita
Group I: Area > population > GNP

		Government expenditure						
	GNP per capita ($/pers.)	Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
Gabon	3,080	0.015	0.021	0.010	52	105	6	6
Venezuela	2,920	0.095	0.457	0.222	70	37	1	2
Algeria	2,590	0.130	0.479	0.207	62	77	6	6
Argentina	2,350	0.128	0.174	0.173	70	33	2	1
Panama	2,330	0.011	0.035	0.041	72	24	6	3
Uruguay	1,900	0.017	0.023	0.010	71	28	2	2
Iran	1,895	1.899	0.375	0.231	59	109	5	6
South Africa	1,850	0.303	0.405	0.064	61	74	5	6
Brazil	1,810	0.273	1.128	0.516	65	65	2	2
Jordan	1,540	0.065	0.027	0.012	65	46	5	5
Chile	1,320	0.068	0.110	0.052	71	20	6	5
Colombia	1,230	0.043	0.140	0.048	65	47	2	3
Ecuador	1,160	0.020	0.051	0.018	66	64	2	3
Peru	1,090	0.176	0.049	0.037	60	90	2	3
Paraguay	1,000	0.004	0.006	0.002	67	43	5	6
Congo	990	0.009	0.012	0.006	58	75	7	6
Cameroon	910	0.019	0.035	0.011	56	96	7	7
Botswana	840	0.003	0.013	0.005	59	69	2	3
Mongolia	835	0.021		0.003	64	47	7	7
Nicaragua	790	0.054	0.023	0.030	61	65	5	6
Côte d'Ivoire	730	0.010	0.048	0.012	52	96	6	5

Table 3.2B (continued)

		Government expenditure						
	GNP per capita ($/pers.)	Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
Papua New Guinea	720	0.004	0.018	0.013	52	64	2	2
Zimbabwe	620	0.034	0.061	0.021	58	74	4	6
Bolivia	600	0.010	0.011	0.002	53	113	2	3
Angola	522	0.138	0.044	0.016	44	139	7	7
Yemen, People's Democratic Republic of	470	0.023	0.007	0.003	50	142	6	7
Liberia	460	0.003	0.007	0.003	54	87	5	5
Mauritania	420	0.005	0.006	0.002	47	127	7	6
Senegal	420	0.002	0.005	0.001	47	130	3	4
Sudan	320	0.061	0.047	0.003	49	108	4	5
Kenya	300	0.019	0.055	0.021	57	74	6	5
Zambia	300	0.010	0.015	0.009	53	82	5	5
Central African Republic	290	0.002	0.006	0.001	50	134	7	6
Somalia	280	0.008	0.012	0.000	47	134	7	7
Guinea	270	0.007	0.008	0.003	42	148	7	5
Niger	260	0.001	0.009	0.002	44	135	7	6
Tanzania	250	0.026	0.037	0.012	53	108	6	6
Madagascar	230	0.008	0.012	0.008	53	130	5	5
Mozambique	210	0.031		0.011	48	120	6	7
Afghanistan	200						7	7

Table 3.2B (continued)

	GNP per capita ($/pers.)	Government expenditure: Military % global	Government expenditure: Education % global	Government expenditure: Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
Mali	180	0.004	0.005	0.001	47	144	7	6
Laos	178		0.001		50	146	7	7
Chad	160	0.005	0.002	0.001	45	134	7	7
Zaire	160	0.018	0.003	0.007	52	100	7	7
Bhutan	150				45	139	5	5
Burkina Faso	150	0.004	0.004	0.002	47	140	7	6
Ethiopia	120	0.052	0.029	0.008	46	155	7	7

Notes: Data is for 1986, except where otherwise noted.
All dollar amounts are in 1986 U.S. dollars.
All percentages are of the global total. The global total is the sum of data for all countries listed.
Within each group countries are listed in descending order in terms of percentage of the world GNP.
GNP/cap: GNP per capita, stated in terms of dollars per person ($/pers.).
Political rights and civil liberties are on a scale from 1 (most free) to 7 (least free); See Gastil 1988, pp. 7–8.
Sources: Population, GNP, area, life expectancy, and infant mortality:
World Bank 1988.
For countries with missing data: Central Intelligence Agency (various years).
Government expenditure: Sivard 1989.
Political rights and civil liberties: Gastil 1988.

Table 3.2C Per capita dimensions: Ranked by GNP per capita
Group I: Area > population > GNP

	GNP per capita ($/pers.)	Population density (pers./km²)	Government expenditure: Military $/person	Government expenditure: Education $/person	Government expenditure: Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
Gabon	3,080	4	124	155	65		323	37	1,052	951	747
Venezuela	2,920	20	46	194	79	593	251	99	563	537	1,483
Algeria	2,590	9	50	161	58	275	330	37	352	454	690
Argentina	2,350	11	35	42	35	579	286	51	221	152	849
Panama	2,330	29	43	120	117	191	218	19	1,096	1,343	357
Uruguay	1,900	17	47	58	22		205	18	363	273	286
Iran	1,895	28	355	62	32			34	295	255	684
South Africa	1,850	26	80	95	12	344	99	96	571	402	2,864
Brazil	1,810	16	17	62	24	420	166	22	162	112	2,807
Jordan	1,540	37	155	57	21	137	92	31	204	676	684
Chile	1,320	16	48	68	27			27	346	282	490
Colombia	1,230	25	13	36	10	192	202	23	176	133	4,684
Ecuador	1,160	34	18	40	12	247	178	19	227	189	4,547
Peru	1,090	15	76	19	12	173	92	16	127	143	2,566
Paraguay	1,000	9	9	13	4	135	254	7	62	152	118
Congo	990	6	41	44	18	64	87	12	337	315	231
Cameroon	910	22	15	25	7	91	239	8	196	144	159
Botswana	840	2	23	91	29	45	41	45	502	1,276	293
Mongolia	835	1	91		11			48			1,123
Nicaragua	790	26	134	51	56	231	191	9	73	226	168
Côte d'Ivoire	730	33	8	34	7	83	247	6	299	189	9,562
Papua New Guinea	720	7	10	41	24	60	252	9	304	332	171

Table 3.2C (continued)

	GNP per capita ($/pers.)	Population density (pers./km^2)	Government expenditure Military $/person	Education $/person	Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
Zimbabwe	620	22	33	53	15	151	65	19	150	130	406
Bolivia	600	6	13	13	2	124	154	10	85	108	172
Angola	522	7	131	37	11			3	199	120	69
Yemen, People's Democratic Republic of	470	7	91	25	8			20	72	222	451
Liberia	460	21	10	22	7	21	160	4	176	102	79
Mauritania	420	2	22	27	8		141	4	233	202	89
Senegal	420	35	2	6	1	70	123	4	90	150	85
Sudan	320	9	23	16	1	22	116	2	22	50	40
Kenya	300	36	8	19	6	30	83	2	57	78	54
Zambia	300	9	12	17	8	74	26	8	100	103	115
Central African Republic	290	4	5	16	3	20	138	1	48	81	16
Somalia	280	9	13	17	1	25	243	3	16	80	54
Guinea	270	26	9	9	3	7	126	2	71	56	42
Niger	260	5	2	10	2	9	144	2	50	66	29
Tanzania	250	24	10	12	3	17	103	1	15	46	24
Madagascar	230	18	6	9	5		108	1	31	37	20
Mozambique	210	18	19		5		106	1	11	34	23
Afghanistan	200	24						3	36	91	51
Mali	180	6	4	5	1	11	72	1	50	58	14
Laos	178	16		3				1	498	402	22,988
Chad	160	4	8	3	1			1	24	40	11
Zaire	160	14	5	1	1	2	55	2	58	47	1,135

Table 3.2C (continued)

	GNP per capita ($/pers.)	Population density (pers./km^2)	Government expenditure Military $/person	Education $/person	Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
Bhutan	150	28						1			7
Burkina Faso	150	30	5	4	1		52	1	14	40	14
Ethiopia	120	36	10	5	1	11	55	1	10	25	13

Notes: Data is for 1986, except where otherwise noted.
All dollar amounts are in 1986 U.S. dollars.
Within each group countries are listed in descending order of GNP.
MnVA: Total value added in manufacturing. MnVA data (from World Bank 1988) is for 1985.
AgVA: Total value added in agriculture.
CEC: Commercial energy consumption.
Carbon emissions: Carbon dioxide emissions from energy, cement, and deforestation. Deforestation figures are for 1980.
Sources: Population, GNP, MnVa, AgVA, exports, and imports:
World Bank 1988.
For countries with missing data: Central Intelligence Agency (various years).
Government expendature: Sivard 1989.
Commercial energy consumption: World Resources 1989.
Carbon emissions from energy and cement: Marland et al. 1989.
Carbon emissions from deforestation: Houghton et al. 1987.

critical element of its environmental assets. Tropical rain forests, in effect, have been harvested—or cleared and burned—partly in order to obtain what often turns out to be shallow grazing and farm lands. Effluents from this burning, in turn, have produced clouds of gases which may be transmitted by atmospheric processes over the spaces of other countries.

A number of group I countries possess domestic resource bases that could allow them to grow, depending on the levels and rates of advancement of their respective knowledge and skills. Vividly highlighting some of the potential contradictions between environmental sustainability and economic growth and development, however, the World Bank and other financial and development institutions, national and international—for a time, at least—in effect underwrote excessive Brazilian timber cutting. This policy was designed not only to support badly needed economic expansion, but also to facilitate the repayment of the loans that these same institutions were making available. The debt/environmental paradox is defined by this type of often deleterious trade-off.

Overall, the conclusion to be drawn from the group I country profiles is clear. Despite a number of exceptions, the major trends are strong: From bottom to top, economic and quality-of-life indicators (including political rights and civil liberties) tend to improve somewhat—and per capita energy consumption and carbon emissions tend to increase. The challenges are to promote energy-efficient technologies and expand access to energy-efficient resources, domestic and foreign, in pursuit of some dynamic equilibrium between growth and development on the one hand and environmental sustainability on the other.

Group II is defined as: $[P > R > T]$

With populations that are "large" relative to area (however large such an area may be) and with GNPs that are "small" relative to both population and area, the countries in group II can be characterized as having populations that have grown—and still may be growing—relative to levels of technology and rates of resource access. As with many bottom countries of group I, Malawi, Bangladesh, and Bhutan have often been identified as among the world's most dire cases.

Characteristically, group II countries (somewhat like those in group I) tend to possess relatively large territories and resource bases but are

Table 3.3A Dimensions of Growth: Ranked by GNP
Group II: Population > Area > GNP

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
China	21.602	7.266	2.089	3.982	11.997	8.052	1.495	1.986	8.393
India	16.015	2.499	1.497	1.491	9.272	2.278	0.563	0.749	2.685
Mexico	1.644	1.499	0.986	1.826	1.649	1.408	0.779	0.552	1.614
Indonesia	3.410	1.458	0.539	0.479	2.794	0.515	0.711	0.615	3.333
Nigeria	2.113	0.702	0.436	0.309	2.870	0.183	0.317	0.207	1.099
Turkey	1.055	0.594	0.378	0.514	1.380	0.531	0.383	0.507	0.520
Thailand	1.078	0.391	0.281	0.322	1.001	0.256	0.422	0.422	1.643
Iraq	0.338	0.331	0.264			0.121	0.000	0.469	0.139
Egypt	1.019	0.761	0.250		1.179	0.365	0.222	0.438	0.301
Pakistan	2.033	0.611	0.229	0.207	1.058	0.278	0.162	0.247	0.198
Philippines	1.174	0.228	0.212	0.337	1.154	0.149	0.229	0.248	0.995
Malaysia	0.330	0.251	0.195			0.181	0.666	0.498	0.139
Syria	0.221	0.141	0.112		0.503	0.141	0.064	0.124	0.127
Bangladesh	2.115	0.109	0.109	0.056	1.043	0.070	0.042	0.124	0.047
Morocco	0.461	0.340	0.088	0.084	0.451	0.079	0.118	0.175	0.076
Viet Nam	1.297	0.251	0.082			0.079	0.000	0.000	0.622
Tunisia	0.150	0.125	0.055	0.041	0.175	0.056	0.084	0.133	0.050
Guatemala	0.168	0.083	0.050			0.017	0.050	0.041	0.015
Burma	0.779	0.514	0.050	0.028	0.561	0.035	0.014	0.028	0.799
Sri Lanka	0.330	0.050	0.043	0.034	0.219	0.021	0.058	0.090	0.015
Ghana	0.271	0.182	0.034	0.022	0.290	0.014	0.041	0.036	0.011
Dominican Republic	0.135	0.037	0.031	0.029	0.131	0.031	0.034	0.066	0.027

Table 3.3A (continued)

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
Yemen, Arab Republic	0.168	0.148	0.030	0.011	0.180	0.013	0.001	0.048	0.012
Costa Rica	0.053	0.039	0.025		0.127	0.014	0.054	0.053	0.009
Uganda	0.312	0.179	0.023	0.005	0.363	0.005	0.019	0.016	0.003
Honduras	0.092	0.085	0.022	0.018	0.116	0.010	0.041	0.040	0.008
Albania	0.061	0.022	0.018			0.043	0.000	0.000	0.040
Nepal	0.348	0.107	0.017	0.005		0.005	0.007	0.021	0.004
Haiti	0.125	0.021	0.013			0.004	0.018	0.023	0.003
Rwanda	0.127	0.020	0.012	0.011	0.105	0.002	0.009	0.016	0.002
Malawi	0.152	0.090	0.008	0.005	0.058	0.003	0.012	0.012	0.002
Sierra Leone	0.078	0.055	0.008	0.003	0.076	0.003	0.007	0.007	0.002
Burundi	0.098	0.021	0.008	0.004	0.091	0.001	0.008	0.010	0.001
Benin	0.086	0.086	0.007	0.002	0.094	0.002	0.009	0.018	0.002
Togo	0.064	0.043	0.005	0.002	0.046	0.002	0.013	0.017	0.002
Lesotho	0.033	0.023	0.004	0.001	0.007	0.000	0.000	0.000	0.000

Notes: See table 3.2A.

defined as lacking the technologies needed for locating, extracting, and otherwise exploiting many of the raw materials that would facilitate growth and development. China, for example, was considered resource poor (with only limited availabilities of low-grade coal and oil) until (under the Maoist regime) new technologies and expanded exploration located wholly new reserves. But group II countries suffer additionally from constraints imposed by their relatively large populations.

With improved health services and better nutrition, death rates in many group II countries have fallen sharply in modern times, often without corresponding reductions in birthrates. Some countries, including India and China, have made efforts to curb birthrates, but with varying success. Not without high costs in terms of human rights, China's draconian measures have been relatively successful, but in view of the country's huge population base, it is not surprising that the numbers of people continue to increase, albeit at considerably lower rates.

A number of group II countries have undertaken strong modernization programs calculated to reduce the economic gaps between themselves and the industrialized West, with varying degrees of success. Despite measures imposed to reduce birthrates, however, the wide gap between population levels and rates of growth and technological development has remained a stubborn obstacle. Continuing population increases in several of these countries threaten to further constrain the effects of technological infusions and economic expansion on per capita income levels. High fertility rates, in short, combined with weak economies, reduced mortality rates, and impaired access to vital resources, have exacerbated the poverty already prevailing. By the year 2025 the population of India is expected to reach 1.445 billion—almost overtaking China, whose population, despite powerful fertility control policies and the effects of nascent industrialization, is projected to reach about 1.49 billion.

As in the past, burning vegetation on jungle slopes in India and many other group II countries still releases various effluents—carbon dioxide, hydrocarbons, nitrogen oxide, nitric acid, and so forth. Over recent decades a number of developing group II countries have made notable progress toward industrialization combined with continuing population growth, yielding many of the standard environmental consequences (see tables 3.3A, B, and C). With the addition of many of the same pollutants resulting from modern technologies, expanding urban areas in many of these countries—Shanghai, Bombay, Calcutta, and Mexico City among dozens of others—are shrouded by industrial and vehicular emissions.

For the most part, the production of effluents among the countries of group II tends to be low relative to that of industrialized countries, but—in spite of (and partly as a consequence of) population densities—somewhat higher than that of group I states. Bangladesh, a state with one of the densest national populations in the world (and one of the lowest GNPs per capita) is also one of the lowest producers of carbon emissions. As if that were not enough, the country regularly receives the brunt of disastrous floods (exacerbated by soil erosion and deforestation), typhoons, and tidal waves it cannot control. While these events are frequently labelled "natural disasters," they are also the product of human alterations of ecological balances in conjunction with "normal" ecological processes (see figure 1.1).

Among the group II countries the distinction between population/territorial size and level of development (as indicated by GNP per capita, at least) is not always taken into sufficient account. In general, the smaller countries in the group tend to be the least developed, whereas several middle-sized to medium/large but relatively less densely populated countries (Tunisia, Jordan, Turkey, Egypt, Mexico, and Iraq) are the more developed—and also among the higher per capita producers of carbon. It is the largest states (China and India) that best demonstrate the constraints on technological and economic development exerted by high population levels. But note that these two large but somewhat less developed states (as measured by GNP per capita) rank with the others in carbon dioxide emissions. Again, these are important differences that help us distinguish between size and profile.

Countries in group II that spend more on military development than on education or health include Yemen, Burundi, India, Pakistan, China, Jordan, Turkey, Egypt, and Iraq. The reasons vary, as do the predispositions, but this pattern is strong. In the absence of a persuasive theoretical explanation for the differences, an operational hypothesis might relate to the type of regime and to the priorities of the regime derived from their own conceptions of security.

Overall, per capita GNP levels for group II countries are somewhat—

Table 3.3B Dimensions of development: Ranked by GNP per capita
Group II: Population > area > GNP

	GNP per capita ($/pers.)	Government expenditure: Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
Iraq	2,424	1.426	0.186	0.048	63	71	7	7
Mexico	1,860	0.158	0.798	0.586	68	48	4	4
Malaysia	1,830	0.210	0.309	0.085	69	27	3	5
Syria	1,570	0.341	0.150	0.024	64	50	6	7
Costa Rica	1,480	0.003	0.025	0.034	74	18	1	1
Tunisia	1,140	0.060	0.055	0.036	63	74	6	5
Turkey	1,110	0.416	0.200	0.059	65	79	3	4
Albania	933	0.020		0.015	71	41	7	7
Guatemala	930	0.015	0.025	0.011	61	61	3	3
Thailand	810	0.192	0.222	0.083	64	41	3	3
Egypt	760	0.380	0.234	0.060	61	88	5	4
Honduras	740	0.024	0.023	0.014	64	72	2	3
Dominican Republic	710	0.009	0.011	0.012	66	67	1	3
Nigeria	640	0.085	0.136	0.048	51	104	7	5
Morocco	590	0.031		0.011	60	85	4	5
Philippines	560	0.066	0.075	0.039	63	46	4	2
Yemen, Arab Republic	550	0.040	0.034	0.009	46	152	5	5
Indonesia	490	0.244	0.386	0.087	57	87	5	6
Sri Lanka	400	0.044	0.031	0.013	70	29	3	4

Table 3.3B (continued)

	GNP per capita ($/pers.)	Government expenditure: Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
Ghana	390	0.007	0.030	0.003	54	89	7	6
Lesotho	370	0.002	0.003	0.002	55	102	5	5
Pakistan	350	0.278	0.103	0.011	52	111	4	5
Haiti	330	0.004	0.004	0.003	54	119	5	4
Sierra Leone	310	0.002	0.005	0.001	41	154	5	5
China	300	2.215	1.126	0.699	69	34	6	6
India	290	0.881	0.961	0.315	57	86	2	3
Rwanda	290	0.004	0.007	0.002	48	116	6	6
Benin	270	0.003	0.005	0.001	50	117	7	7
Togo	250	0.003	0.006	0.002	53	96	6	6
Burundi	240	0.005	0.004	0.001	48	114	7	6
Uganda	230	0.037	0.011	0.002	48	105	5	4
Burma	200	0.026	0.020	0.012	59	64	7	7
Viet Nam	196				65	47	7	7
Bangladesh	160	0.029	0.049	0.016	50	121	4	5
Malawi	160	0.004	0.006	0.005	45	153	6	7
Nepal	150	0.005	0.011	0.004	47	130	3	4

Notes: See table 3.2B.

Table 3.3C Per capita dimensions: Ranked by GNP per capita
Group II: Population > area > GNP

	GNP per capita ($/pers.)	Population Density (pers./km²)	Government expenditure: Military $/person	Education $/person	Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
								1	0	0	20
Iraq	2,424	38	737	85	18			20	107	618	555
Mexico	1,860	41	17	75	46	544	143	47	202	150	1,329
Malaysia	1,830	49	111	145	33			30	862	673	572
Syria	1,570	58	269	105	14		324	35	123	250	779
Costa Rica	1,480	51	9	72	82		340	14	433	441	237
Tunisia	1,140	45	71	57	31	134	167	21	241	396	452
Turkey	1,110	66	69	29	7	238	186	28	155	214	667
Albania	933	103	56		32			39	0	0	885
Guatemala	930	75	16	23	9			5	127	110	123
Thailand	810	102	31	32	10	146	132	13	167	174	2,063
Egypt	760	50	65	36	8		165	20	93	191	400
Honduras	740	40	45	38	20	93	179	6	190	194	121
Dominican Republic	710	135	11	13	11	106	138	13	109	217	272
Nigeria	640	112	7	10	3	72	194	5	64	44	704
Morocco	590	50	12		3	89	140	9	109	169	223
Philippines	560	191	10	10	4	140	140	7	83	94	1,148
Yemen, Arab Republic	550	42	42	31	7	32	153	4	2	126	100
Indonesia	490	87	12	18	3	69	117	8	89	80	1,323
Sri Lanka	400	244	23	15	5	50	95	3	75	121	63
Ghana	390	55	5	17	2	40	153	3	65	59	55
Lesotho	370	53	9	14	6	16	31	118	550	1,688	0
Pakistan	350	123	24	8	1	50	74	8	34	54	132
Haiti	330	218	5	4	3			2	61	82	31

Table 3.3C (continued)

	GNP per capita ($/pers.)	Population Density (pers./km²)	Government expenditure: Military $/person	Government expenditure: Education $/person	Government expenditure: Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
Sierra Leone	310	53	4	10	2	19	139	2	37	41	39
China	300	110	18	8	4	90	79	21	30	41	526
India	290	238	10	9	3	46	83	8	15	21	227
Rwanda	290	238	5	9	2	42	118	1	30	56	16
Benin	270	37	6	10	2	10	155	1	43	92	35
Togo	250	54	8	14	4	16	103	2	89	122	39
Burundi	240	171	9	7	2	18	133	0	35	43	9
Uganda	230	64	21	5	1	9	166	1	26	23	14
Burma	200	56	6	4	2	18	103	3	8	16	1,389
Viet Nam	196	192						3			649
Bangladesh	160	717	2	4	1	13	70	2	9	26	30
Malawi	160	62	4	6	4	17	55	1	33	35	20
Nepal	150	121	3	5	2	6		1	8	27	15

Notes: See table 3.2C.

but not much—more favorable than those of group I nations. Several bottom states with low (but not the lowest) per capita GNPs are also among the more densely populated. By contrast, most of those with the higher per capita GNPs have relatively lower population densities. Although somewhat lower than in group I, quality-of-life indicators (including political rights and civil liberties) again improve with increases in per capita energy consumption and carbon emissions, but again there are important exceptions. Despite its high growth levels, per capita GNP, energy consumption, and carbon dioxide emissions, the People's Republic of China ranks near the middle among group II countries, and its quality-of-life indicators are mediocre at best. Its political rights and civil liberties are close to the bottom.

Insofar as we look to the future, China is the developing state par excellence, with the world's eighth largest GNP (in 1986) and the world's third highest level of carbon dioxide production (contrasted with its low per capita GNP, low per capita energy consumption, and low *per capita* production of carbon dioxide). A large part of the national product is attributable to agriculture, though it is increasingly generated by industry and supported by vehicular traffic. Consider, therefore, the environmental consequences insofar as China's industrialization advances ("modernizes") and its level of carbon emissions rises commensurately. Many of the same considerations can be applied to India, where industrialization proceeds; trucks, buses, and passenger cars already jam the highways, and the atmosphere yellows or darkens despite low per capita levels of carbon emissions.

Group III is defined as: $[P > T > R]$

With large populations relative to GNPs and large GNPs relative to areas, group III nations are also subject to constraints on their resource bases and levels of technology. In contrast with group I states, however, they have technologies that have advanced relative to their resource bases. Countries with group III profiles can generally be distinguished according to their respective responses to these constraining dimensions.

The most spectacular demonstration of the potentials of group III countries for success and failure is attributable to Japan from the Meiji Restoration to the termination of World War II. Beginning in the last quarter of the nineteenth century, Japan undertook a developmental transformation that moved it from something approaching a group II profile to a group III program of growth and technological (and economic) development. Responding to that country's population growth and consequent pressure on a limited resource base, Japanese leaders imported technologies from Western nations; "modernized" the country's production, military, and naval forces; and undertook a strategy of territorial expansion (guided by their interpretation of the successes of European and U.S. expansionism). Their expectation was that colonial raw materials (and markets) would compensate for the insufficiencies of Japan's domestic resources.

In the wake of the Japanese Empire's World War II defeat and occupation, a new Japanese leadership—under the strategic umbrella of the United States—undertook a second transformation that moved Japan from its pre-war group III profile to its late twentieth century group VI profile. As a consequence, through further development (scientific, industrial, economic, and political), the Japanese were able to compensate for their limited domestic resource base by substituting high domestic production, effective but competitive exports of goods and services to foreign markets, and the peaceful importation of energy and other resources from abroad (Choucri, North, and Yamakage 1992).

Are there candidates for transformations of this order among today's group III states? Characterized by years of internecine warfare, two bottom states, El Salvador and Lebanon, defy such analysis at this writing. The less developed of the two, El Salvador, has spent almost twice as much on its military as on education and four times more than on health. Comparable data (1986) are not available for Lebanon, whose GNP per capita is reported as relatively high, largely due to its commercial capabilities. Characterized by ethnic and religious contention, Yugoslavia has formally disintegrated. Portugal, a major imperial power in the past, seems to be relatively stable today, with modest levels (for a marginal industrial power) of per capita GNP, energy consumption, and carbon dioxide production.

Four of the eleven countries listed for group III—Korea, Cuba, Syria, and El Salvador—allocated more funds per capita to military expenditures than to education or health, and Yugoslavia was only slightly better. El Salvador (lowest ranking in per capita GNP, energy consumption, and carbon dioxide emissions) and Lebanon were generally low on

Table 3.4A Dimensions of growth: Ranked by GNP
Group III: Population > GNP > area

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
South Korea	0.851	0.074	0.650	1.025	1.737	0.739	1.666	1.453	0.687
Poland	0.769	0.238	0.513			1.910	0.579	0.531	1.885
Yugoslavia	0.478	0.195	0.354		1.034	0.617	0.497	0.541	0.527
Portugal	0.209	0.070	0.152		0.279	0.147	0.348	0.444	0.123
Hungary	0.217	0.071	0.141		0.562	0.433	0.440	0.442	0.320
North Korea	0.428	0.092	0.126			0.627	0.000	0.000	0.608
Cuba	0.209	0.087	0.124			0.156	0.000	0.000	0.136
El Salvador	0.100	0.016	0.027	0.025	0.116	0.010	0.036	0.042	0.008
Jamaica	0.049	0.008	0.013	0.017	0.021	0.028	0.029	0.044	0.025
Lebanon	0.055	0.008	0.012			0.030	0.024	0.101	0.027
Mauritius	0.020	0.002	0.008	0.008	0.026	0.005	0.032	0.031	0.004

Notes: See table 3.2A.

Table 3.4B Dimensions of development: Ranked by GNP per capita
Group III: Population > GNP > area

	GNP per capita ($/pers.)	Government expenditure: Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
South Korea	2,370	0.616	0.653	0.043	69	25	4	5
Yugoslavia	2,300	0.398	0.430	0.578	71	27	6	5
Portugal	2,250	0.105	0.154	0.241	73	18	1	2
Poland	2,070	0.734	1.129	1.197	72	18	6	5
Hungary	2,020	0.182	0.329	0.331	71	19	5	5
Cuba	1,833	0.174	0.164	0.101	75	14	6	6
Mauritius	1,200	0.000	0.006	0.004	66	35	2	2
North Korea	909	0.301		0.041	68	25	7	7
Jamaica	840	0.004	0.017	0.010	73	19	2	3
El Salvador	820	0.017	0.012	0.006	61	61	3	4
Lebanon	667						5	4

Notes: See table 3.2B.

Table 3.4C Per capita dimensions: Ranked by GNP per capita
Group III: Population > GNP > Area

	GNP per capita ($/pers.)	Population density (pers./km^2)	Government expenditure: Military $/person	Education $/person	Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
South Korea	2,370	423	127	119	7	590	291	48	837	761	1,094
Yugoslavia	2,300	91	146	139	157		309	72	444	504	1,494
Portugal	2,250	111	88	114	149		190	39	710	946	797
Poland	2,070	120	167	227	201			138	322	308	3,319
Hungary	2,020	114	146	234	197		368	110	865	906	1,995
Cuba	1,833	89	145	122	63			41			881
Mauritius	1,200	500	3	44	24	185	178	13	675	684	265
North Korea	909	173	123		12			81			1,922
Jamaica	840	218	14	55	28	170	62	32	248	402	679
El Salvador	820	233	30	18	8	122	165	6	154	184	109
Lebanon	667	270	952		95			30	185	816	651

Notes: See table 3.2C.

quality-of-life indicators, Syria surprisingly high, and Portugal slightly higher. Each of these patterns represents different sociopolitical conditions shaped and influenced by profile configurations. (The link to policy preferences still remains to be made explicit.)

The strongest candidate for a Japan-style transformation to group VI status is probably the Republic of Korea, a high-density country (denser than Japan) with a per capita GNP which (in 1987) was higher than that of any group II country listed (or any group I or group II country except Algeria or Iraq) and substantially higher than that of any other group III country except Portugal. Korea's per capita energy consumption has been moderately low, its quality-of-life indicators mediocre, and its carbon emissions moderately low for the level of its per capita GNP. If we set aside the Korean Republic's relationship with communist North Korea (which raises a host of analytical and empirical difficulties), the country's challenge for the twenty-first century is likely to be three-fold: to stabilize population growth; to pursue the most efficient technologies, fuels, and other resources that can be made available; and to stabilize (if not reduce) its current generation of carbon and other effluents.

Group IV is defined as $[R > T > P]$

Group IV countries are characterized by relatively small populations possessing relatively well developed knowledge and skills and with large amounts of resources occupying a spacious resource base. In developmental terms, group IV countries—typified by Australia, Canada, and the former USSR (data is from 1986)—could be viewed as one-time group I countries with profiles transformed by technologies that have accelerated relative to their populations and national territories. On the face of it, we might expect a country with this profile to be almost ideally situated, but the obvious differences among the seven group IV countries listed here raise empirical and analytical issues that require close scrutiny.

In particular, three countries—Oman, Saudi Arabia, and Libya—require special attention. What sets these countries apart is the nature of their resource endowments which, while extensive relative to their population levels, are limited in two fundamental respects: First, their territories are generally arid (in large part desert), but they are rich in one extraordinarily valuable resource—petroleum; second, their populations are not only sparse (as sparse as those of group I countries), but also

dependent in large part on technologies that have been imported from industrialized countries of the West, but not well integrated into their respective societies. Further, a large fraction of their populations has been imported to help apply the new technologies that were, and continue to be, imported.

In order to implement and manage the extraction and shipping of oil, these countries have also introduced technical and managerial expertise from the West (and from India and other developing countries), as well as skilled and service labor (from India, Pakistan, and other more populated countries) to perform lower-level functions. For purposes of analysis, these special factors amount to intervening variables that in particular and influential ways condition the master variable profiles of these nations. Over time, foreign populations settle and remain in these countries. Through changes in fertility/mortality dynamics they endogenously alter the master variables. On theoretical grounds these three cases highlight an important generic issue. Changes in the master variables occur in three ways: (a) gradually, through "normal" processes of growth due to investments, budgetary allocations, dynamics of births and deaths, etc.; (b) sharply through importation of technology, people, resources, or all three; and (c) as a combination of (a) and (b).

Although the per capita GNPs of all three countries are higher than any manifested in the listings for groups I to III, Libya's is the most outstanding. Primarily due to the domestic availability of oil, this apparent affluence and related characteristics make these countries appear anomalous—not only in terms of the master variables, but also in terms of the interplay among intervening variables (imported knowledge, skills, equipment, expertise, and service labor) that derive from the basic characteristics of the master variables and, in turn and over time, alter them in potentially fundamental ways. Also notable is the consideration that although Oman's per capita levels of energy consumption and carbon dioxide emission are the highest we have encountered so far, the other two oil-producing countries (Saudi Arabia and Libya), while roughly comparable energy consumers, are not high-level producers of carbon dioxide. With allowance for faulty data, this discrepancy may be attributable to differences in technological and/or resource use efficiencies.

If oil and the knowledge and skills associated with its exploitation and processing can dominate—but fail to be sufficiently integrated into—

the profiles of Saudi Arabia and Libya, it is not surprising that vast expanses of open space (with only two and three persons per square kilometer), combined with sophisticated technologies, go a long way toward defining Australia and Canada. With allowance for geographic and related factors (deserts in Australia and frozen tundra in Canada), these two countries—and especially the former USSR—have ample space (literally and figuratively) for growth over generations to come. Against this background, the former USSR, Australia, and Canada seem to emerge as ideal manifestations of the group IV profile—all three typified by sparse populations, high levels of indigenously developed knowledge and skills, and expansive and generally rich territories and resources. Of these three, the former USSR's population, while sparse relative to those of most major countries, is denser than those of Australia and Canada.

Canada stands out as the group IV country with the highest GNP per capita, the highest consumption of energy per capita (8,945 kilograms of oil equivalent, in 1986 the highest in the world), and a comparably high level of per capita carbon dioxide production. In assessing these levels we must keep in mind the sparsity of Canada's population relative to spatial factors (driving per capita values upward arithmetically). We must also remind ourselves of the environmental responsibility of each individual Canadian as an ultimate source of anthropogenic depletion, pollution, and other forms of resource degradation. (The same is true of all of us.)

Another sparsely inhabited country, Iceland, is by far the smallest on the group IV list. Roughly the size of Ohio, but nudging the Arctic Circle, Iceland has the highest per capita GNP among the seven countries. Its energy consumption per capita is low compared with U.S. levels but not remarkable among industrialized nations. The country's production of carbon dioxide is relatively low, however. If Iceland is notable for its high per capita productivity, the former Soviet Union (given its spectacular resource base and low population density) was productively mediocre—a consideration that is much more evident now than it was in 1986 when the data were compiled. To a large extent, countering this low level of productivity is the challenge that newly independent components of the "new Russia"—an entity well advanced along the group IV path of growth and development—confront at this writing.

Table 3.5A Dimensions of growth: Ranked by GNP
Group IV: Area > GNP > population

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
Soviet Union	5.761	17.024	15.571			19.481	4.671	4.089	15.303
Canada	0.525	7.581	2.388	2.465	1.560	2.700	4.328	3.914	1.593
Australia	0.328	5.842	1.260	1.287	1.202	1.155	1.086	1.201	0.928
Saudi Arabia	0.246	1.634	0.551	0.318	0.495	0.540	0.964	0.879	0.469
New Zealand	0.068	0.204	0.163	0.253	0.426	0.142	0.282	0.278	0.083
Libya	0.080	1.337	0.132	0.051		0.146	0.288	0.208	0.126
Oman	0.027	0.228	0.043	0.011		0.117	0.121	0.110	0.083
Iceland	0.005	0.078	0.022	0.026	0.053		0.074	0.063	0.007

Notes: See table 3.2A.

The former Soviet Union's per capita GNP in 1987 (roughly $8,670) provided a somewhat different perspective. Despite advancements in many dimensions, Soviet technological development had always been notoriously uneven, in part because of the country's highly centralized and regimented economy, but also for other reasons. Overall, the structured economic, political, planning, and managerial bureaucracies in the country discouraged individual initiative and committed serious errors in allocating critical materials, knowledge, and skills within technological enterprises (sufficient for the support of heavy industry and the military, for example, but not enough for basic science and management). As a consequence, within the former USSR craftsmanship and sophisticated technological and economic control systems have often suffered. (Such inferences must remain tentative, however, until time series analyses have been completed).

Group IV countries that allocated more to military expenditures than to education or health included Oman, Libya, Saudi Arabia, and the USSR. (The same caveats noted earlier with respect to other groups pertain.) Quality-of-life indicators at the bottom ranged from those of Oman (103 infant deaths per 1000 births and a life expectancy of 54 years) to Saudi Arabia (64 deaths, 63 years) to the industrialized former USSR (30 deaths, 70 years) to oil-rich Libya (85 deaths, 61 years). These countries also scored low on political rights and civil liberties. At the top, Canada, Australia, and Iceland scored high on all measures (more favorably than the group V U.S. on infant mortality and life expectancy measures). If allowances are made for national territories that are relatively resource poor, the potentials for growth and development—through the introduction of more advanced (or appropriate) technologies—of nations on the group IV path including those not listed here (those "behind" as well as those "ahead") should be relatively positive.

Group V is defined as: $[T > R > P]$

Characteristic of group V countries is the consideration that their technologies are dominant, their domestic resource bases (areas) are larger than their populations, and their GNPs are larger than either their populations or their resources. Or, from a slightly different perspective, their population densities are relatively low, and their GNPs per capita are relatively high. In principle, at least, this means that—on average—

Table 3.5B Dimensions of development: Ranked by GNP per capita
Group IV: Area > GNP > population

	GNP per capita ($/pers.)	Government expenditure: Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
Canada	14,120	0.951	3.569	3.800	76	8	1	1
Iceland	13,410		0.019	0.030	77	5	1	1
Australia	11,920	0.627	1.348	1.614	78	10	1	1
Soviet Union	8,384	31.782	16.344	11.959	70	30	7	7
New Zealand	7,460	0.002	0.010	0.005	74	11	1	1
Saudi Arabia	6,950	2.050	1.078	0.492	63	64	6	7
Libya	5,128	0.293	0.278	0.099	61	85	6	6
Oman	4,980	0.218	0.059	0.035	54	103	6	6

Notes: See table 3.2B.

Table 3.5C Per capita dimensions: Ranked by GNP per capita
Group IV: Area > GNP > population

	GNP per capita ($/pers.)	Population density (pers./km²)	Government expenditure Military $/person	Education $/person	Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
Canada	14,120	3	317	1,053	936	2,299	424	285	3,523	3,323	4,110
Iceland	13,410	5		593	770	2,588	1,550		6,337	5,638	1,984
Australia	11,920	2	334	636	636	1,921	523	195	1,414	1,632	3,829
Soviet Union	8,384	13	964	439	268			187	346	316	3,596
New Zealand	7,460	12	5	23	9	1,830	897	116	1,782	1,828	1,652
Saudi Arabia	6,950	6	1,457	678	259	632	287	122	1,674	1,593	2,584
Libya	5,128	2	641	539	160	312		101	1,540	1,157	2,142
Oman	4,980	4	1,430	343	172	205		243	1,944	1,847	4,229

Notes: See table 3.2C.

each person in each of these countries has access to more resources, contributes to greater productivity, and has the possibility of gaining more advantage therefrom than his or her numerical counterparts in many roughly comparable countries with quite different profiles.

As exemplified by the United States over the course of its history, nations with group V profiles—with allowances made for the size and richness of their respective resource endowments—have had unique potentials for growth and development, with populations "moderate" relative to their resource bases areas, and rated "high" on technology. Insofar as their areas remain stable, their population increases, and their technologies continue to advance, however, such countries, under the pressure of increasing demands for resources, are likely to reach out for new resources. This reach tends to be made through trade, discovery of new domestic resources, or territorial acquisition.

The United Arab Emirates (UAE) appears as a bottom country on the group V list. Like Oman, Saudi Arabia, and Libya on the group IV list, the United Arab Emirates owe their level-of-development indicators to the oil in their respective resource bases which, as an intervening variable, exerts strong effects on their master variable profiles. The UAE also ranks high—remarkably high—in per capita energy consumption and production of carbon dioxide.

With low population densities relative to those of most industrialized countries, group V Finland, Sweden, and Norway (a developed oil-producing state), along with group IV Iceland, have reputations as peaceful and effective trading and welfare-producing countries with high qualities of life, and their per capita energy consumption and carbon dioxide production are "moderate," if still relatively high. To a large extent, the low population densities of these four Scandinavian states result from early migrations (to the United States in particular), demographic transitions, strong family planning programs, and advancing technologies.

Altogether, such considerations seem to speak well for the potentials of a high-technology, low-density, favorable-resource-access profile—if the issue is viewed in a strictly national context. But there is a caveat. For example, through its corporate activities overseas, Norway is one of the largest fertilizer producers of the world. Carbon emissions associated with such activities are "counted" as part of some other (host) country's balances, not those of Norway. While this is true as a general

Table 3.6A Dimensions of growth: Ranked by GNP
Group V: GNP > area > population

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
United States	4.952	7.115	27.902	33.642	12.866	24.695	10.428	17.809	18.192
Sweden	0.172	0.342	0.730	0.874	0.552	0.443	1.788	1.504	0.246
Norway	0.086	0.246	0.427	0.332	0.371	0.298	0.875	0.934	0.135
Finland	0.100	0.256	0.394	0.511	0.723	0.299	0.785	0.706	0.225
United Arab Emirates	0.029	0.064	0.136	0.114		0.105	0.475	0.343	0.083

Notes: See tables 3.2A.

accounting procedure, it raises some qualifications about the environmental soundness of the Norwegian-type profile. In 1991 the Norwegian government imposed a ceiling on carbon emissions for industrial enterprises within Norway, not a ceiling for all Norwegian enterprises operating outside its territory. The same type of qualification is generally applicable to other countries of this group.

To the extent that populations in group V countries grow faster than their technologies advance, however, pressures on their domestic resource bases are likely to increase (access to new resources will be more costly to acquire) and per capita shares in the economy may be expected to diminish—unless they are compensated for by exports and imports and/or increasingly efficient knowledge and skills (transformable from more knowledgeable and skillful populations).

Although it is clearly the "top state" on the group V size list, the United States drops to third place (after Norway and Sweden) in the development table. Compared with the Scandinavian countries, the United States ranks high on military expenditures, energy consumption, and involvement in warfare—and somewhat lower on education, health, and other quality-of-life indicators. Responsible for generating more than 22 percent of the (1987) global level of carbon, the United States can be characterized as a state that, conceived in resource abundance, "learned" environmental profligacy during its earliest formative years. (In Chapter 6 we will show evidence of "learning" environmental responsibility as reflected in the trends of U.S. environmental legislation over time.)

Group VI is defined by: $[T > P > R]$

Countries in group VI are characterized by higher GNPs relative to their populations and resources (areas). These countries have relatively high per capita levels of GNP, energy consumption, and carbon dioxide production. Greece and Spain are clearly among the lowest. Middle states include Israel and Singapore.

A number of group VI nations—notably Japan, Britain, West Germany, France, Italy, the Netherlands, Belgium, and Spain—are the developed cores of former empires stripped of their overseas colonies. What is notable about all of them is the extent to which—relative to the United States, which is more industrialized ($17,480 per capita GNP), and much

Table 3.6B Dimensions of development: Ranked by GNP per capita
Group V: GNP > area > poulation

		Government expenditure						
	GNP per capita ($/pers.)	Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
United States	17,480	32.948	29.667	29.970	75	10	1	1
Norway	15,400	0.233	0.569	0.550	77	9	1	1
United Arab Emirates	14,680	0.220	0.063	0.034	69	33	5	5
Sweden	13,160	0.389	1.156	1.455	77	6	1	1
Finland	12,160	0.118	0.474	0.573	75	6	2	2

Notes: See table 3.2B.

Table 3.6C Per capita dimensions: Ranked by GNP per capita
Group V: GNP > area > population

			Government expenditure								
	GNP per capita ($/pers.)	Population density (pers./km^2)	Military $/person	Education $/person	Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
United States	17,480	26	1,163	927	782	3,325	370	276	899	1,602	4,974
Norway	15,400	13	474	1,023	825	1,890	614	192	4,340	4,833	2,118
United Arab Emirates	14,680	17	1,341	339	153	1,939		203	7,071	5,319	3,894
Sweden	13,160	19	395	1,039	1,092	2,485	457	143	4,436	3,892	1,934
Finland	12,160	15	206	730	738	2,490	1,027	165	3,338	3,130	3,029

Notes: See table 3.2C.

Table 3.7A Dimensions of growth: Ranked by GNP
Group VI: GNP > population > area

	Population % global	Area % global	GNP % global	MnVA % global	AgVA % global	CEC % global	Exports % global	Imports % global	Carbon emissions % global
Japan	2.490	0.283	10.307	16.547	8.849	4.771	10.114	5.869	3.877
West Germany	1.248	0.189	4.861	8.444	2.542	3.735	11.677	8.792	2.820
France	1.135	0.416	3.924	5.211	3.998	2.306	5.996	5.954	1.489
United Kingdom	1.162	0.186	3.323	4.249	1.474	3.276	5.131	5.812	2.516
Italy	1.172	0.229	3.231	3.935	3.666	1.996	4.694	4.576	1.437
Spain	0.793	0.384	1.243	1.880	2.050	0.924	1.305	1.613	0.755
East Germany	0.340	0.082	1.239			1.445	1.331	1.261	1.398
Netherlands	0.299	0.031	0.967	0.966	1.025	1.136	3.812	3.464	0.531
Czechoslovakia	0.318	0.097	0.951			1.060	0.982	0.969	0.996
Romania	0.469	0.181	0.912			1.126	0.602	0.526	0.845
Switzerland	0.133	0.031	0.759			0.277	1.798	1.888	0.174
Belgium	0.203	0.024	0.604	0.778	0.394	0.599	3.306	3.159	0.402
Austria	0.156	0.064	0.502	0.766	0.446	0.327	1.086	1.201	0.219
Denmark	0.105	0.033	0.425	0.407	0.572	0.296	1.022	1.053	0.259
Bulgaria	0.184	0.084	0.404			0.571	0.641	0.628	0.497
Hong Kong	0.111	0.001	0.247	0.282	0.023		1.701	1.627	0.105
Greece	0.205	0.100	0.243	0.228	0.854	0.264	0.271	0.522	0.243
Israel	0.088	0.016	0.176		0.126	0.119	0.342	0.494	0.110
Kuwait	0.037	0.014	0.165	0.069		0.160	0.354	0.269	0.124
Singapore	0.053	0.001	0.127	0.181	0.017	0.117	1.079	1.174	0.135
Ireland	0.074	0.053	0.121	0.029	0.450	0.141	0.607	0.535	0.119
Trinidad and Tobago	0.025	0.004	0.042	0.022	0.038	0.099	0.066	0.062	0.074

Notes: See table 3.2A.

less dense (26 persons per square kilometer), but consumes much more energy and produces more carbon dioxide—they appear to have achieved at least modest technological and energy-use efficiencies together with relatively low levels of per capita carbon emissions.

To the extent that GNP per capita is regarded as an indicator of development, Switzerland—a relatively "dense" industrialized country (never an empire)—ranks relatively high among group VI countries, i.e., low in per capita energy consumption and production of carbon dioxide per capita. Similarly, an even denser Japan (323 persons per square kilometer), with a high GNP per capita and a slightly lower level of energy consumption per capita, had a 1987 level of carbon dioxide per capita that was not much higher.

Much the same can be said of other group VI countries—France, the Netherlands, Belgium, and Italy. Given their population densities and limited domestic resource bases, the quality-of-life indicators for these countries, from Cyprus to Japan, are also favorable. Their numbers are in sharp contrast, however, with those of the two oil-producing countries, Kuwait and Bahrain. None of the major industrialized states in group VI allocates more to military expenditures than to education or health. In regard to political rights and civil liberties, all "top" group VI countries (with one exception) are assessed at the 1/1 level. The single exception is France, with a 1/2 assessment. The lower-ranking countries in group VI include Greece (1/2), Israel (2/2), and Bahrain (6/5).

The profiles of group VI countries are notably different from those of countries in groups I through V in that their GNP levels are high (especially in Japan and Germany)—both absolutely and per capita—compared with their populations, which are also high relative to their areas (only 585 square kilometers for the city-state of Singapore). As an indicator of domestic resource availabilities (bases), area is clearly a constraining factor in the group VI profiles, but by industrialization (and/or the building of financial institutions, as in Switzerland) the more technologically advanced of these countries have succeeded in achieving and maintaining high export levels in order to pay for high import levels and thus to compensate for limited domestic resource bases.

To summarize, table 3.8 lists the countries in each of the six profile groups derived empirically for 1987. It is essential to stress that over time the positions of countries (both *within* and *across* profiles) change

Table 3.7B Dimensions of development: Ranked by GNP per capita
Group VI: GNP > population > area

	GNP per capita ($/pers.)	Government expenditure: Military % global	Education % global	Health % global	Life expectancy (years)	Infant mortality (per 1000)	Political rights	Civil liberties
Switzerland	17,680	0.252	0.735	1.246	77	7	1	1
Kuwait	13,890	0.164	0.148	0.013	73	19	6	5
Japan	12,840	1.841	10.292	12.003	78	6	1	1
Denmark	12,600	0.161	0.652	0.560	75	8	1	1
West Germany	12,080	2,659	4.374	7.343	75	9	1	2
East Germany	11,295	0.844	0.737	0.602	72	9	7	6
France	10,720	2.811	4.754	6.397	77	8	1	2
Netherlands	10,020	0.513	1.253	1.696	77	8	1	1
Austria	9,990	0.113	0.609	0.641	74	10	1	1
Czechoslovakia	9,284	0.496	0.496	0.685	70	14	7	6
Belgium	9,230	0.330	0.679	0.824	75	10	1	1
United Kingdom	8,870	2.970	3.556	4.299	75	9	1	1
Italy	8,550	1.414	2.827	3.790	77	10	1	1
Singapore	7,410	0.117	0.127	0.038	73	9	4	5
Hong Kong	6,910				76	8		
Bulgaria	6,800	0.189	0.260	0.227	72	15	7	7
Israel	6,210	0.599	0.257	0.087	75	12	2	2
Romania	6,026	0.167	0.220	0.271	71	26	7	7
Trinidad and Tobago	5,360	0.008	0.047	0.029	70	21	1	2
Ireland	5,070	0.040	0.170	0.230	74	9	1	1
Spain	4,860	0.537	0.856	1.384	76	10	1	2
Greece	3,680	0.305	0.152	0.252	76	12	2	2

Notes: See table 3.2B.

Table 3.7C Per capita dimensions: Ranked by GNP per capita
Group VI: GNP > population > area

	GNP per capita ($/pers.)	Population density (pers./km²)	Government expenditure: Military $/person	Education $/person	Health $/person	MnVA $/person	AgVA $/person	CEC (petajoules/ mil. pers.)	Exports $/person	Imports $/person	Carbon emissions (thous. metric tons/ mil. pers.)
Switzerland	17,680	159	331	854	1,209			115	5,765	6,314	1,766
Kuwait	13,890	100	779	620	44	919		240	4,102	3,247	4,563
Japan	12,840	327	129	640	623	3,252	507	106	1,735	1,050	2,108
Denmark	12,600	119	270	966	692	1,908	780	157	4,175	4,486	3,353
West Germany	12,080	245	372	542	761	3,311	290	166	3,996	3,138	3,059
East Germany	11,295	154	433	335	229			235	1,670	1,651	5,561
France	10,720	101	433	648	728	2,246	502	113	2,255	2,336	1,775
Netherlands	10,020	356	300	648	733	1,580	488	210	5,441	5,157	2,402
Austria	9,990	90	127	605	532	2,408	408	116	2,977	3,435	1,905
Czechoslovakia	9,284	121	273	242	279			185	1,320	1,358	4,246
Belgium	9,230	319	284	518	525	1,876	277	164	6,959	6,935	2,681
United Kingdom	8,870	231	447	474	478	1,790	181	156	1,886	2,228	2,931
Italy	8,550	190	211	373	418	1,643	446	94	1,710	1,739	1,659
Singapore	7,410	2,600	385	368	93	1,658	46	121	8,652	9,812	3,423
Hong Kong	6,910	5,400	0	0	0	1,248	29	999	6,563	6,549	1,280
Bulgaria	6,800	81	179	218	159			171	1,483	1,517	3,644
Israel	6,210	205	1,188	451	128		204	75	1,660	2,497	1,691
Romania	6,026	96	62	72	75			133	548	499	2,437
Trinidad and Tobago	5,360	240	53	297	153	430	218	223	1,147	1,129	4,065
Ireland	5,070	51	96	357	404	193	869	106	3,516	3,228	2,183
Spain	4,860	77	118	167	226	1,160	368	65	703	906	1,288
Greece	3,680	76	260	115	159	545	594	71	565	1,135	1,603

See table 3.2C.

as a result of changes in growth and development. The broader task of our research program, therefore, is to examine these changes—and their environmental implications. Figures 3.3–3.8 show, in graphic terms, six countries at roughly the "top" and "bottom" of each profile group to illustrate the differences in size and scale *within* and *across* profile groups.

Policy Paradox

Compared with the overall challenge of this book, our intent in this chapter was limited. Our purpose here was to present a theoretically and empirically derived approach to the analysis of socioeconomic observations that appear to be relevant to the apparent contradictions between economic and political growth, development, and stability, on the one hand, and environmental sustainability on the other. In the longer run, our concern is for providing the theoretical and empirical underpinnings necessary for the analysis of economic, political, and environmental decision and policy making on national, international, and global levels through time.

In framing the profiles, this chapter has addressed the potential contradictions that exist between the achievement of environmental sustainability within national, international, and global economies, on the one hand, and the growth and development that are indispensable for achieving and maintaining economic, political, and social stability, on the other. This paradox is salient in modern societies, in which the undeniable benefits derived from applications of technology, energy in various forms, and other natural resources are increasingly balanced against consequent ecological debits. Each increment of growth and development appears to exact costs in resource depletion, pollution, and other forms of degradation. Conversely, serious efforts undertaken to protect the environment are perceived as threats to agricultural and industrial production, commercial enterprises, employment, and the general welfare as it is conventionally defined.

Systematic analysis of these apparent contradictions is constrained by the extent to which serious investigations must draw upon the knowledge and skills of diverse disciplines from physics, chemistry, meteorology, and biology to economics and political science. Also relevant are the

Table 3.8 Country profiles, 1986

Group I	Group II	Group III	Group IV	Group V	Group VI
Brazil	China	South Korea	Soviet Union	United States	Japan
Iran	India	Poland	Canada	Sweden	West Germany
Argentina	Mexico	Yugoslavia	Australia	Norway	France
South Africa	Indonesia	Portugal	Saudi Arabia	Finland	United Kingdom
Algeria	Nigeria	Hungary	New Zealand	United Arab Emirates	Italy
Venezuela	Turkey	North Korea	Libya	Iceland	Spain
Colombia	Thailand	Cuba	Oman		East Germany
Peru	Iraq	El Salvador			Netherlands
Chile	Egypt	Jamaica			Czechoslovakia
Ecuador	Pakistan	Lebanon			Romania
Cameroon	Philippines	Mauritius			Switzerland
Côte d'Ivoire	Malaysia				Belgium
Sudan	Syria				Austria
Kenya	Bangladesh				Denmark
Tanzania	Morocco				Bulgaria
Uruguay	Viet Nam				Hong Kong
Jordan	Tunisia				Greece
Zimbabwe	Guatemala				Israel
Ethiopia	Burma				Kuwait
Panama	Sri Lanka				Singapore
Zaire	Ghana				Ireland
Angola	Dominican Republic				Trinidad and Tobago
Bolivia	Yemen				
Paraguay	Costa Rica				
Gabon	Uganda				
Afghanistan	Honduras				
Mozambique	Albania				
Senegal	Nepal				
Nicaragua	Haiti				
Papua New Guinea	Rwanda				
Madagascar	Malawi				
Zambia	Sierra Leone				
Congo	Burundi				
Niger	Benin				
Guinea	Togo				
Mongolia	Lesotho				
Somalia					
Mali					
Burkina Faso					
Liberia					
Yemen, People's Democratic Republic of					
Botswana					
Chad					
Central African Republic					
Mauritania					
Laos					
Bhutan					

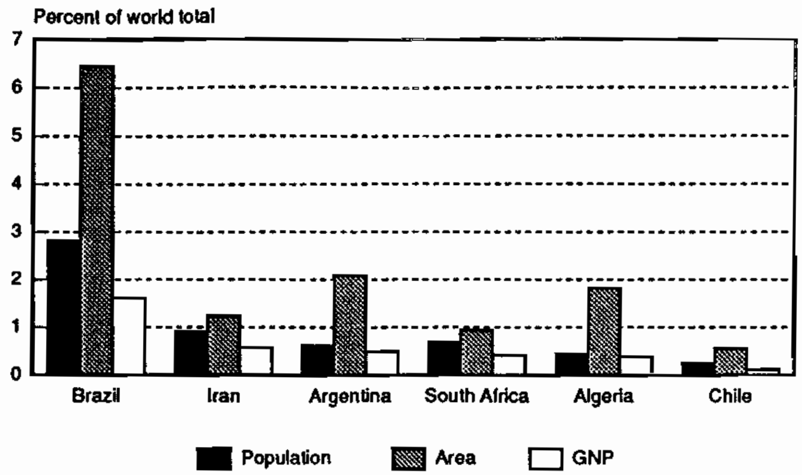


Figure 3.3
Group I: Area > Population > GNP
Source: Data in Tables 3.3–3.8.

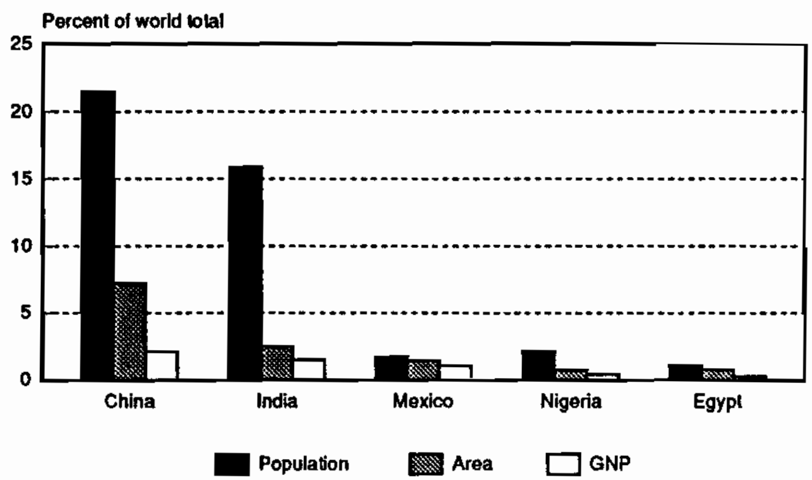


Figure 3.4
Group II: Population > Area > GNP
Source: Data in Tables 3.3–3.8.

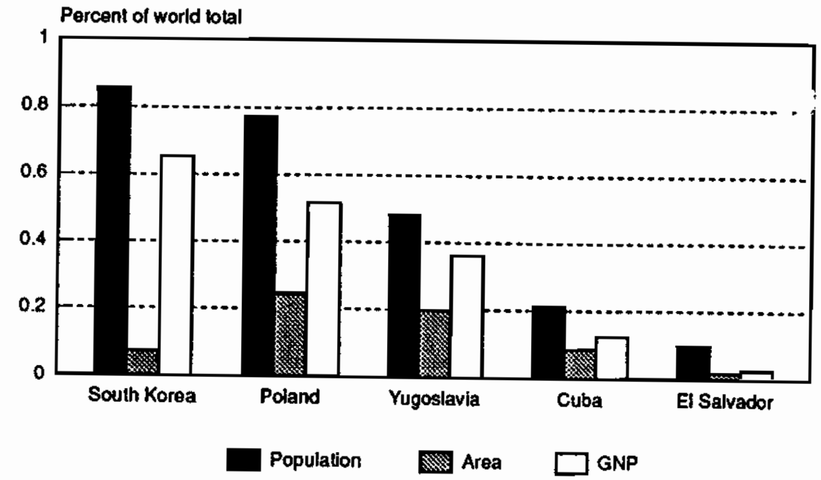


Figure 3.5
Group III: Population > GNP > Area
Source: Data in Tables 3.3–3.8.

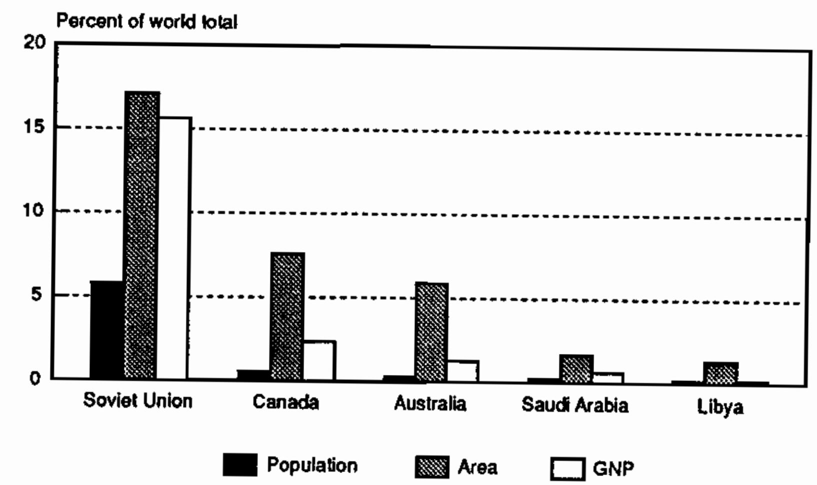


Figure 3.6
Group IV: Area > GNP > Population
Source: Data in Tables 3.3–3.8.

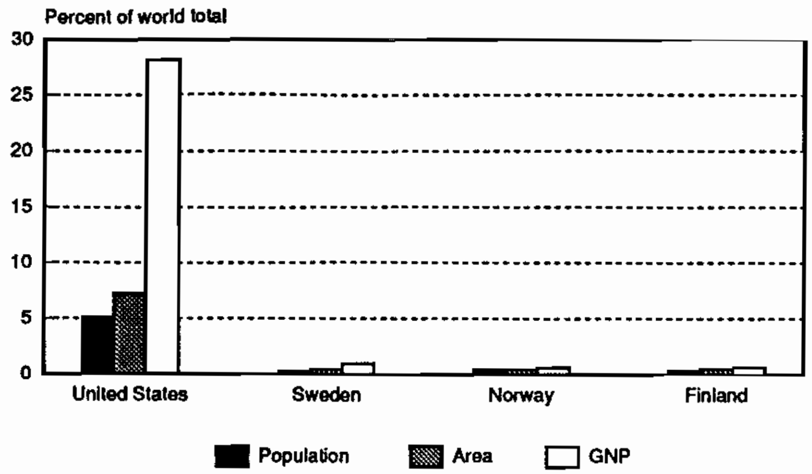


Figure 3.7
Group V: GNP > Area > Population
Source: Data in Tables 3.3–3.8.

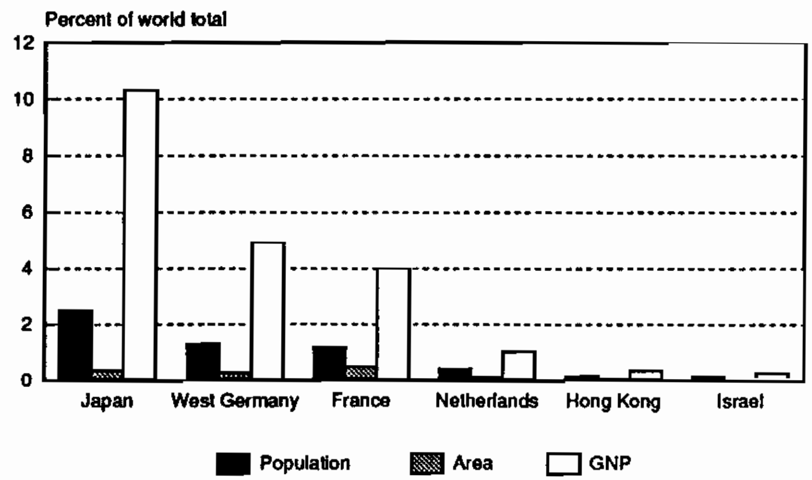


Figure 3.8
Group VI: GNP > Population > Area
Source: Data in Tables 3.3–3.8.

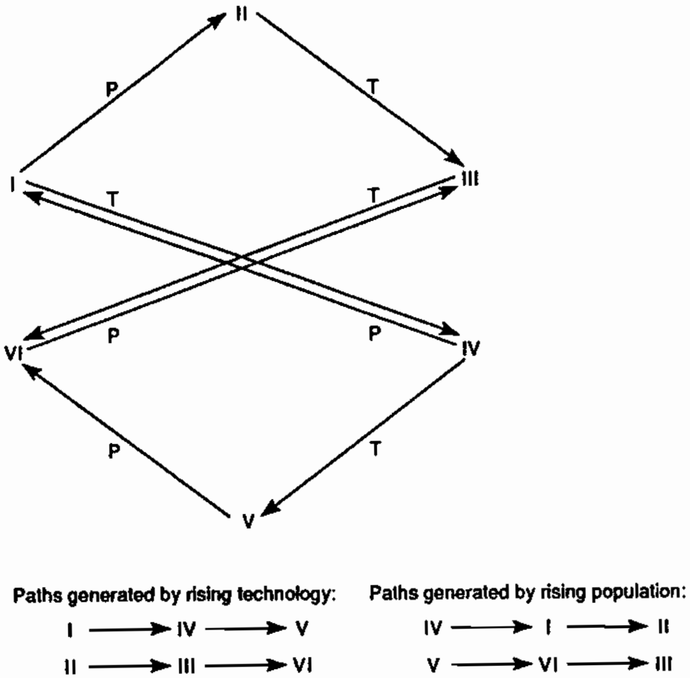
uneven quality and availability of data required by these disciplines if progress is to be achieved. In the formulation and execution of policy, relatively objective paradoxes of this sort tend to emerge as subjective decision- and policy-making dilemmas with contradictory horns around which polarized coalitions (developers and environmentalists, for example) tend to rally and organize. Both the characteristics and the salience of such polarities differ in different contexts.

Managing Change: Two Development/Environment Paths

Two main growth and development pathways emerge from this empirical perspective and from the uneven growth and development of the three master variables, population, resources, and technology: *Path A.* Considered sequentially, countries in Groups I → IV → V describe a pathway, starting from countries like Brazil and Argentina and progressing through two profile transitions as technology first "overtakes" populations (best represented by Iceland, Canada, and Australia) and subsequently overtakes resource bases represented by Norway, the United States, and Sweden). *Path B.* Also traced sequentially, countries in Groups II → III → VI describe a different pathway, starting from China, India, and Mexico and progressing through two profile transitions as technology first outpaces resource bases (as in Portugal and the Republic of Korea) and subsequently outpaces population (as Switzerland, Japan, and Germany). Although the orientation of these pathways is primarily directed toward economic, political, and social growth and development, the right-hand columns in each of the tables and figures in this chapter provide clues to the environmental implications.

A simplified schematic of the paths to profile alteration is presented in figure 3.9. The ways in which profiles may change as a function of growth in (a) population or (b) GNP are shown in figure 3.9. Note again that GNP is used as a surrogate for technology and that area (and material imports) is a proxy for resources—with all the caveats and qualifications in mind.

There are two ways in which political behavior and public policy shape such transformations. The first is the outcome of the aggregate of all of the bargaining, leveraging, and other interactions that have resulted from the activities, through time, of individuals and organizations within a state in pursuit of their undifferentiated interests without formal artic-



Dynamics of profile change

Notes:			
I:	Resources	> Population	> Technology
II:	Population	> Resources	> Technology
III:	Population	> Technology	> Resources
IV:	Resources	> Technology	> Population
V:	Technology	> Resources	> Population
VI:	Technology	> Population	> Resources

Source: MIT Program on Global Accord: International Relations and Global Environment. Prepared by Jan Sundgren.

Figure 3.9
Dynamics of profile change

ulation or framing of relevant policy. The other possibility amounts to the converse—that is, the transformations that are attributable to policy formulations and implementations undertaken precisely in order to achieve intended outcomes or transformation (as in the case of Japan from the Meiji Restoration). These two paths bear directly on the *endogenization* of the master variables, the context of dynamic analysis over time. Population, resources, and technology can be "modeled" as growing "normally," depending on their previous values and current investments, or they can be altered more radically, through effective policy intervention (immigration, importation, innovation, etc.) or a combination of both. In essence, therefore, while we have treated the master variables as independent variables or dependent variables (as the case may be), how they assume these characteristics is in itself both an empirical question and a policy issue.

Left to largely undirected, largely conscious trial-and-error adaptation, over many generations countries might "learn," however painfully, to sustain the local and global environments upon which their welfare depends. However, with a deeper awareness of how we and our organizations (including states) threaten these environments, we might succeed in reducing the "pain" and other costs in decades rather than generations or centuries. Here are a few over-simplified and (until time series analyses have been undertaken) highly tentative future strategies for countries on each of the two pathways:

Path A. Allow population to grow along the I → IV → V pathway only to the extent that energy-efficient technologies and resource availabilities develop well in advance of the numbers of people and are sufficient to ensure social welfare and quality of life. It is critically important to avoid the artificial "development" patterns associated with some of the oil-rich nations, along with organizational and management dysfunctions such as those in Yugoslavia and the former USSR, and the resource and waste profligacy of the United States. In these terms the more advanced countries in groups IV and V need to focus on the development of technological and resource efficiencies both within their own borders and worldwide.

Path B. With respect to countries on the II → III → VI path, group II and III countries need to constrain population growth sharply but acceler-

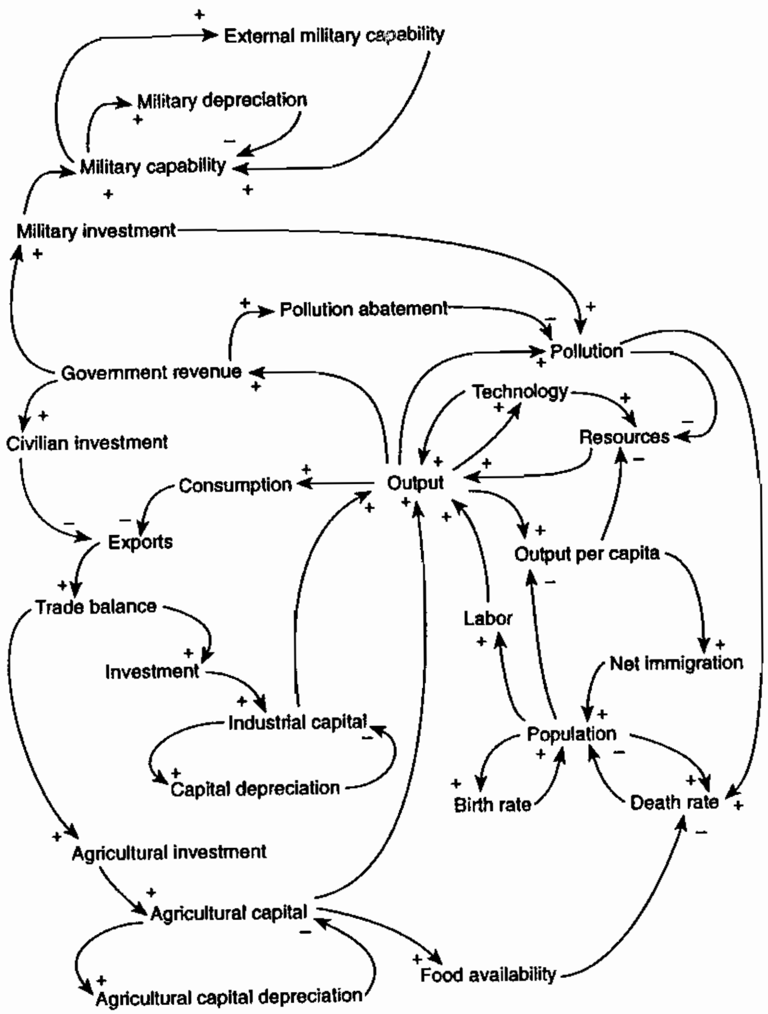


Figure 3.10
Dynamic feedback relations: Some illustrations
Source: Based on Choucri and Bousfield (1978) and Lichtman (1988).

ate technological advancement while expanding resource availabilities domestically by developing appropriate knowledge and skills and externally through worldwide trade. Heavy emphasis needs to be placed on the development or importation of energy-efficient technologies and resources. Meanwhile, national and global environments alike will benefit to the extent that group VI nations join relatively advanced group IV and V countries in assuming primary global responsibility for the speedy facilitation and distribution of technological and resource efficiencies and demographic stabilization both domestically and worldwide.

Figures 3.9A and 3.9B thus show schematically the alternative potential pathways of growth and development across profiles. The stylized paths in Figures 3.9A and 3.9B are presented for illustrative purposes only to show how profile transformations can take place.

For all countries and their components, pending time series analysis, the profile approach suggests the need to (1) accelerate resource efficient technological development in advance of population growth; (2) pursue stable balances between economics and demographics; (3) grant high priority to the development of energy-efficient and energy-saving technologies and resources; (4) develop and systematically monitor more sophisticated environmental and quality-of-life indicators; and, correspondingly, (5a) establish and maintain local, national, and global institutions in order to accelerate environmental/economic development and sustainability, and (5b) respond with "firehose" measures when indicators signal or preferably forewarn of a negative trend. The next challenge is to develop a dynamic model of these changes (Laird 1972; Choucri, Laird, and Meadows 1972; Choucri and Bousfield 1978; Litchman 1988) along the lines of figure 3.10.

Notes

1. The dynamic representation in figure 21.2 in Choucri and Bousfield 1978 (p. 314) provides the basis for figure 3.10 in this chapter.

2. Implicit here is the need to incorporate the pervasive environmental dimension relative to conditions of complex interdependence. See Keohane and Nye 1989 as a basis for international institutional responses. See Alker 1977 for a comprehensive conceptual approach to the notion of interdependence and Choucri 1976 for a detailed empirical analysis of international interdependence in the area of energy.

3. Initially we set out to identify the immediate structural outcomes—the specific

profiles of individual states—resulting from unevenness, in times series, of the master variable indicators of each. Conceptually, each individual profile could be envisaged as an instantaneous photograph (or X ray) of the population/technology/resource access structure of a particular state at a particular cross section of time. In time series, however, the "snapshot" becomes a cinematic unfolding as a given state (with measurable growth and "sizes" of master variables) pursues its own particular paths of growth and development or transformation (or relative decline).