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Sustainability

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Sustainability as a concept seems to have found a place within everyday discourse. One might ask, however, what it is that we wish to sustain. Reflection on this matter leads quickly to a conclusion that there is not yet a fully shared understanding of the meaning of sustainability. Conservation advocates often are most concerned with the sustainability of nature. For others, the meaning of sustainability is bound up with preserving human health and well-being, or—most broadly—"quality of life." For still others, sustainability is primarily about sustaining resources to fuel industrial society as we know it. Almost all individuals, meanwhile, are concerned about the sustainability of our collective (and, of course, thereby perhaps their own personal) prosperity.

What all these definitions have in common is a realization that any and all human activities, especially economic activities that depend on large-scale extractions from nature, carry costs that can and should be understood in terms of environmental sustainability. Nature is fragile, and we humans are a part of nature. Despite our considerable adaptive capabilities, we will not survive for long without breathable air, potable water, or food. Nor do we understand all of the ways in which we depend on the health of ecosystems and countless other species of plants and animals. Indeed, our capacity to affect negatively all those aspects of nature essential to our long-term prosperity and health is growing continuously as both human numbers expand and human technologies evolve.

Consequently, the growing concern worldwide with sustainability as an animating principle in building a results-based sense of common purpose is really a matter of learning as a species how to anticipate, avoid, or

ameliorate many of the risks we continuously pose to ourselves and to nature. In the process, we must learn as well to judge and gauge our economic initiatives and efforts broadly rather than narrowly. Thus, analysts such as John Elkington indict societies' traditional focus on economic "bottom lines" as being decidedly too narrow (namely, economic development) for these purposes. They speak instead of the necessity of employing three bottom lines in order for sustainability to gain any traction in policy decisions: the social, the environmental, *and* the economic.[1]

To be sure, viewing economic initiatives more broadly within the context of this definition and operationalization of sustainable development is not without its perils. As Robert Durant with Thanit Boodphetcharat argues later in this volume (chapter 3), for example, traditional regulatory politics can morph readily into a highly conflictual redistributive politics of "livelihood" that effectively still allows economic bottom lines to trump environmental values. Likewise, the lessons drawn by various authors in this volume (especially Gary Bryner, Ken Geiser, James Meadowcroft, and Denise Scheberle) equally are applicable to operationalizing the concept of sustainability: in practice, it faces formidable methodological, bureaucratic, interorganizational, intergovernmental, political, and cultural obstacles. Thus, using sustainability as a basis for building a results-based sense of common purpose in environmental governance in the twenty-first century will not be easy.

Much as Amartya Sen argues within the context of development economics, however, the integrated analysis of economic, social, and environmental values that sustainability demands as a means for building common purpose is critical for humanity's future.[2] As such, the arguments of this chapter are fivefold. First, definitional differences aside, sustainability is fundamentally about relating economic purposes to limits imposed on them in the natural world and to the advancement of quality of life in the social world. Second, this "multiple-bottom-line" or "contextual economic" perspective is one that North Americans in particular must take to heart, given their decidedly disproportionate wealth and consumption patterns relative to the rest of the world. Third, embracing sustainability as a central animating concept of economic development means eschewing claims that economic progress automatically improves quality of life, using the evolving techniques of "sustainability analysis" to weigh such

claims empirically, and then altering behavior accordingly. Fourth, informed by these social science techniques and aided by the natural sciences, humanity now has the capability to determine democratically the mix of expenditure allocations that will maximize public welfare. Finally, although the obstacles (especially among North Americans) to building a results-based sense of common purpose in this fashion are formidable, there is reason for guarded optimism.

The chapter begins by offering a synopsis of the logic and evolution of the concept of sustainability itself. It emphasizes how an ongoing tendency to distort the concept into a call for unconditional economic growth has occurred and explains that the best way to counter this call is to develop analytic methods that are neutral on this point. Next, and to this end, the chapter suggests how and why techniques of sustainability analysis can clarify and advance the concept of sustainability on a national, international, and global basis. Put most simply, sustainability analysis can model how societies and economies function in environmental and quality-of-life terms, rather than in economic terms alone. The chapter then concludes by reviewing the technical, political, and organizational challenges, choices, and opportunities facing reformers who strategically promote the use of sustainability analysis as a tool for building a results-based sense of common purpose in environmental governance in the future.

The Conceptual Foundations of Sustainability

Sustainability in its broadest terms is concerned with the optimization of human well-being, ever mindful of a simultaneous need to minimize ecological damage and resource depletion. Sustainability in this sense is at the heart of human existence: a perpetual development of economic and sociopolitical activities and institutions to better human lives individually and collectively in both the short and the long term.

The Malthusian Conundrum

The analytic consideration of environmental sustainability, broadly defined, goes back at least to the writings of Thomas Robert Malthus (1766–1834). Malthus was, of course, a rigid and gloomy moralist who

concluded that human population inevitably would outstrip our ability to produce sufficient food. As he saw it, population increased geometrically (or exponentially), whereas production increased arithmetically (or incrementally).

Malthus was the ultimate naysayer to the boundless optimism of the ascendant liberal intellectual circles of his time. Within these circles, the intelligensia imagined that progress and increasing prosperity were natural characteristics of the human condition, not only in their time, but also for the foreseeable future. Whereas liberals believed in the perfectibility of humans through education, science, and democracy, Malthus was a pessimist who only hoped that human depravity and overpopulation could be checked sufficiently to avoid the worst of resource shortfalls and misery. He saw misery for the poor, however, as one of the necessary checks on excessive human population growth. In the spirit of some of today's extreme conservatives, he thus opposed the Poor Laws of his time as overly generous.

Few contemporary sustainability advocates are eager to embrace Malthus as an intellectual ancestor, nor are they enthusiastic about W. Stanley Jevons, who published *The Coal Question* in 1865. Jevons calculated a rise in coal consumption in Great Britain between 1854 and 1864 (at 3.5 percent annually) and concluded, given known domestic reserves, that the burgeoning nascent industrial society of his day was not likely to be long-lived. In his words, "We cannot long maintain our present rate of increase of consumption. . . . [W]e can never advance to the higher amounts of consumption supposed. . . . [T]he check on our progress must become perceptible within a century. . . . [T]he cost of fuel must rise, perhaps within a lifetime, to a rate injurious to our commercial and manufacturing supremacy; and the conclusion is inevitable, that our present happy condition is a thing of limited duration."[3] Jevons, of course, did not allow for the rise of an industrial economy based on other fossil fuels, traded globally and extracted even from the Arctic or from under the sea.

As off the mark as both Malthus and Jevons were, they *were* right that ultimately resources are available in only finite amounts. There *are* limits to the size of the human population that can be supported within nature's capacities, and resource limits *will* in some circumstances restrain economic development and social well-being. Where they were wrong,

however, was in assuming that shortages in one particular resource, at one given level of technological development, always and significantly will limit human well-being for an extended period. Having not allowed for these possibilities, they naturally also failed to appreciate the implications of continuous and simultaneous growth in human population, resource extraction, *and* industrial production.

The greater danger, as it turns out, is not so much that the human population and total economic output cannot possibly continue to grow to levels unimaginable in Malthus's and Jevons's times. Rather, the danger is that they *can* do so and that ultimately a severe ecological price must be paid. This price can be reduced, of course, by technological innovation and technological selectivity. However, as we can now see, human numbers and human affluence are not boundless, even with optimal technologies. This more contemporary view of sustainability is accepted widely now (though decidedly not universally).

Toward Sustainability

Two other, more modern prophets of the contemporary sustainability debate are the twentieth-century American conservationists Fairfield Osborn and Samuel Ordway. Osborn spoke in 1953 of the goal of humanitarianism being "not the quantity, but the quality of living."[4] Population restraint and resource conservation in the name of a higher quality of life were central objectives for both Osborn and Ordway. Ordway, also writing in 1953, feared that without careful use "basic resources will come into such short supply that rising costs will make their use in additional production unprofitable, industrial production will cease, and we shall have reached the limit of growth. If this limit is reached *unexpectedly,* irreparable injury will have been done to the social order."[5] His solution: restraint and perhaps redirection of human material wants. In Osborn's words, we "must temper [our] demands and use and conserve the natural living resources of the earth."[6] Added Ordway with rhetorical flourish, "our needs can be supplied if our wants are bridled. . . . The false ideology which worships unlimited expansion must go."[7]

Osborn and Ordway's views were penned but not widely influential in the hyperexpansionist 1950s. At the time (as was almost as true in the 1990s, when we should have known better), each year's dominant new

automobiles were larger and typically less fuel efficient.[8] These authors' sustainability-oriented views, as such, would have greater resonance when three strands of environmental thought—ecology, health, and sustainability—came together in an integrated way in the late 1960s. These concerns reached an even wider public following the 1972 publication of *The Limits to Growth* and especially in the wake of the 1973 and 1979 energy crises induced by the Organization of Petroleum Exporting Countries. Prior to these events, such concerns only rarely were taken to heart outside conservationist circles. However, in the 1970s and beyond, sustainability as a concept evolved rapidly from *Limits to Growth* to the 1987 publication of *Our Common Future* and on to sustainability indicators and sustainability analyses.[9]

Limits to Growth was read widely, in part because the research underpinning its findings utilized a then-novel tool: the computer. Technological novelty aside, however, it brought sustainability issues and concerns home to a significant segment of the public. The work was overstated, of course, in several aspects of its argument. For example, its authors (as had Malthus) underestimated potential increases in agricultural output and implied that reserves of nonrenewable resources (especially metals and minerals) were so limited that industrial society might experience shortfalls (in some cases within decades). Some readers, of course, quickly dismissed *Limits* as "Malthus with a computer."[10] Others raised doubts about its findings, arguing that it had not made sufficiently clear that global resource use is skewed radically in favor of a small number of wealthy nations. Consequently, these critics argued, "limiting growth" is altogether unwarranted in many contexts.

Incorporating these concerns, Mihajlo Mesarovic and Eduard Pestel soon updated *Limits* for the Club of Rome, the original sponsor. This second report, published in 1974, gave greater emphasis to the fundamentally uneven rates of resource use in the various regions of the world. As these authors put it, "Two gaps, steadily widening, appear to be at the heart of mankind's present crises: the gap between man and nature and the gap between 'North' and 'South,' rich and poor. Both gaps must be narrowed if world-shattering catastrophes are to be avoided."[11] Despite its flaws, this version of *Limits* did express effectively an intelligent discomfort with mindless opulence and thus joined its predecessor in advancing

wider recognition that economic growth comes at a price. Moreover, in the context of the energy crisis of the 1970s and early 1980s, *Limits* informed wide discussions of steady-state economics and the impossibility of exponential growth.

Also notable in conveying an early sense of the normative and logical underpinnings of sustainability analysis was the Science Council of Canada's publication in 1976 of the report *Canada as a Conserver Society*. A conserver society was defined in part as a society that "promotes economy of design of all systems, that is, 'doing more with less'; favors re-use or recycling and, wherever possible, reduction at source; and questions the ever-growing per capita demand for consumer goods, artificially encouraged by modern marketing techniques."[12] The concept of a conserver society foreshadowed contemporary sustainability analysis in advocating materials- and energy-use efficiency, without necessarily excluding growth in gross domestic product (GDP). Yet the conserver society document (again in tune with contemporary analysis) also explicitly rejected a blanket endorsement of growth in all circumstances and by any means.

An additional aspect of the contemporary view of sustainability then arose out of *Our Common Future,* a work that made explicit many of the environmental costs associated with poverty. In the process, this report took the discussion of economic growth and sustainability toward a more balanced view. At the same time, however, it also risked lapsing contemporary debates back into a "growth-without-questions" mentality, especially whenever unbridled growth advocates distorted the meaning of the amorphous concept of sustainable development to advance their agendas.

The concept of sustainability thus has come to be informed by a perspective that is both complex and subtle. It rejects the view that the only societal and global goals of consequence are economic goals. Nonetheless, it allows that economic growth in some contexts can have net positive environmental, economic, and social effects, and that some forms of growth may impart only minimal environmental harm. The enormous challenge in this perspective, of course, is to sort out when, in what forms, and at what levels growth is or is not desirable. The ongoing risk remains that this view can be, and frequently is, distorted into something

near to advocacy of unconditional economic growth. When this happens, "sustainable development" is understood as growth in marginally less-damaging forms. The best hope to avoid this lapse is to develop analytic methods such as sustainability analysis that are neutral on this point.

The Emerging Science of Sustainability Analysis

Sustainability analysis has been seen as, in essence, the study of the relationships among three corners of a triangle: economic factors (prosperity), social factors (well-being), and environmental factors (seen variously as a comprehensive array of indicators of environmental impact, as energy and material throughputs, or as "societal metabolism").[13] Each corner contributes to and may impose costs on the objectives embodied within each of the others. Thus, sustainability analysis depends fundamentally on the construction of valid, objective, and agreed-upon sustainability indicators. These indicators include measures not only of economic performance, but also of environmental inputs and impacts, as well as of social well-being. Sustainability analysis thus can be seen as a complement to economic analysis or even as a rebuttal to it. Indisputably, however, it is a means of systematically and rigorously integrating the findings of the natural and social sciences, including economics, into a comprehensive analytic model.

Consider, for example, what sustainability analysis can reveal to policymakers in the way of trade-offs. Environmental protection initiatives, for example, might contribute to economic prosperity by reducing health care costs, by making freshwater more available, or by helping to create pollution abatement and energy conservation technologies and industries. On the other hand, environmental protection might restrain some industries by imposing additional costs or by reducing the need for some products through technological selectivity or simply through the "imposition" of enhanced energy efficiency. Environmental protection also produces a variety of social benefits, of course, including improved health, recreational opportunities, or a greater subjective sense of well-being from knowing that biodiversity and wild nature will thrive into the future.

Looking from another angle, economic growth can benefit both society and the environment by enhancing a nation's capacity to spend on health, education, and environmental protection. But, alternatively, economic

growth may be based on improved industrial competitiveness that in turn depends on slashing those very programs. This situation might occur in developed nations in an era of budget deficits or (as the editors of this volume suggest) in developing nations under pressure from the International Monetary Fund or World Bank to cut the size of public deficits as a condition for future loans.

As discussed later in this chapter, some analysts such as Aaron Wildavsky have argued that society is almost always better off in terms of net well-being if it opts for economic growth, even if that growth seems to carry an environmental risk. Wealth, they contend, produces health in a myriad of ways.[14] In contrast, others have argued that there may be a level of wealth per capita that is optimal or sufficient in terms of well-being outcomes; beyond this level, the environmental and social costs of wealth production may offset or even overwhelm the gains.[15] Even if this scenario is not true, larger gains in well-being may come from elevating societies to a level of basic food, education, health services, and shelter. Beyond that level, however, the gains are less dramatic per unit of GDP per capita.

To be sure, improved social well-being clearly involves improved health and education, which in turn make for a more effective economic workforce. Consider, for example, how the economies of many African nations are threatened today by hunger and the AIDS epidemic. In this same vein, indications are that rising levels of comfort associated with prosperity are also associated with increased attention to environmental protection, whereas economically challenging times tend to have the opposite effect.[16] Still, certain levels of social and environmental spending may reduce competitiveness. Indeed, this might even be the case were a pattern of social and environmental performance standards within trading blocks to be established, as the European Union has attempted. Overall, the point is clear: each dimension (the social, the environmental, and the economic) considered by sustainability analysis either can contribute to or impose on each of the other two.

The challenge to policymakers that sustainability analysis makes explicit, however, is how to achieve balance or, ideally, how to find policies and strategies that lead to win-win-win outcomes. Analysts John Robinson and Jon Tinker have explored this challenge in important ways in their work.[17] They note that "there is little consensus among experts in

each discipline on how the ecological, economic, and social systems are related to one another."[18] Where John Elkington speaks of three bottom lines, Robinson and Tinker argue that "it is more fruitful to think in terms of three interacting, interconnected, and overlapping 'prime systems': *the biosphere* or ecological system; *the economy,* the market or economic system; and *human society,* the human social system. The third prime system includes the political system (governance), the social system (family, communities, and so on), and cultures."[19]

Each "system," according to these scholars, is understood to have its own value-laden imperative, and "sustainable development" is seen as an attempt to reconcile the three distinct imperatives. Again, in their words, "*The ecological imperative* is to remain within planetary biophysical carrying capacity. *The economic imperative* is to ensure and maintain adequate and equitable material standards of living for all people. *The social imperative* is to provide social structures, including systems of governance, that effectively propagate and sustain the values that people wish to live by."[20]

One important hesitation regarding the divisions Robinson and Tinker offer, however, is that the economic system as it actually functions today would not appear to be bound by such a set of imperatives. The social and ecological imperatives, in fact, might or might not have wide public support, especially were well-being gains to come at a cost to economic outcomes (as Wildavsky might suggest). The economic imperative within a capitalist economic system is quite clearly the maximization of total economic output (and of yield to the owners of capital). Thus, economic goals are sometimes compatible with each other, but less often incompatible with, and possibly contrary to, the equity-oriented imperative ascribed by Robinson and Tinker. Nevertheless, Robinson and Tinker *do* argue rightly that the three imperatives are interconnected, though each is independently important. Ignoring any of the imperatives, they say, is unacceptable because each of the three societal bottom lines is essential to human well-being. However, the attainment of "adequate material standards of living for all people" implies a significant political conflict with the owner-managers of the global economic system. Indeed, given the possibility of ecological and resource limits, there may even be three-way bottom-line conflicts.

It is arguably better, however, in terms of equity or environmental protection to have these complex tensions out in the open than simply to assume the existence of a beneficent economic system, as so many analysts presently do. With Wildavsky, many economists and almost all political conservatives argue that only what seems to be greed begets dynamic growth, and only dynamic growth will lead to adequate social and environmental outcomes. Whether or not this is the case is a matter sufficiently empirical in character that the interrelationship among the ecological, economic (in terms of growth), and social (in terms of broad human well-being) imperatives should be demonstrable through sustainability analysis. Moreover, no reason exists to think that a balanced outcome among the three imperatives could not be achieved were it to be attempted consciously and collectively.

In the end, Robinson and Tinker's principal policy objectives are important for this chapter because they adumbrate the role that sustainability analysis might play in building a results-based sense of common purpose in environmental governance. They advocate "uncoupling economic growth from environmental impact." That is, they seek ways whereby societies can achieve more economy per unit of environmental damage or per unit of energy and virgin raw materials used. In their words, "industrialized countries need to 'dematerialize' the economy by uncoupling human well-being from the throughput of matter and energy in our society." Such a process has been called *eco-efficiency* and is consonant with the basic premise of "industrial ecology."[21] One parallel measure of eco-efficiency, and inefficiency, is the size of a society's (or a city's or an industry's) "ecological footprint." This footprint is essentially a measure of sustainability where all factors are converted to the land area necessary to sustain human activities of a particular sort, or the sum total of activities within a given community or society.[22]

Consequently, Robinson and Tinker call for the development of "policy wedges" or policy tools (for example, changes in taxation) to accelerate gradually the separation of goods and services consumption from energy and materials usage. In their view, the economy gradually might "dematerialize": remain as large or larger in the dollar value of transactions, but become less materials and energy intensive. This dematerialization occurs whenever vehicles or light bulbs become more energy efficient,

communications replace transportation (Internet use replacing trips to the library or bank), or appliances and other goods become lighter and more compact, but equally effective.

Robinson and Tinker identify two policy wedges and two forms of uncoupling as essential to moving toward sustainability as a central animating principle for building a results-based sense of common purpose in environmental governance. As noted, one form is the decoupling of economic output from energy and material throughputs, especially the extraction of raw resources from nature. The other is the partial decoupling of social well-being from GDP per capita (that is, improving quality of life faster than increases in wealth—or getting "more" well-being for the money expended). The former might be achieved through policy wedges such as increased energy taxation or, alternatively, by encouraging sustainable industrial design and process innovation. However, the policy basis for partially decoupling prosperity and well-being is both less obvious and almost certainly more politically controversial. It might be achieved, for example, through improved health services or income distribution, or even through reductions in work time. To many, such shifts may seem value laden and thereby controversial, but they are so only in contrast to the unquestioned assumption of contemporary economic policy that we need only to maximize total short-term prosperity in order for all that might be desired to come to pass.

Some of this potential "political heat" possibly can be converted to social scientific "light" through the use of sustainability indicators and sustainability analysis. This might be particularly true if the transition from social values to policy objectives can be made less value laden through polling and various public participation mechanisms (such as those James Meadowcroft discusses in greater detail in chapter 5). Indeed, in combination, communities themselves might help to select appropriate sustainability indicators.[23] Thus, although one should never underestimate the potential here for controversy, some aspects of well-being and environmental costs across jurisdictions and through time can be measured usefully (and even collaboratively).

Collaborative or not, a more fully developed sustainability analysis methodology holds great promise. It is capable of revealing the extent to which economic growth comes at an environmental price and the extent

to which it leads to improved well-being for society. Perhaps even more important, sustainability analysis can be used to rank societal performances and thereby to challenge governments. It also can be used to identify production (goods and services) mixes and policy patterns that might help to minimize environmental costs and maximize well-being.

The Techniques of Sustainability Analysis: Implementation Lessons from the Field

In contrast to benefit-cost analysis that has the same broad objective, sustainability analysis does *not* attempt to reduce all values to monetary terms. For this reason, it might be called *nondollar economics* or (better yet) *embedded* or *contextual economics*. Regardless of what term is used, technical lessons are emerging already from implementation experiences related to the metrics, methods, and modeling that are necessary before sustainability analysis can become, at least technically, a key component of building a results-based sense of common purpose in environmental governance.

Alex Farrell and Maureen Hart define a *sustainability indicator* as a measure that "provides useful information about a physical, social, or economic system, usually in numerical terms." "Indicators," they go on to say, "can be used to describe the state of the system, to detect changes in it, and to show cause-and-effect relationships."[24] Everyday life is full of such indicators in other areas, from won-lost records in sports to blood pressure, temperature, and barometric pressure in the health and weather fields. Needless to say, economic indicators (including attitudinal indicators such as consumer confidence) are reported widely, understood, and acted upon. The challenge for proponents of sustainability is to make sustainability indicators just as widely understood.

To these ends, the organization *Sustainable Measures* identifies four characteristics of effective indicators that policymakers must ensure: relevance, ease of understanding, reliability and accessibility, and availability in sufficient time that action can be taken. Analogy is made to the gas gauge on a car: it provides the necessary information in a clear and reliable way and in sufficient time to remedy the potential problem. Likewise, during the Clinton administration, the White House Task Force on

Livable Communities offered the following list of what indicators should do: (1) reflect a trend, with a timeline appropriate to the topic; (2) be verifiable and reproducible; (3) be readily understandable; (4) reflect community circumstances and goals, as well as relationships to the region and the nation; (5) be supported by data; and (6) provide information for understanding the relationships among the economic, environmental, and social elements inherent in livable communities.

Overall, prior experience suggests that sustainability indicators should measure and communicate fundamental qualities of human societies, as well as the effects on the natural environment of the full range of their activities. It is crucial, as a consequence, that sustainability indicators be rooted in a larger theory of sustainability. As with outcome measures more generally, they should in the process be accurate, straightforward, powerfully communicative, and, when taken together, comprehensive. Sustainability indicators collectively must capture and convey a set of realities as important to society as are the vital signs (pulse, temperature, breathing rhythm) typically used as indices of human health. Indeed, some analysts see measures of environmental sustainability, the basic inputs and outputs of social economy, as measures of societal metabolism.[25]

In turn, the measures used must be meaningful in the sense that they measure what matters most to policymakers and to citizens. One way to achieve this goal is to involve the public in the process of selecting environmental and social indicators, much as Shelley Metzenbaum describes regarding the ongoing effort to clean up the Charles River in Boston, Massachusetts.[26] Similarly illustrative is how the 1990 Washington Global Tomorrow Conference in Seattle selected a set of forty indicators as bellwethers of sustainability. As Farrell and Hart put it, these indicators reflected "something basic and fundamental to the long-term cultural, economic, environmental, or social health of a community over generations" and were also "accepted by the community; attractive to local media; statistically measurable; and logically or scientifically defensible."[27]

To these ends, sustainability analysts have used different and varied measures as environmental indicators and as measures of well-being.[28] These differences notwithstanding, all of the environmental measures

used to date imply a need for both demand-side and supply-side monitoring and management. Sustainability analyses, in general, thus have included both "input" (for example, energy and resource use) and "output" indicators (most basically, measures of pollutant releases or the degree of degradation of land areas or watercourses). The latter, in turn, tend to measure *unintended* outputs because the conscious goals of economic actors are personal income and wealth as well as general gains in societal income and wealth.

To date, sustainability analysts in a number of European or joint European–U.S. research initiatives have emphasized input variables as measures of environmental sustainability.[29] The most familiar and widely used of these variables has been total material requirement (TMR), essentially a measure that captures total energy and materials use within an economy. The overall efficiency of materials and energy use is then calculated as the ratio of TMR to GDP per capita, or material intensity per unit of "service." Units of service, in turn, are defined as nondollar substantive economic outputs, such as measures of transportation usage (passenger miles or ton miles), adequately lighted space, and calories in food produced. Presently, however, there is no commonly accepted combined measure on the unintended output side of this equation. Different analysts select different pollution indicators, usually on the basis of importance and data availability.

Prior experience suggests that the measures used, their precise nature aside, must operationalize a widely shared model of societal and economic functioning that goes beyond a traditional sense of economics to a more explicitly *contextual* sense. The model portrayed in figure 1.1—a variation on the models developed by Marina Fischer-Kowalski and Helmut Haberl, as well as by Robinson and Tinker—captures in broad strokes the logic of such a contextual perspective. This model portrays the economy as embedded in both the environment and society, and understands it as essentially a means by which to convert resources extracted from the environment into social well-being. In turn, the by-products of the processes comprising the economy are returned to the environment as a "sink."

The model significantly does not assume that economic output necessarily produces societal well-being. Or, put differently, it *does* assume that the efficiency by which this transformation takes place can be highly

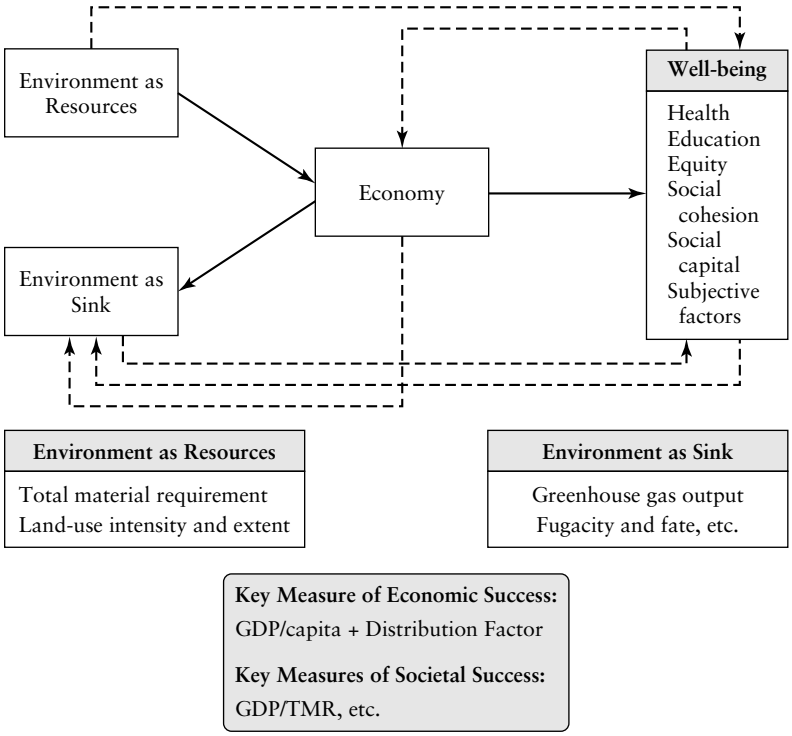

Figure 1.1
A sustainability analysis model.

variable. Especially important, the model implies, is studying the links among economic performance, environmental performance, and social performance in a systematic way. Granted, conditions and outcomes in each of the four boxes can be measured independently in their own terms. Yet the overall task of governance is understood to be three dimensional, rather than one dimensional: to minimize extractions and impositions on the environment as a sink, to maximize well-being, and to improve the efficient conversion of environmental capacities to social well-being. Economic output, as such, is optimized rather than maximized.

The well-being measures indicated in the upper right-hand box can be measured on an individual basis but are essentially based in, a part of, or a result of the effectiveness of social institutions. Conceptualized in this fashion, performance in relation to each of the four aspects of the

embedded economic process can be measured independently. Whereas economic performance is measured traditionally in terms of GDP or GDP per capita, embedded economic performance is measured contextually in terms of the efficiency with which societal benefits are produced or with which environmental capacities are utilized.

Prior experience also suggests that "environment as resources," the upper left-hand box, can be measured in terms of such variables as the TMR or the extent and intensity of land use. TMR may be the best single comprehensive environmental indicator, given the proportion of environmental problems associated with materials and energy extraction (for example, mining, forestry, agriculture, fisheries, and energy production). However, other environment-as-source indicators might include land-use measures such as proportion of land degraded, proportion of all land designated as protected wilderness, rate of prime agricultural land urbanization, or the proportion of net primary production appropriated directly or indirectly for human needs.[30]

The extent of extraction required also has a significantly direct bearing on the impositions on the environment as a sink because extractive economic activities are especially waste intensive. Measures of utilization of the environment as a sink (see the lower right-hand box) are perhaps somewhat less standardized at this point but might include: (1) greenhouse gas emissions (especially carbon dioxide), (2) fugacity and fate measures and models,[31] (3) proportion of flux[32] of anthropogenic origin within basic natural chemical cycles, and (4) equilibrium lipid partitioning for organic pollutants in aquatic ecosystems.[33]

In addition, calculating both source and sink measures relative to GDP is animated by a conviction that improvements *per unit of GDP* should exceed the rate of GDP growth. Otherwise, prior experience suggests that overall environmental quality will not improve. Indeed, many of the sink measures typically taken today exceed acceptable levels. Thus, proposals such as President George W. Bush's alternative to the Kyoto Accords clearly are inadequate because they are premised on environmental gains as a proportion of GDP. *Current* emission levels, after all, are already warming the planet, and a good rate of economic growth would see, at best, overall U.S. emissions frozen at those levels.[34] More broadly, economic measures that incorporate embedded energy and material

throughputs (in effect measuring environmental as well as economic efficiency) are more valid measures of economic and societal success than are more narrow economic measures such as GDP. Measures of a successful embedded economy might incorporate ratios of wealth per capita to TMR, environmental outflows to carrying capacity, and level of well-being relative to per capita GDP.

Sustainability: Challenges, Choices, and Opportunities

The preceding discussion has chronicled the development of sustainability as a concept for building a results-based sense of common purpose in environmental governance and has suggested how and why sustainability analysis might help clarify and advance this concept for policymakers. Still, the question remains whether the triple bottom line that sustainability analysis offers policymakers can ever become a central animating force in their decision making, let alone a tool for building common purpose among disparate interests in the twenty-first century. As Gary Bryner and others in this volume attest, both of these aims are unrealized. Indeed, aside from the technical challenges of its implementation, and implicit in the discussion in the previous section, a formidable set of strategic challenges, choices, and opportunities faces proponents of sustainability analysis in the years ahead. Not the least of these problems involves societies making strategic choices to: (1) seize the opportunity to use sustainability analysis to resolve ongoing policy debates empirically; (2) overcome bureaucratic resistance to information sharing and invest in the technical capacity building necessary to ensure that the information culled from sustainability analyses can inform decision making; (3) create a "race to the top" rather than one to the bottom in setting environmental standards; (4) shift cost structures to capture the true social costs of development; and (5) rein in existing North American propensities toward "cowboy capitalism."

Toward Empirically Informed Dispute Resolution?

Two of the most significant opportunities afforded by sustainability analysis are the promise it holds for clarifying what sustainability means and for resolving long-standing debates over the relationship between economic

development and well-being. Consider, for example, Wildavsky's claim that wealth almost inevitably produces incremental improvements in health. As the upper right-hand box in figure 1.1 indicates, well-being is broader than human health, even though health might be the single most important measure. Nevertheless, comparative assessments of the health aspects of well-being relative to GDP per capita at the national level might help to determine the validity of Wildavsky's claim.

An initial look at this question suggests that the generalization includes many anomalies.[35] Some nations perform better than might be predicted by GDP per capita (for example, Belize, Cuba, and Sri Lanka), and some sharply less well (many Middle Eastern states). Moreover, the United States performs somewhat below expectations, despite having far and away the highest per capita health care expenditures in the world. The best explanation for this performance would seem to be relatively high rates of violent crime, less than universal access to health insurance, and very low incomes within the lowest income quintile (for example, compared to Canada, Japan, and many European nations).[36] Reasons aside, sustainability analysis offers to shed empirical light on this issue.

Relatedly, the comprehensive measures of environmental costs and well-being that sustainability analysis offers provide an opportunity to address another major set of issues that can be resolved only by using cross-national research designs. What is the relationship between a nation's level of economic development, its environmental quality, and its social well-being? How effective are public policies in different nations at converting wealth (as a means) into well-being (as an end)? To what extent and how can increases in GDP per capita be achieved with the least amount of resource demand (source data) and environmental damage (sink data)?

Some analysts, for example, have asserted that environmental damage is associated most strongly with the early and middle stages of economic development. That is, beyond some threshold of economic development, governments likely (almost automatically) will respond to increasing demands for pollution control. In trade policy circles, this tendency has been taken as a reason for concentrating on the possibilities of GDP growth among trading partners (for example, Mexico) rather than on the current effectiveness of their regulatory enforcement.

To be sure, Kenneth Arrow and his associates have responded effectively to these assertions. They argue, "The general proposition that economic growth is good for the environment has been justified by the claim that there exists an empirical relation between per capita income and some measures of environmental quality. It has been observed that as income goes up, there is increasing environmental degradation up to a point, after which environmental quality improves." They counter, however, that "it is important to be clear about the conclusions that can be drawn from these empirical findings. While [these findings] do indicate that economic growth may be associated with improvements in some environmental indicators, they imply neither that economic growth is sufficient to induce environmental improvement in general, nor that the environmental effects of growth can be ignored, nor, indeed, that the Earth's resource base is capable of supporting indefinite economic growth." [37]

Nor do Arrow and his associates deny the possibility of an inverted-U-shaped relationship between economic development and some forms of pollution. In this instance, a rise in early industrial stages might be followed by a stage where pollution is no longer "an acceptable side effect of economic growth." They *do* note, however, that this generalization is based on studies suggesting only that this pattern may hold for nitrous oxides, sulfur dioxide, suspended particulates, carbon monoxide, and basic sanitation (fecal chloroform). Moreover, they note five specific environmental impacts where prior experience suggests that the U-shaped pattern is *not* likely to apply, specifically when: (1) pollutants that have long-term and dispersed costs are involved (such as climate change); (2) accumulation of stocks of waste exist (emissions may tend to decline, but performance on ecological restoration is both less consistent and more expensive); (3) resource stocks are involved, especially soils, forests, and ecosystems (as nations get wealthier, they may reduce resource extraction per dollar of GDP, but none yet has done so absolutely); (4) opportunities for pollution export exist (nations may export as many of their environmental problems as they cure); and (5) environmental costs are borne by the poor, by future generations, or by those outside the jurisdiction within which they arise. Each of these propositions, however, remains controversial and ripe for testing with sustainability analysis.

Finally, the cross-jurisdictional aspect of the fifth proposition suggests that sustainability analyses might address fruitfully certain significant linkages between sustainability and trade policy. As chapter 3 chronicles in greater detail, this matter is highly contentious, at least in part because of the explicitly redistributive nature of the stakes involved. Indeed, redistribution has informed many recent protests in places such as Genoa, Quebec City, and Seattle. Still, time-series and comparative analyses of environmental and sustainability outcomes might clarify whether enhanced global economic integration helps or hinders environmental protection. One might compare, for example, high-trade and low-trade nations to determine if rising trade leads to rising wealth and if and when it also leads to increased environmental costs, to well-being gains, or to both.

Building a Will and a Way?

If taken seriously, sustainability analysis decidedly broadens the comprehensiveness of environmental governance well beyond the historic mandate of environmental and natural resources agencies. As such, it has the potential in the United States, for example, to elevate environmental and sustainability considerations to the level of the Treasury secretary, taxation policy, and the Office of Management and Budget. A useful beginning, however, will require policymakers' conscious choice to step up to this challenge by doing two things that have been the exception rather than the rule historically (as Denise Scheberle discusses in greater detail in chapter 10). First, they must choose to engage in greater coordination between natural-resources and environmental agencies, and, second, they must choose to pursue a wider mandate from legislators for the two types of agencies to act in concert. Ultimately, environmental agencies would play a greater and more institutionalized role in the sustainable demand-side management of scarce resources, especially water and energy, that historically have been handled largely by pro-development agencies.

Without question, a sustainability perspective appears to be critically dependent on the extent to which both information gathering and policies cut across traditional administrative distinctions at the federal government level (for example, among the Departments of Agriculture and the Interior, the Environmental Protection Agency [EPA], and even the various

social agencies in the United States). Nor does this need end at the federal level or even among public agencies. States, localities, and private sectors or firms must make similar choices to cooperate and share information. Because sustainability analysis crosses quickly into the realm of economic analysis and equally quickly to all levels of government and to the private sector, all actors must ask: Are the most rapidly growing economic sectors more or less sustainable than older sectors of the economy? How and why are some firms within a sector more sustainable than others? How and why are some municipalities more or less sustainable than others? Are the key factors that account for these differences readily amenable to policy initiatives (or are they largely derivative of climate or topography)?

Also important is choosing to continue and deepen the shift within the EPA toward encouraging pollution prevention rather than end-of-pipe solutions. Pollution reduction can involve, of course, pollution abatement technologies. As Ken Geiser further elaborates in chapter 12, however, it is also part and parcel of any movement toward dematerialization. Resource extraction as well as energy production and use are responsible for the predominant share of all forms of environmental damage, including pollution. To the extent that policymakers encourage the adaptive modification and continuing reuse of existing buildings and urban infrastructure, for example, they promote dematerialization *and* pollution prevention.

This effort, of course, also would involve a parallel adaptation not only within the whole array of natural resources agencies (including the Department of Agriculture in the United States), but also within all other domestic and international agencies that affect development decisions. Historic and present practices have served as fundamental organizational, interorganizational, and cross-sectoral barriers to sustainability. Yet for the concept of sustainability to reach its full potential, U.S. departments such as Transportation and Housing and Urban Development will have to play a larger and unaccustomed role in resource management on both the supply and the demand side. Because the editors and other authors of this volume discuss these obstacles to organizational change in greater detail, it suffices here to note that the task of reframing administrative and political mindsets in this fashion is likely to be a long and arduous one.

Creating a Race to the Top?

Choosing to pursue sustainability initiatives in North America is vitally important to advancing sustainability in the world as a whole, most obviously because North Americans consume so much more of everything, especially on a per capita basis. Consumption patterns presently show that although North Americans constitute some 5 percent of the world's population, they are responsible for nearly 50 percent of its consumption. Indeed, some analysts plausibly assert that humans would require the resources of several Earths if the world as a whole lived a North American "lifestyle."[38] Perhaps just as important, however, is the potential for change inherent in this otherwise negative North American dominance in consumption in a global economy. More precisely, if North Americans (as well as the nations of the Organization for Economic Cooperation and Development [OECD]) choose to make sustainability a key component of international trade, they may create a positive "California effect" worldwide (like that *within* the United States, as described by Denise Scheberle in chapter 10).

According to David Vogel, the California effect arises whenever consuming jurisdictions adopt environmental standards that are significantly more stringent than the average standards within a trading region.[39] The effect, some claim, may be the opposite of a "race to the bottom" in terms of environmental standards (wherein jurisdictions seek to attract industries by *lowering* their environmental standards). In California's case, stringent air pollution standards for automobile emissions induced the redesign of automobiles. Moreover, they did so not only in all of North America, but even in jurisdictions worldwide, where the national standards for vehicle production were significantly less stringent than in the United States. Nearly everyone who produces automobiles, after all, wants to sell them in California, a state with a large market of wealthy consumers prone to use automobiles rather than public transportation.

Certain options short of choosing systematically to establish and enforce global environmental standards might expand the California effect worldwide. More precisely, policymakers might pursue an OECD-led initiative to set environmental (and perhaps social) minima for industries that produce primarily for export into OECD or other jurisdictions. Indeed, such an initiative might be effective were it applied *only* to

OECD-based firms and their suppliers, as Durant with Boodphetcharat's discussion of the impact of European Union regulations on the genetically modified food industry attests. Disallowed, thereby, would be competition between "our" firms on the basis of lesser environmental standards and intolerably low well-being outcomes for developing nations compared to "our own" or both.

Relatedly, opportunities to trade with North America or Europe or to become a full participant in the World Trade Organization (WTO) also might be available only to nations and corporations that meet tougher standards and who require that their suppliers meet certain standards of behavior. Lest a gigantic bureaucracy be created, such licenses need be reviewed only infrequently. Nevertheless, firms might be held to improving sustainability performance through whatever time period is chosen. In this way, the number of mandatory aspects of sustainability could be few (again to restrain the natural tendency to swell bureaucracies), but in each case significant. One aspect of such a regime might be rating the environmental performance of a nation in terms of existing international treaties, such as protection of biodiversity, climate change, and emissions of persistent organic pollutants.

In the present political climate, particularly in the United States, such a proposal might appear outlandish. It should be clear by now, however, that without linking environmental agreements to trade, they are often little more than a pretense. At the very least, sustainability analysis may show that trade policy and environmental policy should not be conceived as wholly detached administrative realms.

In this effort, one must distinguish such an approach to public policy from the increasingly widespread global movement to reject trade regimes (and global economic integration) altogether. The initiative offered here is a political middle ground between the unabated, unapologetic export of pollution and the rejection of the systematic expansion of global trade and global trade regimes. It asserts instead a limit to the export of environmental problems and a recognition that a global economy carries implications for all aspects of public policy within all nations.

Shifting Underlying Cost Structures?

Advancing sustainability as a central animating premise of environmental governance also would seem to require a fundamental and worldwide

shift in natural resource costing structures. To be sure, consciously choosing this route flies in the face of both recent economic history and North American political culture, not to mention very powerful economic interests. But how else might societies accelerate the dematerialization of the economy, slowing growth in both source and sink environmental impacts while still achieving economic growth? Without detailed economic planning, which in all likelihood would fail abysmally, significant adjustments are difficult to imagine on the "source" side without a fundamental change in the price regime. This change, in turn, is difficult to imagine without a choice to change tax regimes fundamentally (albeit gradually) from income and property taxes to energy and raw materials taxes.[40]

Granted, a choice to use regulation as a policy tool might work within a limited range of sustainability objectives (such as fleet-average fuel efficiency standards or appliance efficiency standards). However, the myriad of shifts necessary to achieve sustainability—from product design to personal habits—requires changes in underlying cost structures. Moreover, for the necessary changes to occur in a nondisruptive manner, they must occur gradually. We design cities (and suburbs) now that will set transportation patterns for much of the twenty-first century. Energy costs in 2050 almost certainly will be very different, but the energy, materials, and environmental costs of altering, if not rebuilding, infrastructure and buildings will be no easier to meet than they are at present. It is arguably better to anticipate as best as possible the likely material conditions of the future through sustainability analysis and act gradually to shift cost structures for them with sustainability in mind.

Formidable obstacles stand in the way of policymakers making choices to shift the underlying cost structure of natural resources in this way. Natural resources agencies historically and currently have interpreted their mandates as maximizing, or at least optimizing, "resource outputs." To this end, they have engaged in all manner of direct and indirect production subsidies. Some of the cultural reasons for this approach are discussed in the concluding section of this chapter. The triumph of Pinchot's "gospel of efficiency" over preservation finally may have had its day, however. The negative externalities afforded, for example, by vast increases in the North American population, economic output, and personal consumption are known and lamented widely. And with this

recognition has grown a politically active, influential, and networked postmaterialist movement concerned about the negative environmental consequences that these increases produce. If public subsidies exist, postmaterialists aver, they should favor end-use efficiency for key commodities such as energy, water, and nonmotorized travel (cycling and walking) or public transit. Consequently, a significant political opportunity may exist now for proponents of sustainability-based revisions in cost structures to advance their cause.[41]

Getting Beyond Cowboy Economics in a Globalizing Economy?

Meeting the sustainability challenge on a global scale means fundamentally that policymakers must choose to embrace the idea that certain energy, material, and land restraints to growth are not adequately taken into account today. Recognizing these constraints does not imply necessarily choices to limit overall economic growth. Indeed, *limit* and *restraint* may be the wrong terms here: it is better perhaps to speak of a growing need for energy-, materials-, and land-use efficiency. In the long term, sustainability is preferable not only socially and environmentally, but economically as well.

Attending to sustainability in this fashion, however, means challenging consistently the global economy and the subglobal economies and corporations within it to better their performance. This improvement must occur environmentally, socially, and economically. In an era of global economic integration, policymakers increasingly must choose to conceptualize their public policies on a global scale. Policies need not apply exactly equally to every nation or class of nations, but many of them must be adopted at the level of, and somehow enforced within, the global economic system.

The rub, of course, is that although sustainability *has* entered North American discourse, it is a very long way from being taken seriously at the political, policy, or administrative levels. The reasons for this neglect are to a considerable extent cultural. They thus represent a major challenge to those advocating sustainability as a central animating principle for building a results-based sense of common purpose in environmental governance. To be sure, economic interests (especially within the resource sector) also would be challenged were sustainability to be taken seriously.

But it is the cultural context that keeps North Americans from dealing with resources in terms of demand restraint (efficiency) rather than in terms of supply enhancement and "multiple use." The very limited effectiveness of the President's Council on Sustainable Development during the Clinton administration and its profound eclipse today indicate the level of challenge that lies ahead in the United States.[42]

The key cultural factors that have contributed historically to the inability of the United States to take sustainability seriously are fourfold: (1) the nation's frontier mentality; (2) its abiding faith in technological innovation; (3) its citizens' predisposition toward individualism and presumption against planning; and (4) the American Dream, understood in material terms as "getting rich." Some of the implications of the frontier for North American society and politics were identified and detailed in the mid-twentieth century by Frederick Turner and Louis Hartz, among others.[43] It suffices to note here that the frontier was an "escape valve" in the nation's culturally formative years, allowing waves of immigrants to seek their livelihoods and fortunes unbridled by competition for scarce resources in overcrowded and opportunity-deficient cities in the industrial East.

Much later Kenneth Boulding spoke of "cowboy" and "spaceship" economies resulting from this mentality. Indeed, even today, North Americans imagine wide-open spaces and vast tracts of "unsettled" and "undeveloped" land, especially in the West. This image occurs despite the fact that California and much of the mountain West have been overpopulated for decades, especially relative to sustainable supplies of water. As David Roodman argues, this lingering "frontier" perspective has led to a political and administrative unwillingness to rethink no-longer-warranted public subsidies to resource extraction.[44]

Inventiveness and innovation have been watchwords of the North American ethos for centuries and have served the nation well. Thomas Edison, Henry Ford, and the pioneers of the computer age, for example, rightly and widely are revered. These individuals and countless others have analyzed human needs and found new ways to meet them. As a consequence, however, U.S. citizens routinely presume that whatever needs might arise in the future similarly will be satisfied by innovation and technology. Indeed, such an article of faith is this that North

Americans travel only 0.3 of their passenger miles on fuel-efficient trains—despite the obvious limits of nuclear energy, the perils of Middle Eastern politics, and the imminent peaking of conventional oil supplies. Moreover, until very recently we have all but celebrated urban sprawl, and many still make possession of sport utility vehicles a middle-class suburban norm.

As Ken Burns, the noted producer of documentaries, was so right to assert, jazz music is quintessentially American music: it is inventive; it is individualistic; and it is unplanned. Jazz solos spring brilliantly from their creators' minds; they are unscripted. Similarly, Americans notoriously are disinclined to governmental "interference" except under the direst of circumstances. Detailed materials' inventories and calculations of GDP per ton of TMR might well strike captains of industry and assembly-line workers alike as pointless undertakings, if not akin to Soviet-style five-year plans. Many in the business community might argue, "If we can pay for it, we should be able to get it." They relatedly might argue that the (one-dimensional) balance sheet should define all limits and that governments should "stick to their business." Their plea, essentially, might be to let corporations handle problems spontaneously and creatively (as and when they arise), employing for redress the hard work and creative energy that the free market allows and requires.

Finally, the American Dream is in part about getting rich—or, rather, about hoping to get rich. A thousand enterprises are launched in that hope, despite a wide awareness that only a very few produce significant wealth. Consider, for example, how athletes spend endless hours playing basketball, knowing that only one in a million who play the game will be recruited into the National Basketball Association. The dream is, at once, about individual opportunity, crass materialism, and, as F. Scott Fitzgerald saw it in the 1920s, a redirection of the American frontier from the West toward the "green light" of wealth, east or west. Sustainability, in its recognition of the ultimate reality of resource limits, may well seem to challenge this deeply held, albeit improbable and possibly illusory hope of future comfort, prosperity, and wealth for all.

On the face of it, then, the United States is, in its own mind, still the land of Horatio Alger and accordingly an unlikely place for sustainability aspirations to take hold. They certainly would not have been a part of the

mindset at Enron and other recent corporate failures. However, as Jan Mazurek points out in chapter 13 in this volume, many in the business community *are,* for various reasons, embracing environmental management systems. Likewise, as DeWitt John, James Meadowcroft, and other authors in the volume suggest, there *are* conditions under which public-private partnerships emerge at the grassroots to address environmental issues. At the same time, and as noted earlier in my discussion of postmaterialist values in American society, increasing numbers of Americans understand that their aspirations can be fulfilled in nonmaterial ways.

North Americans also must come to see that although free markets cannot be managed in detail, the inventiveness they allow and inspire perhaps can be harnessed to serve wider collective purposes. Indeed, Daniel Fiorino's chapter suggests a variety of ways that this already is occurring. Again, however, attaining sustainability requires both citizens and policymakers to make new and enduring fundamental choices. Merely producing sustainability analyses will not assure that they will change policymakers' behavior. For this change to occur, citizens and policymakers alike must understand more fully the ways in which nature is limited and thus how both the global economy and *our* particular economy are increasingly vulnerable in economic terms to the absence of effective sustainability initiatives.

In sum, environmental limits, in terms of both sources and sinks, imply choices that optimize the efficient creation of societal and personal well-being. Markets are not, in fact, "free" from nature because economies are embedded *in* nature. Moreover, markets are not ends in themselves, but tools at the service of human well-being—one of the greatest tools that human ingenuity has devised (with the possible exception of democratic governance). Humanity chose to invent markets. Similarly, it can opt to put them fully to use in service to collective social purposes, not to what some imagine are the "purposes" of the markets themselves. By means of democratic institutions and with the help of the social sciences, societies *can* choose to determine the mix of expenditure allocations that will maximize well-being outcomes. Policymakers also *can* determine, with the help of the natural sciences, source and sink limits and accelerate market-based sustainability initiatives through a small number of specific price, tax, and regulatory interventions.

In the end, sustainability is about choosing to see limits and purposes, while having the courage to view governance as a means for firmly and flexibly embedding our economy and society within that context. To date, as the editors suggest in their introduction, progress along this line and in other aspects of the reformers' agenda to build a results-based sense of common purpose has been halting, halfway, and patchworked. Unless both citizens and policymakers meet the challenges, make the choices, and seize the opportunities identified in this chapter, progress toward sustainable development will remain equally frustrated in the future.

Notes

1. John Elkington, *Cannibals with Forks: The Triple Bottom Line of 21st Century Business* (Stony Creek, Conn.: New Society, 1998). See also the excellent early discussion of sustainability analysis in B. J. Brown, M. E. Hanson, D. M. Livermore, and R. W. Meredith Jr., "Global Sustainability: Toward Definition," *Environmental Management* 11 (November 1987): 713–719, and the follow-up article by the same authors, "Global Sustainability," *Environmental Management* 12 (March 1988): 133–143.

2. Amartya Sen, *Development as Freedom* (New York: Random House, 1999).

3. W. Stanley Jevons, *The Coal Question* (New York: Augustus M. Kelley, 1965 reissue), p. 271.

4. Fairfield Osborn, *The Limits of the Earth* (Boston: Little, Brown, 1953), p. 226.

5. Samuel H. Ordway, *Resources and the American Dream* (New York: Ronald Press, 1953), p. 31.

6. Fairfield Osborn, *Our Plundered Planet* (Boston: Little, Brown, 1948), p. 201.

7. Ordway, *Resources and the American Dream,* p. 39.

8. "Automobiles" were becoming more fuel efficient, but only because sport utility vehicles (SUVs) were defined as trucks for purposes of calculating the fleet-average fuel efficiency of North American output, an ever-increasing proportion of which has been pickup trucks and SUVs.

9. Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens III, *The Limits to Growth* (New York: Universe Books, 1972); World Commission on Environment and Development, *Our Common Future* (New York: Oxford University Press, 1987).

10. H. S. D. Cole, *Thinking about the Future* (London: Chatto and Windus, 1973), p. 5.

11. Mihajlo Mesarovic and Eduard Pestel, *Mankind at the Turning Point* (New York: Dutton, 1974), p. ix.

12. Science Council of Canada, *Canada as a Conserver Society* (Ottawa: Government of Canada, 1976), p. 14.

13. For a discussion of social metabolism, see Marina Fischer-Kowalski and Helmut Haberl, "Society's Metabolism," *Journal of Industrial Ecology* 2 (1 and 4): 61–78, 107–136.

14. Aaron Wildavsky, *Searching for Safety* (New Brunswick: Transaction, 1988).

15. Michael Carley and Philippe Spapens, *Sharing the World* (London: Earthscan, 1998).

16. Robert Paehlke, "Cycles of Closure in Environmental Politics and Policy," in Ben Minteer and Robert Pepperman Taylor, eds., *Democracy and the Claims of Nature,* 279–299 (Lanham, Md.: Rowman and Littlefield, 2002).

17. John Robinson and Jon Tinker, "Reconciling Ecological, Economic, and Social Imperatives: A New Conceptual Framework," in Ted Schrecker, ed., *Surviving Globalism: The Social and Environmental Challenges,* 71–94 (London: Macmillan, 1997).

18. Ibid., p. 73.

19. Ibid., p. 74, emphasis in original.

20. Ibid., p. 77.

21. Ibid., p. 80.

22. Mathis Wackernagel and William Rees, *Our Ecological Footprint* (Gabriola Island, British Columbia: New Society, 1996).

23. Alex Farrell and Maureen Hart, "What Does Sustainability Really Mean? The Search for Useful Indicators," *Environment* 40 (November 1998): 4–9, 26–31.

24. Ibid., p. 7.

25. Marina Fischer-Kowalski and Helmut Haberl, "Sustainable Development: Socio-economic Metabolism and Colonization of Nature," *International Social Science Journal* 158 (1998): 573–587.

26. Shelley H. Metzenbaum, "Measurement That Matters: Cleaning Up the Charles River," in Donald F. Kettl, ed., *Environmental Governance: A Report on the Next Generation of Environmental Policy,* 58–117 (Washington, D.C.: Brookings Institution Press, 2002).

27. Farrell and Hart, "What Does Sustainability Really Mean?" p. 28.

28. See Robert Paehlke, "Methods for Sustainability Analysis: Environmental Indicators," in Gertrude Hirsch Hadorn, ed., *Unity of Knowledge in Transdisciplinary Research for Sustainability, Encyclopedia of Life Support Systems,* 6.49.23, available at www.eolss.net.

29. See the studies cited in Carley and Spapens, *Sharing the World,* pp. 192–193; Ernst von Weizsäcker, Amory B. Lovins, and L. Hunter Lovins, *Factor Four: Doubling Wealth, Halving Resource Use* (London: Earthscan, 1998).

30. Helmut Haberl, "Human Appropriation of Net Primary Production as an Environmental Indicator: Implications for Sustainable Development," *Ambio* 26 (May 1997): 143–146. Proportion of land degraded is recommended as an indicator in Robert Prescott-Allen, *The Barometer of Sustainability* (Gland, Switzerland: IUCN website, 2001).

31. *Fate,* in this sense, is chemical behavior in the environment in terms of concentration, reactivity, and location in and movement between air, water, sediment, soils, and biota. *Fugacity* mathematically describes the rate at which chemicals diffuse, or are transported between, phases (as, for example, volatility from soil to air). Regarding the latter, see Donald Mackay, *Multimedia Environmental Models: The Fugacity Approach* (Boca Raton, Fla.: Lewis, 2001), p. 2 and elsewhere.

32. *Flux* is the transfer of material into or out of reservoirs; in total, all flux regarding a specific material is a *cycle* (such as the nitrogen cycle). These changes often are crucial environmentally, as with the flux of carbon from a solid state in biota or soil or coal to a gaseous state in the atmosphere, which underlies climate change. See, for example, James I. Drever, *The Geochemistry of Natural Waters* (Upper Saddle River, N.J.: Prentice Hall, 1997).

33. Equilibrium lipid partitioning has been proposed as a possible ecosystemwide (all media) synoptic indicator of trends in contaminant status. See Eva Webster, Donald Mackay, and Kang Qiang, "Equilibrium Lipid Partitioning Concentrations as a Multi-media Synoptic Indicator of Contamination Levels and Trends in Aquatic Ecosystems," *Journal of Great Lakes Research* 25(2) (1999): 318–329.

34. On this point, see the discussion in Paehlke, "Methods for Sustainability Analysis," and in Farrell and Hart, "What Does Sustainability Really Mean?" regarding critical limit and competing objective views of sustainability.

35. See Aaron Wildavsky, "The Secret of Safety Lies in Danger," *Society* 27 (November–December 1989): 4–5.

36. The tentative conclusions associated with these United Nations Development Program data are discussed more comprehensively in Robert Paehlke, *Democracy's Dilemma* (Cambridge, Mass.: MIT Press, 2003).

37. Kenneth Arrow, Bert Bolin, Robert Costanza, Partha Dasgupta, Carl Folke, C. S. Holling, Bengt-Owe Jansson, Simon Levin, Karl Göran Mäler, Charles Perrings, and David Pimental, "Economic Growth, Carrying Capacity, and the Environment," *Science* 268 (April 28, 1995): 20–21.

38. Wackernagel and Rees, *Our Ecological Footprint*.

39. David Vogel, *Trading Up: Consumer and Environmental Regulation in a Global Economy* (Cambridge, Mass.: Harvard University Press, 1995).

40. See, for example, Timothy O'Riordan, ed., *Ecotaxation* (London: Earthscan, 1997); Alan Thein Durning and Yoram Bauman, *Tax Shift* (Seattle: Northwest Environment Watch, 1998).

41. Samuel P. Hays, *Conservation and the Gospel of Efficiency* (Cambridge, Mass.: Harvard University Press, 1959).

42. The President's Council on Sustainable Development was an important initiative, but it saw little, if anything, through to legislation or policy implementation. Nonetheless, or indeed for this very reason, an analytic history of this organization should be written.

43. Frederick Jackson Turner, *The Frontier in American History* (New York: Holt, Rinehart and Winston, 1962); Louis Hartz, *The Liberal Tradition in America* (New York: Harcourt, Brace, 1955); Louis Hartz, *The Founding of New Societies* (New York: Harcourt, Brace and World, 1964).

44. Kenneth E. Boulding, "The Economics of the Coming Spaceship Earth," in Herman E. Daly, ed., *Toward a Steady-State Economy,* 121–132 (San Francisco: W. H. Freeman, 1973); David Malin Roodman, *Paying the Piper: Subsidies, Politics, and the Environment* (Washington, D.C.: Worldwatch Institute, 1996).