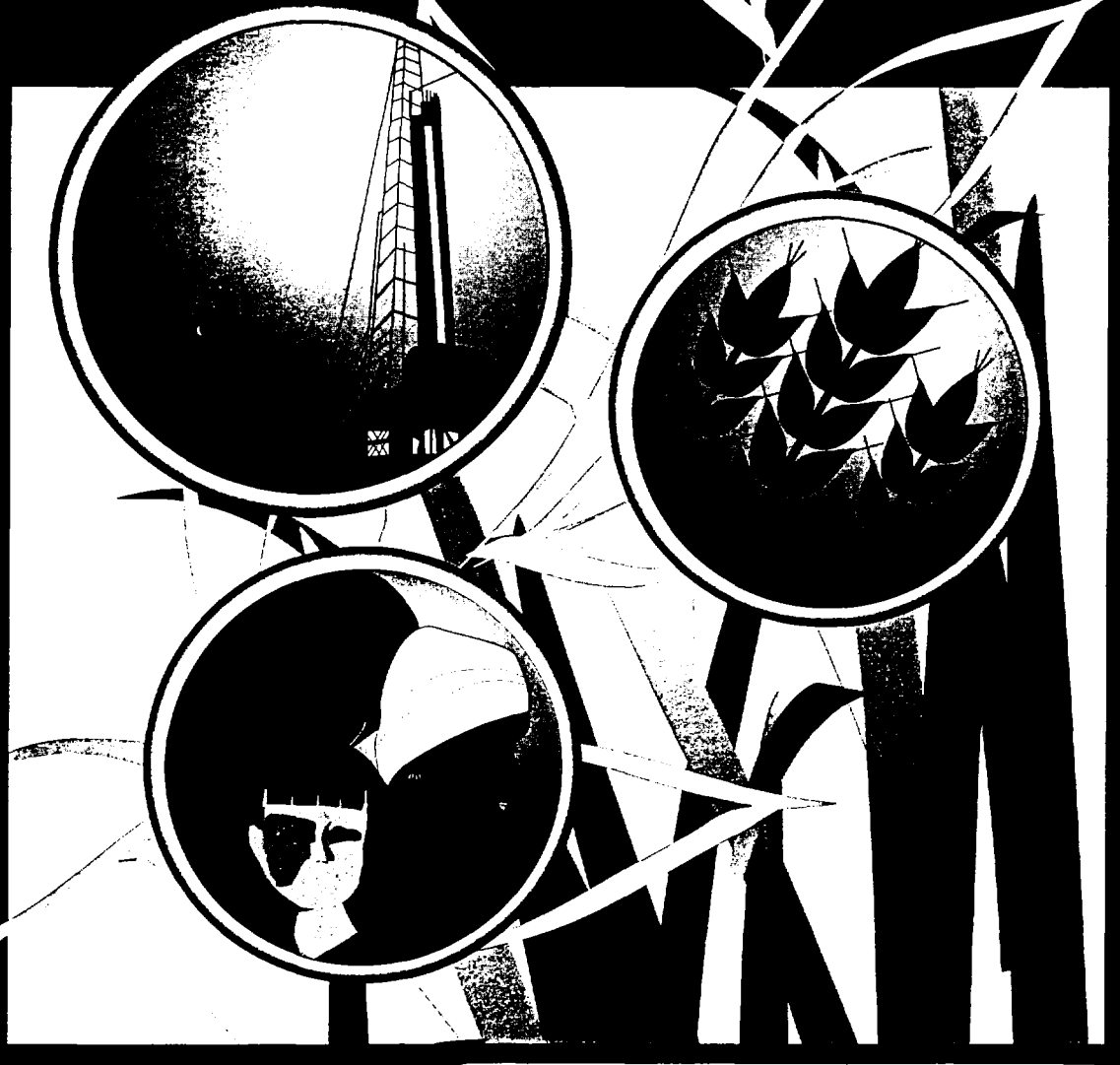
Sustainability and the Wealth of Nations

First Steps in an Ongoing Journey

Ismail Serageldin



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Ismail Serageldin is vice president for Environmentally Sustainable Development at the World Bank.

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Preface

This monograph presents current thinking at the World Bank concerning sustainability and the wealth of nations. It references work appearing in the World Bank's *Monitoring Environmental Progress: A Report on Work in Progress*, published in the fall of 1995, and in related technical papers, including "Global Approach to Environmental Analyses." Thus profound gratitude is due to the authors of that body of work, namely John O'Connor, Kirk Hamilton, Claudia Sadoff, David Cassells, Andrew Bond, Christiaan Grootaert, and John Kellenberg, under the general direction of Andrew Steer and myself. An earlier draft of this monograph was distributed at the Third Annual World Bank Conference on Environmentally Sustainable Development in October 1995 as a more accessible and focused statement of the key ideas and findings in *Monitoring Environmental Progress* and "Global Approach to Environmental Analyses." Finally, this monograph benefited from the inputs of John Dixon, John O'Connor, and Jan Bakkes. My thanks to them and to Andrew Steer. Any shortcomings are purely my own.

Ismail Serageldin
Vice President
Environmentally Sustainable Development
The World Bank

Sustainability and the Wealth of Nations

The following thoughts are advanced as reflections about the kind of conceptual framework that could unite the ongoing efforts of many people at the World Bank and elsewhere[1] to make the concept of sustainability more operational.[2]

Introduction

The material presented here draws on many works. These are partly driven by some conceptual ideas sketched out by myself, Andrew Steer, and others, especially where the idea of sustainability as opportunity is concerned.[3] On the more technical matters pertaining to indicators, measurement, valuation, and the estimates of the wealth of nations, the material draws heavily on work in progress published by the World Bank in *Monitoring Environmental Progress: A Report on Work in Progress*, a publication conceived by Andrew Steer and realized under his direction. A team led by John O'Connor prepared the first edition, which was released as part of the 1995 Third Annual World Bank Conference on Environmentally Sustainable Development.[4] In turn, this document is only part of a broader initiative by international agencies, academics, businesses, and nongovernmental organizations to improve indicators of environmentally sustainable development.[5]

I see exciting opportunities in this field for decisionmaking not only at national and international levels but also in communities, businesses, and households. Because these "lower" levels make so many of the key decisions, it seems particularly important to devise analytical tools that may promote dialogue among these different levels of decisionmakers. However, I am keenly aware that many nonexperts on all levels feel that the discussion of indicators is beyond their grasp or, worse, irrelevant to their decisions. This paper is designed for that audience. It is a personal, nontechnical account of how I see the pieces of the puzzle coming together and of which pieces I think are still missing.

To anticipate the nagging problem that thoughtful readers may have: clearly many of the questions raised in trying to estimate national wealth will not be answered in the near future. Some, such as trying to quantify social capital, seem inherently difficult to accept.[6] Many of the questions raise important conceptual, methodological, and measurement issues and appear to imply incursions into the realm of value judgments.

To these concerns I would point out that *human capital* is now in the mainstream, based on a generation of intellectual investment.[7] We still do not know the exchange rate of human and man-made capital,[8] but we do not find it an impossible obstacle to argue that governments should increase their investments in education, for example, as opposed to adding man-made infrastructure. Likewise, the imperfections of measurement should not prevent us from mak-

ing a series of partial steps that improve our approximation of reality in our analyses. For example, in trying to assess the contribution of public administration to the national income, we have set it, by convention, as equal to the cost of its inputs (for example, the wage bill). If we did not recognize its limitations, this accounting agreement would lead us to the absurd conclusions that we could double the product and the productivity of workers without investing in training or equipment simply by doubling their wages. Nobody makes such arguments, and the limitations do not prevent us from using the approximation in our national income accounts.

This is very much the logic behind these reflections, which should help us move in the direction of defining sustainability more rigorously and of gradually taking it more into account in every aspect of public policy without asking that we necessarily have impeccable answers to everything before we take the first step. So please accept this willingness to proceed with imperfect answers to important questions to see if the results are still likely to be informative.

On Defining Sustainability

There have been many definitions of sustainable development,[9] but the generally accepted definition of sustainability is that given by the Brundtland Commission:

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[10]

This definition is philosophically attractive but raises difficult operational questions. The meaning of *needs* is fairly clear for the poor and the starving, but what does it mean for a family that already has two cars, three televisions, and two VCRs? Yet it is precisely the second type of family that will consume more than 80 percent of the world's income this year.

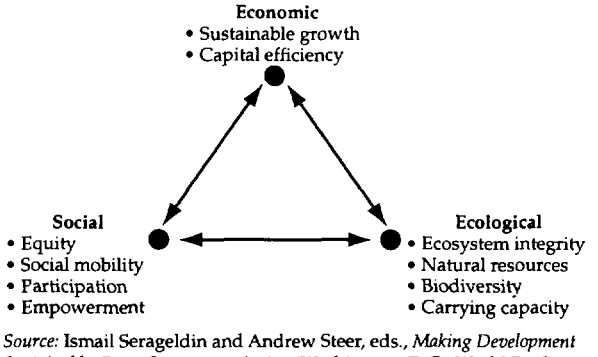
To develop an operational definition, the World Bank has approached it in two steps: first, an immediate approach that enabled us to set in place a systematic way of testing the economic, environmental, and social sustainability of a specific proposal; and second, a more ambitious effort at tackling the concept of sustainability. The first approach, frequently referred to as *the triangle*, is well in place at the World Bank and is increasingly recognized as valuable within and outside the World Bank.[11] It has been well presented in our booklet, *Making Development Sustainable: From Concepts to Action*.[12]

The second approach, still being developed at this time, is the one this essay tries to elucidate. I would refer to it as "sustainability as opportunity" or, in the more conventional language of the economics profession, "expanding the capital stock." This was the title under which it was prefigured in the epilogue to *Concepts to Action*. It has also been presented elsewhere.[13] It is just starting to take shape through work launched in a more collaborative international fashion, work in which we have joined with many other concerned institutions in seeking to lay the groundwork for a meaningful, internationally agreed framework to deal with sustainability questions. A word about each of those two approaches is pertinent here.

A Triangular Framework

As a first step we at the World Bank defined the idea of environmentally sustainable development (ESD) by a triangular framework. We require any technical proposal that we will fund to be sustainable in *economic*, *environmental*, and *social* terms. This idea finds its expression in a triangle, which not by coincidence is also the logo for the ESD vice presidency (figure 1).

Figure 1. ESD triangle

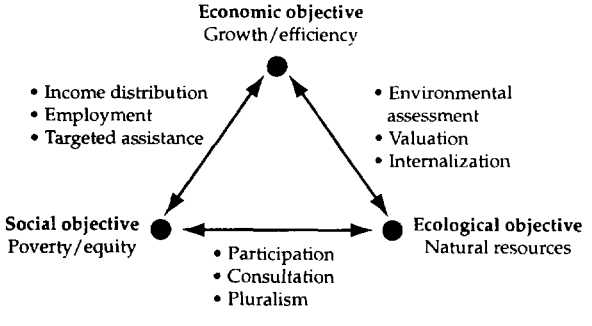


Source: Ismail Serageldin and Andrew Steer, eds., *Making Development Sustainable: From Concepts to Action* (Washington, D.C.: World Bank, 1994), 2.

A proposal has to be economically and financially sustainable in terms of growth, capital maintenance, and efficient use of resources and investments. But it also has to be ecologically sustainable, and here we mean ecosystem integrity, carrying capacity, and conservation of natural resources, including biodiversity. Ecological sustainability is the domain of the biologist and the physical scientist. The units of measurement are different, the constructs are different, and the context and time scale are different. However, equally important is the social side, and here we mean equity, social mobility, social cohesion, participation, empowerment, cultural identity, and institutional development. The social dimension is the domain of the sociologist, the anthropologist, and the political scientist. It is, to my mind, an essential part of the definition of sustainability, because the neglect of the social dimension leads to institutions that are incapable of responding to the needs of society. We see the consequences of that in tragedies from Rwanda to Somalia and from Bosnia to Liberia.

The World Bank is best known as an economic institution; therefore, many of our staff bring an economic outlook to noneconomic issues (figure 2). Here it is important to highlight the limitations of such an approach and to give the noneconomic disciplines their due. If we look at the same triangle, now with the eyes of the economist, we would reduce the economic objective to growth and efficiency, the ecological objective to natural resource management, and the social objective to reduction of poverty (in terms of some number of people below a poverty line) and equity (in terms of income distribution). Such a reductionist view still poses problems. On the link between the economic and social objectives lie some of the most controversial parts of current economic policy: targeted interventions, income distribution, employment generation, and subsidies. On the economic and ecological link lies some of the most recent, cutting-edge work being done on environmental assessment, valuation of natural resources, internalization of externalities, time and discount rates, uncertainty and risk, and national income accounts.

Figure 2. ESD triangle from an economic viewpoint



Source: Serageldin and Steer, *Making Development Sustainable*, 2.

Of the many aspects of economic measurement that we are struggling with, I must emphasize national income accounts because they have been at the center of many international discussions, with the World Bank actively exploring ways of improving them. They are important, but they are only one measurement of reality—and a fairly faulty one. As they now stand, national income accounts give no value to a forest as an existing asset. If cut down, that forest should show up as a reduction in assets. Perversely, however, only if it does get cut down does it contribute to national income accounts—and positively at that! But we at the World Bank, with colleagues elsewhere, have made a significant effort to try to introduce environmentally adjusted national income accounts.[14]

Sustainability as Opportunity

This interim approach based on the triangular framework is being superseded by a much more attractive concept: sustainability as opportunity. From this concept sustainability would be defined in the following way:

> Sustainability is to leave future generations as many opportunities as we ourselves have had, if not more.

How does one measure opportunity? In economic terms one could use the concept of capital. In economics and finance one does not deplete one's capital and consider it an income stream. In fact, it goes to the heart of the definition of income given by Nobel Laureate Sir John Hicks (1946) when he defined income as "the maximum value a person can consume during a week, and still expect to be as well off at the end

of the week as at the beginning." Income based on depletion of capital is not sustainable and should not be accepted as income. But capital and the growth of capital are the means to provide future generations with as many opportunities as, if not more than, we have had, provided that we define it as per capita capital. This takes into account the need to meet the needs of a growing population that is likely to add some 3–5 billion people before the global population stabilizes.

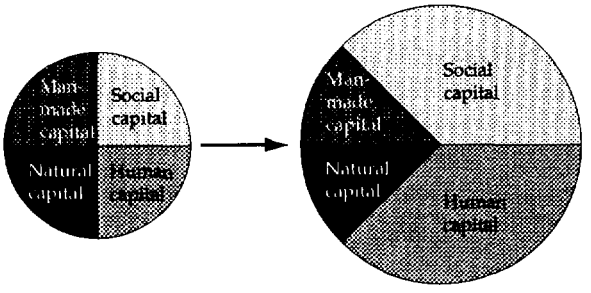
In finance the concept of the inviolability of capital has been recognized by the use of capital and current accounts and by special provisions for computing and factoring in depreciation in the operations of a firm. Methods vary, but well-established conventions exist for dealing with these issues. Sound accounting practices require that we recognize and identify the methods used for calculating depreciation in presenting the financial statements of an enterprise.

If sustainable development is about leaving future generations more capital per capita than we have had, then the rate of *genuine saving* (a term that we will define more accurately later on) becomes a good *measure of whether our aggregate activities are on a sustainable path.*

To get to the heart of the concept of sustainability, we must expand these understandings to include more than man-made capital as conventionally defined and accepted in the economic literature, to include other forms of capital that are every bit as important to our individual and collective well-being.[15] So let us first define the different kinds of capital that must be taken into account for an intellectually satisfying view of sustainability that also holds the promise of operationability in the near future.

Sustainability as opportunity therefore translates into providing future generations with as much capital per capita than we ourselves have had, if not more. But here we are speaking of four kinds of capital that are partially substitutes and partially complements (figure 3). We accept that the composition of the capital we leave the next generation will be different (in terms of its four constituent parts) than the capital we have used in our generation. Yet we must recognize the limits of substitution, because it is impossible to conceive of any type of activity if any of

Figure 3. Sustainability as increasing per capita capital stock (four kinds of capital)



Source: Author's illustration.

the four kinds of capital is driven to zero. Let us therefore look more closely at the four kinds of capital.

Four Kinds of Capital

We recognize that there are at least four kinds of capital: *man-made* (the one usually considered in financial and economic accounts), *natural capital* (as discussed in many works of environmental economics),[16] *human capital* (investments in education, health, and nutrition of individuals), and *social capital* (the institutional and cultural basis for a society to function). Because *man-made capital* has received a vast amount of study, let us give a brief word about the three other kinds.

Natural Capital

Natural capital is basically our natural endowment and is defined as the stock of environmentally provided assets (such as soil, atmosphere, forests, water, wetlands) that provide a flow of useful goods or services. The flow of useful goods and services from natural capital can be renewable or nonrenewable and marketed or nonmarketed. Sustainability means maintaining environmental assets, or at least not depleting them beyond some limits (as is discussed below). Any consumption that is based on the depletion of natural capital should not be counted as income. It must be accounted for as a reduction of natural capital. Unfortunately, most economic analysis today does not make such adjustments and tends to treat consumption of natural capital as income. Unless such adjustments are introduced, there is continuing risk that such analyses

could promote patterns of economic activity that are inherently unsustainable.

Natural capital is distinguished from other forms of capital, namely human capital (people, their education, their health and capacity levels), social capital (institutions, cultural cohesion, collective information, knowledge), and man-made capital (houses, roads, factories, ships). Natural capital is used in combination with other types of capital in any production process.

Until fairly recently natural capital was seldom accounted for, and the focus was on man-made capital. Investments were made in the limiting factor, such as sawmills and fishing boats, because their natural capital complements, forests and fish, were abundant.[17] Today, loss of forest cover and fish populations is showing the folly of ignoring the importance of natural capital in the design of long-term strategies. Even more important is the lack of attention to the contribution of environmental assets to the *sink* function, the ability of the ecosystem to absorb and recycle human-produced wastes. From the ozone layer to global warming to the nearby garbage dump, this is rapidly showing up as a limiting factor to the expanded use of many technologies.

Now that economic expansion has made such significant claims on the environment, we find that the limiting factor for much economic development has often become natural capital (including the capacity of ecosystems to recycle human waste) rather than man-made capital. Fish, rather than fishing boats, have become limiting. As natural forests and fish populations become limiting, we begin to invest in plantation forests and fish ponds. This introduces a hybrid category that combines natural and man-made capital, a category we may call *cultivated natural capital.*

Cultivated natural capital is often a very worthwhile investment, but it does not entirely avoid the problem of complementarity and the limiting role of natural capital. For example, agricultural expansion in the past half century has been spectacular in terms of output, but we are only now beginning to recognize the extent of the loss of some essential inputs of natural capital, such as soil fertility, and should accordingly revise our estimate of the net contribution of this output performance, even if it will undoubtedly remain very considerable. In other words the role of natural capital as a complement to cultivated natural capital must be recognized and factored into the decisions that affect future investments.

In an era when natural capital was considered infinite relative to the scale of human use, it was reasonable not to deduct natural capital consumption from gross receipts in calculating income. That era is past. The question now becomes, how does one account for natural capital? The difficulties in applying the concept arise mainly from operational problems of measurement and valuation.[18] These problems arise in both natural capital and cultivated natural capital and their interactions.

Recent work to assess the sustainability of farming systems, the cultivated natural capital par excellence, shows that the efforts at valuation must include both stock and flow analyses to be meaningful and that the conclusions to be reached will differ if both stock and flow are taken into account than if just one or the other is looked at alone.

Some steps toward a better conceptual framework have been taken, as evidenced by the recent revision of the United Nations System of National Accounts (SNA). For example, the system's national balance sheet now includes a value for forests and subsoil assets, but not for water, much less biodiversity. And a number of national and international experts have conducted case studies, including efforts supported by the World Bank.[19] But until *Monitoring Environmental Progress* there has not been a comprehensive (albeit crude) attempt to see how important natural capital is internationally. Later in this monograph we will go into the way the first estimates of wealth in natural capital were compiled.

Human Capital

In the past three decades very considerable progress has been made in recognizing the importance of human capital formation, meaning that investment in people is now seen to be a very high-return investment, especially in developing countries. The mainstream paradigm of development has been expanded to

include investment in human resources as an essential ingredient of a development strategy.[20]

Investments in health and education and nutrition are now increasingly recommended parts of a national investment strategy.[21] It is nevertheless still difficult methodologically to define the monetary value of such investments, even if ingenious proxies (such as the discounted differential income stream) are used. But even the most conservative measures of such proxies lead to an overwhelming positive value to such investments.

Less clear are the links between such investments and the shifting economic realities of an aging population profile in industrialized countries and the persistence of unemployment and underemployment in many countries, both industrialized and developing. The negative and corrosive impacts of such phenomena on the social fabric and well-being of society as a whole, not just of individuals, is an area deserving more research and policy attention. The policy prescriptions in World Bank studies on these topics mostly relate to economic management but increasingly recognize the importance of social cohesion when implementing measures to deal with these issues.[22]

Attempting to include the value of human resources in the measure of wealth is a bold move. Until now the only effort we could find of such an attempt is Norway's estimates of national wealth.[23] The method used in *Monitoring Environmental Progress*, described below, is a variant on the Norwegian approach. Essentially, it defines the value of human resources as a residual after allowing for the portion of the country's (discounted) future income stream that is attributable to produced assets and natural capital.

Social Capital

Recognizing the importance of social cohesion leads directly to social capital, the fourth form of capital to be considered in this broad-based discussion of sustainability. Without a degree of common identification with the forms of governance and of cultural expression and social behavior that make a society more than the sum of a collection of individuals, it is impossible to imagine a functioning social order. The myriad institutions that we take for granted as the essential premise of a functioning society must be grounded in a common sense of belonging by the members of that society. The institutions must reflect a sense of legitimacy in their mediation of conflicts and competing claims. In short, if that social capital is not there the resulting failures make it impossible to talk of economic growth, environmental sustainability, or human well-being. Examples are all too painfully present, from Somalia to Yugoslavia to Rwanda.

But what constitutes this social capital? It is a difficult question and a very different one from investment in individual human capital. It is based on inclusion, participation, and the promotion of an enabling environment. Yet it is more. The most ambitious work to date on this subject has been the efforts to deal empirically with the link between good governance and development. This requires efforts at definition and measurement, which face quite formidable methodological obstacles. But, happily, some headway is being made.

In a landmark study presented in *Making Democracy Work: Civic Traditions in Modern Italy*, Professor Robert D. Putnam of Harvard University and colleagues have made a convincing case that the existence of civic community is not only the precursor and guarantor of good governance but also the key to sustained socioeconomic development.[24]

Strong civic community is defined as a preponderance of *voluntary horizontal associations*, in contrast to *hierarchical vertical associations*, and the *density* of these voluntary horizontal institutions throughout the society. A matrix of voluntary horizontal associations is found in prosperous, rapidly developing northern Italy, while the less developed, less effective south of Italy is characterized by autocratic vertical institutions.

But which is cause and which is effect? Does the north of Italy have a dense network of horizontal institutions (choral societies, soccer clubs, parent-teacher associations) because it is rich and can afford them? Or is it rich because it has good, responsive government nurtured by longstanding citizen involvement in many such voluntary horizontal institutions? Putnam and his

colleagues went back to data from the nineteenth and the beginning of the twentieth centuries, when the socioeconomic structures and levels of development were similar in some northern provinces and some southern provinces but the horizontal and vertical slants of their civic associations were differentiated. They tested the hypotheses to explain the observed socioeconomic structures and civic institutional structures of northern and southern Italy in 1970, when the Italian government abandoned its 100-year-old centralized administration and created twenty identical regional governments, and to explain their disparate performance today, twenty years later.

The results of their research are indicative of a solid causal link between civic traditions and the effectiveness of government structures to promote sustained socioeconomic development. Prof. Putnam has since expanded his work from the empirical work on Italy to broader aspects of social capital as an essential ingredient for the social cohesion and effective, legitimate institutions that make an economy function.[25] It seems clear that a strong, dense, horizontally structured civil society of voluntary associations is very likely to promote good governance and to nurture sustained socioeconomic performance. But is that an adequate measure of social capital? That is not clear. There are several efforts to deal with this issue, notably by Rose,[26] Klitgaard,[27] and others.[28] The questions remain, however, about how to define and value that capital, showing convincingly the process of accumulation and depletion, and how to measure both its investment level and its returns. This area of research has just started.

Wealth estimates suggest one more approach to measuring social capital. Rather than taking human capital as a residual, this form of wealth could perhaps be approximated by considering the main items that add to the value of the individual, notably education, health, and nutrition. If so, the same residual logic that was applied in *Monitoring Environmental Progress* to measure human resources could be applied to social capital. Thus social capital would be measured by deducting the value of produced assets, natural capital, *and* human resources from the discounted future income stream of today's population.

Juxtaposing a residual approach with attempts at direct measurement of social capital should provide a useful cross-check on such a tricky area of research. This process could also suggest forms of social capital that exist outside the usual income measures, in much the same way as a pristine forest is invisible to conventional national income accountants. If so, one would have to consider whether, and if so how, one could include these supplemental "stocks" of social capital in a national balance sheet, if only to avoid the problem that has become apparent with the commercialization of once-pristine forests. They appear in the national accounts only when they are destroyed and then as a positive value in some other category like furniture!

Defining Levels of Sustainability

Going back to the original premise of this paper, it becomes possible to define sustainability in terms of the combination of these four kinds of capital per capita that we leave to future generations. We are able to set aside a foolish yet still prevalent view among some groups that sustainability requires leaving to the next generation exactly the same amount and composition of natural capital as we found ourselves, by substituting a more promising concept of giving them the same, if not more, opportunities than we found ourselves. This means that the stock of capital that we leave them, defined to include all four forms of capital, should be the same if not larger than what we ourselves found. This immediately opens the door for substituting one form of capital for another.[29] Arguably, it is indeed most worthwhile to reduce some natural capital (for example, reducing the amount of oil in the ground) to invest in increasing human capital (for example, by educating girls). The question then becomes to what degree we can:

- Measure each kind of capital
- Define the production function in terms of degrees of substitutability and complementarity between different kinds of capital and how these may change in a dynamic context
- Define an exchange rate for the different kinds of capital, accepting that it too may well be dynamic

- Define sustainability in terms of a context of thresholds within which the more efficient (highest return) activities could be selected in such a way that individual investments and entire strategies could be meaningfully evaluated.

Such a definition may ultimately be comprehensive and rigorous, but it will require an enormous amount of work to achieve. A good way to think about proceeding is by short steps. We have already made great strides in incorporating human capital in conventional economic analysis, and we are starting to incorporate various aspects of natural capital. That is an area in which we should invest our efforts now, significantly improving our understanding of the interlinkages between these three kinds of capital. Social capital will take longer to elaborate, and in the meantime it can be left to the political processes in each country to arbitrate.

This brings us to the definition of sustainability in terms of the maintenance or increase of these four types of capital, separately and collectively, and their relationship to the expanding population (given that the world's population is increasing), while producing an income stream per individual that is at least the same, if not growing.

Levels of Sustainability

Sustainability has several levels—weak, sensible, and strong—depending on how strictly we elect to hew to the concept of maintenance or nondeclining capital.[30]

Weak sustainability is maintaining total capital intact without regard to its composition (natural, man-made, social, or human). This would imply that the different kinds of capital are substitutes, at least within the boundaries of current levels of economic activity and resource endowment.

Sensible sustainability requires that in addition to maintaining the total level of capital intact, some concern should be given to the composition of that capital between natural, man-made, human, and social. Thus oil may be depleted as long as the receipts are invested in other capital (for example, human capital). In addition, efforts should be made to define critical levels of each type of capital, beyond which concerns about substitutability could arise. Such critical levels should be monitored to ensure that the patterns of development do not promote a depletion of one kind of capital, no matter what is being accumulated in the other forms of capital. This still assumes that man-made and natural capital are to a large extent substitutable, while recognizing that they are complementary too. The full functioning of the system requires at least a mix of the different kinds of capital. Because we do not know exactly where the boundaries of these critical limits lie for each type of capital, it behooves the sensible person to err on the side of caution in depleting resources (especially natural capital).

Strong sustainability requires maintaining the different kinds of capital separately intact. Thus for natural capital receipts from depleting oil should be invested in sustainable energy production rather than in any asset. This assumes that in most production functions natural and man-made capital are not really substitutes but complements. A saw-mill (man-made capital) is worthless without the complementary natural capital of a forest. The same logic would argue that if there are to be reductions in one kind of educational investments, they should be offset by other kinds of education and not by investments in roads.

Those who would demand that strong sustainability never deplete anything are pushing the idea to an absurd level. For nonrenewable resources—absurdly—there could be no use at all; for renewables, only net annual growth rates could be harvested in the form of the overmature portion of the stock.

Application of the Concept: Measurement and Valuation Issues

To apply these concepts, we faced formidable issues of measurement of the physical reality and of the valuation of that physical reality, as well as of the valuation of the human capital, not to mention social capital. Pragmatism and a determination to make better use of what is already available were able to take us a long way. Focusing primarily on the environmental side (natural capital), we could identify two separate

problems: *physical measurement and indicators* and *valuation.*

Physical Indicators

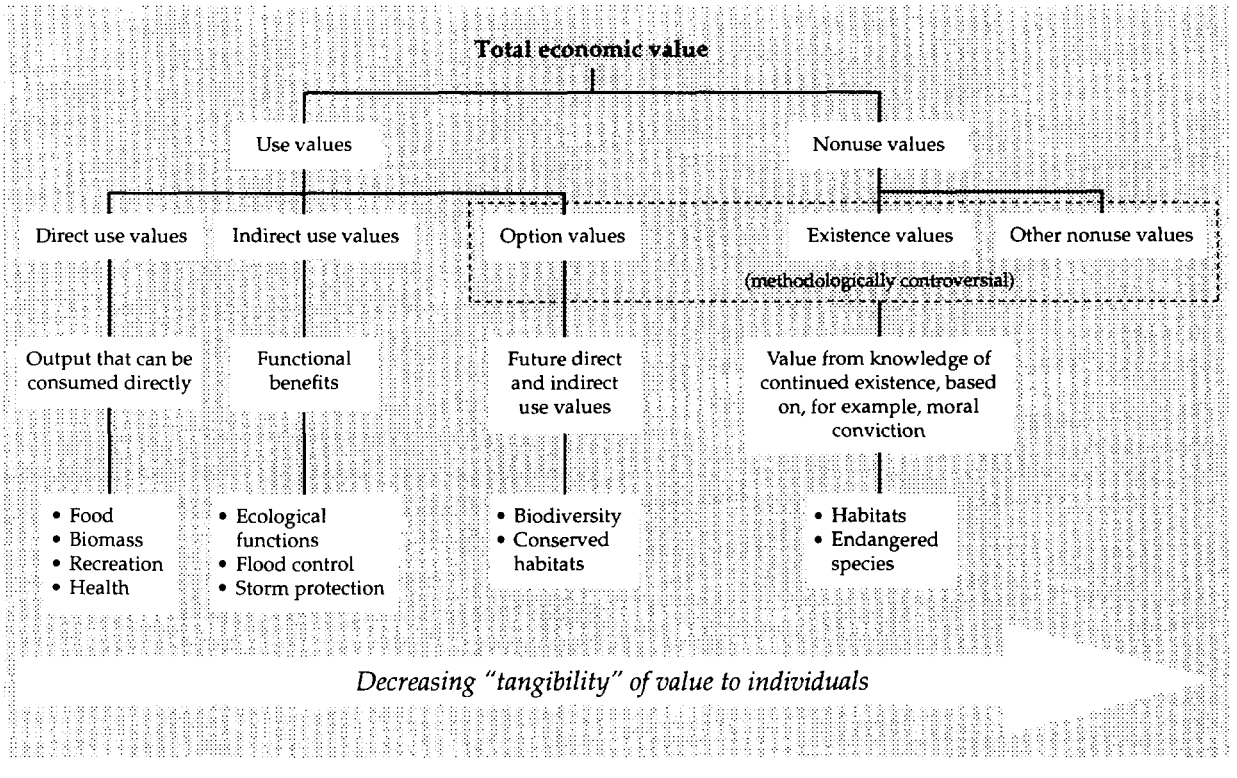
As a user of indicators, the World Bank's position is that *more can and should be done with available information* despite obvious imperfections and caveats. Much of what we have done in this area has been reported in *Monitoring Environmental Progress.*[31]

Nevertheless, there is an obvious lack of international agreement on a single framework or specific definitions, and methodological issues remain. Three areas for improved communications emerge. There are questions about *definitions* (for example, what constitutes a forest, how to combine details about open forests and plantations, and so on). There are issues of *methodology* (for example, how to blend remote sensing and ground surveys of forests, sampling techniques, and so on). And there are *practical considerations* about the creation and maintenance of the massive databases that will be required to come to grips with the complexity of interactions among ecological, social, and economic processes. Much of the most relevant information is location-specific. Despite major advances in geographic information systems, this still raises issues of aggregation and "ground-truthing."

Valuation

Assuming that we have resolved all the questions of what and how to measure the physical realities of our world, translating that into natural capital requires valuation. Valuation, however, is a very complicated exercise (figure 4). It requires the estimation not only of the direct benefits to humans (for example, productivity benefits of good soils and health benefits of clean water) but also of the indirect benefits (for example, watershed protection provided by woodlands). Further, some natural assets, such as biological diversity, have "option" values that we are not even aware of (for example, providing new medicines in the future) and that are

Figure 4. Valuation of environmental assets



Source: Serageldin and Steer, *Making Development Sustainable,* 3.

particularly difficult to estimate. Finally, most of us believe that the natural world has an intrinsic worth above and beyond its value to human beings; here the best we can do is estimate human perceptions of that value.

A number of techniques including contingent valuation, replacement cost estimation, and the use of surrogate markets have been developed for estimating the value of nonmarketed environmental services. The World Bank has significantly strengthened its capacity to assist developing country policymakers in using these techniques. But much remains to be learned, in terms of both methodologies and their empirical application.

In addition, there are problems with valuation to the extent that it puts a monetary value on a number of things that are fixed (for example, land) and cannot be traded equally across the globe. This would imply a weighting of the capital assets of the markets of the rich against those of the poor. In fact, this is true to the extent that it captures one side of the reality we live in, the monetized world of transactions and exchanges. Others have focused on the purely physical accounting of natural assets, relying on a particular set of criteria.[32] It is instructive to compare the results of the two approaches (table 1).

Even such crude estimates indicate that measuring natural capital is a two-sided proposition. The monetary value of comparable land in developing and advanced countries must reflect the vast differences in per capita income, while the nonmonetary value must reflect the far greater importance of developing countries as homes for biodiversity. And just as a monetary indicator must give value to things, notably subsoil assets, that are given no weight in a nonmonetary indicator, so too a monetary indicator would give no value to biodiversity that has no commercial market price. The estimates therefore should be viewed as complements rather than alternatives.

Table 1. Monetary and nonmonetary valuation of natural capital
(Percentage of global share)

Region	*Monetary*	*Nonmonetary*
Sub-Saharan Africa	3.4	12.6
China and India	1.0	7.8
Rest of Asia	1.9	21.0
Latin America and the Caribbean	8.7	28.6
Middle East and North Africa	1.4	3.5
Eastern Europe	7.0	13.8
High-income economies	67.8	21.5

Source: World Bank, *Monitoring Environmental Progress: A Report on Work in Progress* (Washington, D.C.: World Bank, 1995), 23.

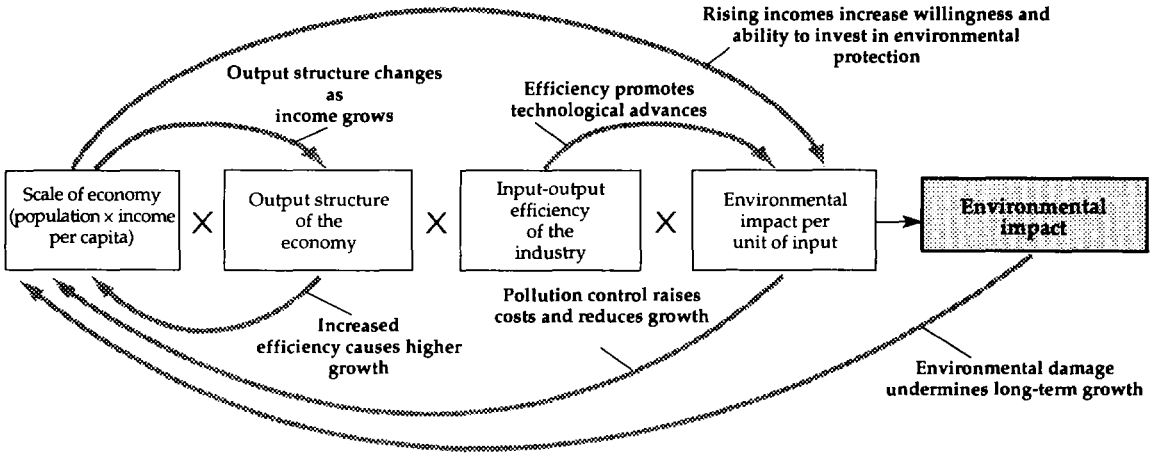
Application of the Concept: Interaction Issues

Our knowledge about the relationship between human activity and ecological process is still fragmentary. In addition, such relationships may be discontinuous; when under stress an ecosystem may "crash" irreversibly in a manner and at a time that could not be predicted. This seriously complicates decisionmaking and makes conventional approaches to risk management (assigning probabilities to possible outcomes and adding an insurance premium to project costs) difficult to implement. However, the high degree of uncertainty is no reason for inaction. The dynamics of poverty, demography, and economics often make the costs of inaction even higher than those resulting from action. But uncertainty does demand rigorous environmental assessments, drawing on the best scientific knowledge available and including careful sensitivity analysis. A key challenge will be to narrow the range of uncertainty and to make the precautionary principle operationally useful.

The links between economic growth and the environment are complex, and the World Bank is making efforts to understand and untangle these connections. Rather than assuming a black box that hides the connections between economic changes and environmental outcomes, policymakers must explicitly identify connections between economic policy and the environment. This knowledge can create more favorable environmental outcomes as well as permit rational assessment of the remaining tradeoffs between growth and environmentally sound objectives.

Some of these links are illustrated in figure 5. Environmental impacts are determined by the scale and structure of the economy, as well as by the technology and efficiency with which resources are used. Some of the feedback loops are positive; for example, increasing efficiency in resource use both conserves natural

Figure 5. Interaction between economic activity and the environment



Source: Serageldin and Steer, *Making Development Sustainable*, 21.

resources and produces fewer negative environmental impacts per unit of output. Other links are negative, such as the growth-reducing impacts of major pollution control expenditures. The figure also illustrates the numerous points at which policy interventions can reduce environmental impacts. This type of understanding is essential for a sensible evaluation of whether what is being done is the most appropriate option possible.

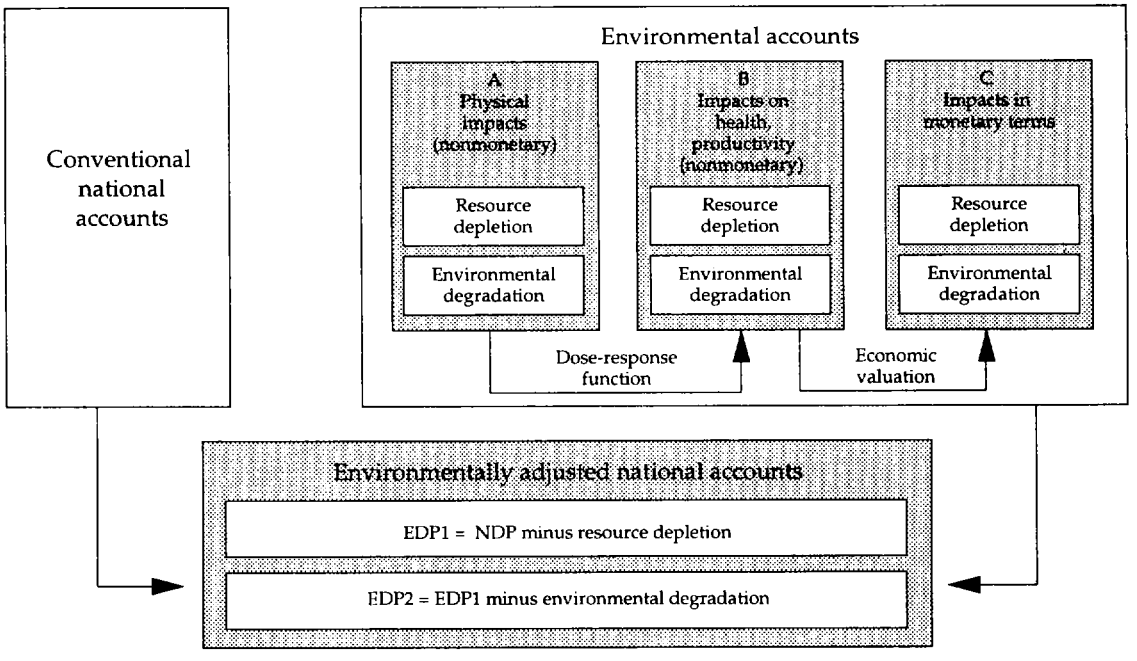
Adjusting National Accounts

Valuation techniques are usually employed to inform decisions at the project and sectoral levels, but they also need to influence decisions and how we measure progress at the national level. Conventional national accounts may serve macroeconomists and central bankers well, but they do a poor job of measuring sustainable income or changes in a nation's productive capacity. That includes estimates of depreciation of man-made capital but not that of natural capital, which in some countries is more important. For example, when a tropical forest is logged, no estimate is made for the loss of an irreplaceable asset. When land cultivation increases the loss of topsoil, which subsequently accumulates in a reservoir, no allowance is made for the harmful effects on soil and water storage.

To address some of these deficiencies, the World Bank has been collaborating with the United Nations Statistical Office and with others to develop a new system of environmentally adjusted national accounts. There are difficult technical issues yet to be resolved, but good progress has been made in developing a system of integrated environmental and economic accounts.[33] The schematic structure of the links between the two sets of accounts is explained in figure 6. There are several steps in the process. First we start with physical accounts, which are nonmonetary accounts measuring resource depletion and environmental effects. Then we compute the nonmonetary impacts. These are estimated impacts on nonmonetary indicators for health, agricultural production, global warming, and ozone depletion. Then we proceed to monetary valuation, the environmental impacts measured in monetary terms through evaluation techniques.

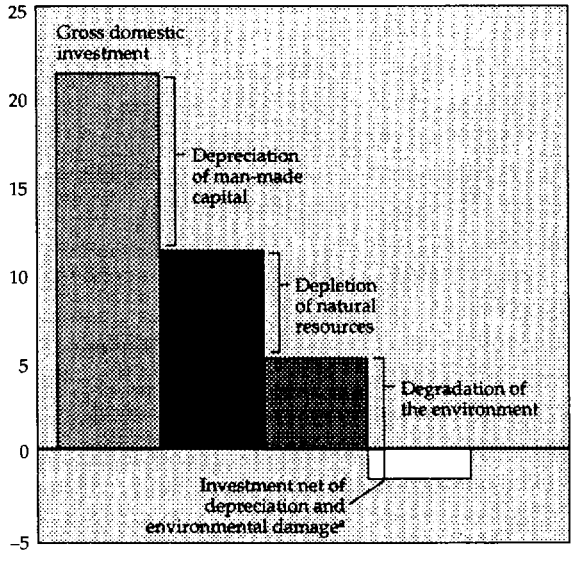
Application of such techniques in certain case studies has already raised substantial questions about the economic performance underlying the economic measures being used, for example, in the case of domestic saving and investment in Mexico in 1985 (figure 7). All this is consonant with the work of others who have been addressing these questions, notably Robert Repetto of the World Resources Institute. More recent work reported on in *Monitoring Environmental Progress* confirms that this is not an isolated case and that the "greening" of national accounts is an important step that needs to be taken not only for the impact it has on the income measures but also for the policy signals that it sends concerning saving

Figure 6. Adjusting national accounts



Source: Serageldin and Steer, *Making Development Sustainable*, 19.

Figure 7. Shrinking investment? Estimated impacts of adjustment for depreciation of man-made and natural capital in Mexico, 1985
(Percentage of GDP)



a. This is not intended as an accurate representation of the change in the nation's productive capacity, because it excludes important components of human capital accumulation and technological change.
Source: Serageldin and Steer, *Making Development Sustainable*, 20, taken from Jan van Tongeren and others, "Integrating Environmental Accounting: A Case Study for Mexico," in *Toward Improved Accounting for the Environment*, ed. Ernst Lutz, A United Nations Statistical Office–World Bank Symposium (Washington, D.C.: World Bank, 1993), 22–24.

and investment, which are discussed in greater detail below (figures 8 and 9).[34]

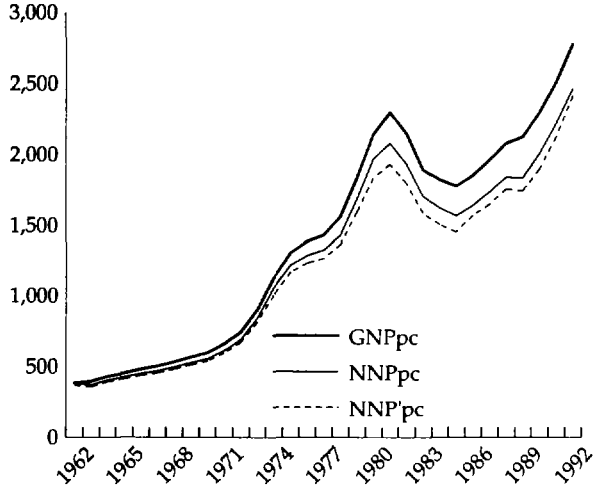
Shortcut Methods

The feasibility of the concept of measuring wealth and approaching sustainability through analysis of capital has been tested by the World Bank. Using published data, the World Bank has actually calculated wealth (comprising man-made and natural capital, with human capital calculated as a residual and leaving aside for the time being the identification of social capital) for 192 countries, reflecting the situation in approximately 1990. For 90 of these countries the World Bank has calculated genuine saving using time series data covering twenty or more years. The results were presented at the April 1995 meeting of the Commission on Sustainable Development. The methodological issues confronted were addressed in the 1995 published report *Monitoring Environmental Progress*.

How Each Type of Capital Was Calculated

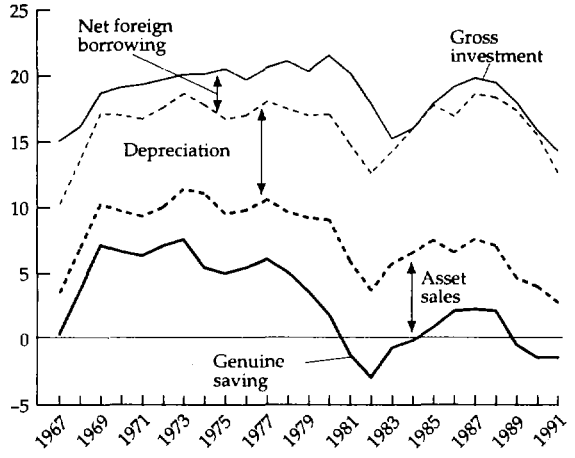
The calculations done by the World Bank and reported in *Monitoring Environmental Progress*

Figure 8. Greening national accounts show little variation on per capita income variants, Latin America and the Caribbean, 1962–92
(Income per capita, US dollars)



Note: GNPpc is gross national product per capita; NNPpc and NNP'pc are net national product per capita.
Source: Adapted by Arundhati Kunte and Jan Bakkes from World Bank, *Monitoring Environmental Progress*, 53–56.

Figure 9. Similar adjustments on saving and investment, Latin America and the Caribbean, 1967–91
(Percentage of GDP)



Note: Gross domestic saving = (gross domestic investment) – (net foreign borrowing). Net domestic saving = (gross domestic saving) – (depreciation of produced assets). Genuine saving = (net domestic saving) – (value of asset sales + damage from carbon dioxide emissions).
Source: World Bank, *Monitoring Environmental Progress*, 55.

were by necessity approximations and estimates based on available data. The exercise demonstrated that even without investing in generating new data and even accepting the limitations of only partial valuation of only some of the assets, the results are quite striking and worth reporting and pondering.

We calculated the value of the three kinds of capital as follows:

1. *Produced assets (man-made capital)* were valued on the basis of a perpetual inventory model, which is based on the World Bank's total factor productivity studies. The deflator used was the U.S. gross fixed capital deflator.
2. *Natural capital* was based on calculating four types of assets: land, water, forest, and subsoil assets.

   Land was classified into four basic types: cropland, forest, pasture, and other. Because the value of land depends on the local market and because that market is related to the prevailing level of income in that country, we estimated the value of land as a multiple of the prevailing per capita net national product (net national income adjusted for extraction of timber and soil assets). This recognizes that an acre of downtown Tokyo real estate is worth more than an acre on the fringes of Bamako, Mali. A rough statistical analysis suggested that the following are acceptable orders of magnitude:

Cropland	2.00 times per capita income per hectare
Forest	1.75 times per capita income per hectare
Pasture	0.75 times per capita income per hectare
Other	0.25 times per capita income per hectare

In addition, we made adjustments that reflected the quality of land. Thus extremely arid (desert) land was set to zero, and protected land and prime land (high soil fertility and irrigated) were given a premium of 0.50 times per capita income per hectare. These adjustments were the closest we came to introducing a value for biodiversity or scenic beauty, assuming that the protected category would be a proxy for that. Note that shifts in land uses would be captured by the changes in the quantities of the various types of land. In addition, as countries grow richer, the value of the land also increases.[35]

Water was valued at 1¢ per cubic meter of fresh water available for human use. Given the ratios of use now and those likely to prevail in the next few years, this is probably on the high side, but it was deemed an acceptable first approximation for this estimate.

Forest, in addition to being reflected in the value of the land, was given an additional value for the standing stock of timber set at 50 percent of the prevailing international market price.[36]

Subsoil assets, meaning stocks of fossil fuels and minerals, were valued at 50 percent of the prevailing international market prices for fossil fuels; minerals values were as reported by the World Resources Institute.

These values were then totaled to estimate the value of natural capital for each of the 192 nations.

3. *Human resources* were valued as the potential of the current population to continue generating its present national income, other things being equal.[37] The calculation was based on a green measure of net national income, discounted at 4 percent a year over the remaining life expectancy of the population of the country. This sum was then reduced for the parts that were already accounted for by produced assets or by natural capital; the residual constitutes the estimated value of human resources.[38] This clearly does not reflect variations in the contribution of the elderly. Nor does it take into account the potential future shifts that could come from changes in the underlying conditions that enable the transformation of labor into output (through changes in technology or policy or through changes in the social capital). It also does not factor in possible changes in equity, social obstacles to the participation of women, or any of a range of other important issues. Nevertheless, since it is a residual calculation, it could be said to include some of these variables. However, because the capitalization is based on the remaining life expectancy of the population, we prefer to refer to it as human resources, rather than as either human or social capital.

Additional Issues

This approximate methodology leaves a number of technical points begging for further discussion. Some of the most important, constituting an important agenda for further research, include:

- *The broader issues of prices and valuation.* No single valuation scheme has much analytical content. A solution may lie in the economists' debate about how to convert local currency gross national products (GNPs) to a common unit of account. One school holds that exchange rates are adequate, subject to some smoothing over time (intertemporally). The other maintains that we need detailed international price comparisons, called purchasing power parities, or a smoothing over countries (interspatially). Both rest on the proposition that the same thing would have the same price everywhere (apart from transport and distribution costs) were it not for market imperfections. They differ in their views about which imperfections are most prevalent in today's world. It is clear that if we had chosen purchasing power parity rather than the exchange rate estimate, that would have increased the wealth of the developing countries and reduced the gap between the industrialized countries and the developing countries. However, that is not very relevant to our present conclusions, which relate to the relative share of different kinds of capital within a single country, not across countries.
- *Alternative monetary valuations.* The use of current instead of constant prices raises questions of the impact of inflation on the value of different kinds of wealth. First, we have to bear in mind that current prices are a special case of monetization, which in turn is a special case of valuation. Given that point of departure, the initial shortcut methods used need to be carefully reviewed for their potential effect on the wealth estimates. For example, the manner in which large areas of remote or low-productivity land are valued is an important factor in explaining the wealth of some countries.
- *Coverage of the natural capital estimates.* Current natural capital estimates include only land, forests, subsoil assets, and water. This obviously leaves out some resources, such as fish, that are important to some countries. Moreover, future changes in both quantity and values should be considered.
- *Quality differences.* Eventually, we will have to take into account ecosystem health rather

than stocks of trees and birds. Ignoring differences in the quality of assets probably introduces a bias toward too high a value for remaining natural capital.

- *Defining social capital.* Conceptual clarity must be created in the first place. If human resources are calculated as a residual, does the calculation capture social capital as well? How do we define and measure social capital? How do we bring in issues of equity, social cohesion, and participation?

Finally, sustainable development studies are concerned with policies and actions that improve our medium- and long-term prospects. The precision with which they need to record today's market prices is not the same as that needed for short-term concerns, because a broader set of policy options is available, including many with diffuse effects, such as education. While the valuation of wealth must build on data designed for short-term analyses, it cannot be constrained by that kind of precision.[39] Rather, it must ensure the relevance of what is being assessed today, considering what may concern future generations and the range of policies and actions available to decisionmakers today or in the near future.

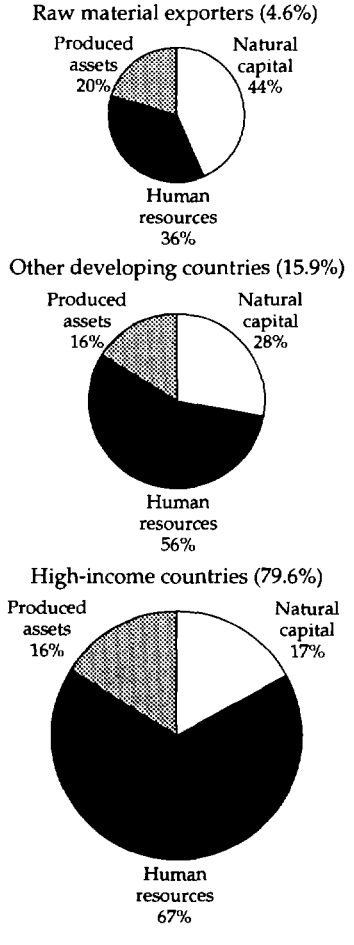
First Results: Sustainability and the Wealth of Nations

The current work of the World Bank on these issues is reported in *Monitoring Environmental Progress.* The World Bank has made it absolutely clear that these are preliminary research results and that it will not defend any individual country calculation without considerably more country-specific work. It is the overall patterns that emerge from the calculations that are worthy of note, not the individual country numbers or the relative position of individual countries (see appendix).

The main conclusions are:

- *Sustainabililty as opportunity.* Defining sustainability in these terms points to the importance of capital and of looking at wealth, not just income. But it is important to recognize the different kinds of capital (produced assets, natural, human, and social capital), which are partially complements and partially substitutes.
- *Analysis of stocks* is needed in addition to analysis of flows, which is what income measures have focused on. No corporation would run its affairs on the basis of cash flow and income statements without looking at balance sheets and net worth. Countries need to do the same.
- *The role of human resources.* It is astonishing to observe that with the exception of some raw material exporting countries, the value of human resources as defined here in the countries included in the calculations is equal to or exceeds both natural capital and produced assets combined. It gives credence to the view that development is best achieved by investing in people. (The results are graphically summarized in figure 10.) Equally important is that produced assets (man-made capital)

Figure 10. Composition of world wealth, by income group
(Percentage of total)



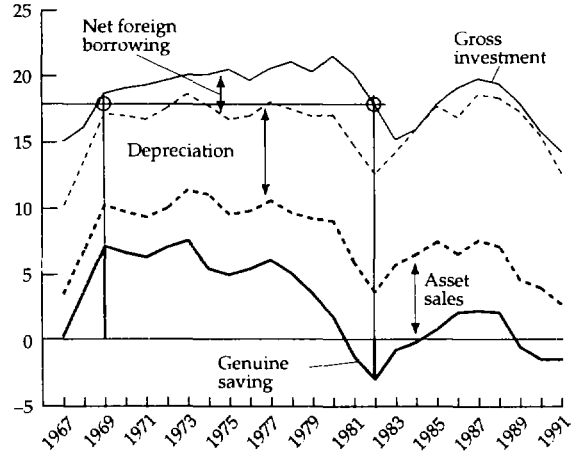
Source: World Bank, *Monitoring Environmental Progress,* 63.

represent only 16 percent to 20 percent of the wealth of most of the countries studied. Yet it is on this portion of total wealth that most current economic policy focuses.

- *The importance of genuine saving.* The results show that adjusting the national accounts makes little difference for the trends in traditional income measures (see figure 8) but that adjusting gross investment data provides important signals on saving and investment (see figure 9). It is important to note that were we to remain content with the gross investment as a fraction of GNP, that could mask major variations in genuine saving. For example, as shown in figure 11, a level of 18 percent of GNP for Latin America would translate into a positive saving of 7 percent in 1969 and in a negative saving of 2 percent to 3 percent in 1982. This clearly underlines the importance of going beyond the traditional aggregate level to look into the composition of investment financing and the level of genuine saving.

Just how important is the level of genuine saving as an indicator of sustainability? And just how reliable are these rough calculations? While I am attracted to the idea of genuine saving as an indicator that a country's overall pattern of development is sustainable for that country, I recognize that it may not be adequate because of supranational considerations and global issues. In considering whether we can have confidence in the broad patterns emerging from this preliminary work, one observation is interesting. Aggregating our results on a regional basis (figure 12), we find that Sub-Saharan Africa has been dissaving since the late 1970s, whereas East Asia has taken off in terms of genuine saving since the early 1980s. These findings, which conform to general observations, add credibility to the indicators and the calculations behind them.

Figure 11. Masked variations in genuine saving, Latin America and the Caribbean, 1967–91
(Percentage of GDP)

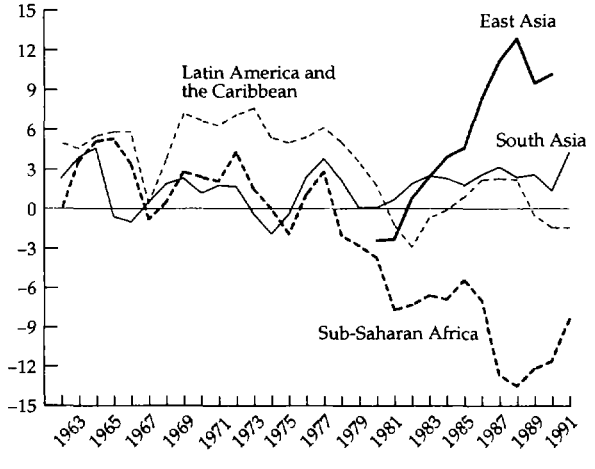


Note: Identical figures of gross investment as a percentage of GDP could mask real differences in genuine saving. Gross domestic saving = (gross domestic investment) – (net foreign borrowing). Net domestic saving = (gross domestic saving) – (depreciation of produced assets). Genuine saving = (net domestic saving) – (value of asset sales + damage from carbon dioxide emissions).
Source: World Bank, *Monitoring Environmental Progress*, 55.

Next Steps in an Ongoing Journey

Although this schematic presentation is indicative of work in progress, it also highlights the general direction for the months and the years ahead. Next steps will include detailed case studies to assess the viability of the methodology and the confidence limits of the shortcut methods used in the *Monitoring Environmental Progress* exercise. In addition, testing the approach on a number of country scenarios would show the extent to which this kind of analysis would in fact result in different policy signals. Broader dissemination and discussion of these results would also enable a more meaningful dialogue on method and substance; the

Figure 12. Regional patterns of genuine saving, 1962–91
(Percentage of GDP)



Source: World Bank, *Monitoring Environmental Progress*, 54.

World Bank could learn much from the insights and ideas of others.

Methodologically, future work must also start addressing the issue of social capital. It must seek to integrate the concepts of poverty and equity in assessing the viability of the measurements that are being made of the state of a country. The quality of the natural capital, including the value of an ecosystem, not just its constituent parts, is another area to be addressed. The long-term equilibrium price relativities to be used for the valuations must also be put on a more rigorous footing. The local and supranational effects (externalities) must be addressed, integrating the pieces of the continuum from local to global. These efforts and so much more remain to be done.

Pragmatism has to be our abiding concern in the development of new measurements and methodologies, as well as in the pursuit of policies and investments in the interim, while our tools are still evolving.

Operationally, this pragmatism translates into:

- Encouraging the growth of natural capital by reducing our level of current exploitation
- Investing in projects to relieve pressure on natural capital stocks by expanding cultivated natural capital, such as tree plantations to relieve pressure on natural forests
- Increasing investment in human resources, particularly those of the poor, who are both the victims and the unwitting agents of environmental degradation in many of the earth's poorest societies.

Methodologically, it is better to follow the wise advice of Nobel Laureate Robert Solow, who advocated a series of imperfect steps to improve our current work rather than an interminable debate about the "perfect" formulation to be used. With that kind of effort must come a major effort at improving our databases for the different kinds of capital, especially the physical stocks and flows of natural capital, and our understanding of their interactions in a coherent view of ecosystem integrity and resilience at regional and global levels.

It is a tall order, and it will be a long journey before the concept of sustainability sketched here is operational in a meaningful sense. But the longest journey starts with a single step, and on this journey many steps have already been taken.

APPENDIX

Background data

The overall patterns reported in the text are based on the regional patterns given in table A.1. The patterns are based on very crude estimates for individual country wealth numbers. These numbers are only *first approximations* in a research report. They are likely to change, although we do not expect the overall regional patterns to change that much. *We will not defend any individual country estimate without more in-depth individual country analysis.*

Table A.1. Composition of wealth, by region
(Percentage of total wealth)

	Human resources	*Produced assets*	*Natural capital*
World	64	16	20
High-income countries	67	16	17
Developing countries			
Sub-Saharan Africa	31	17	52
Eastern and southern Africa	33	14	52
Western Africa	25	25	50
India and China	73	18	9
Other Asia	75	13	12
East Asia and Pacific	75	13	12
South Asia	76	16	9
Latin America and the Caribbean	50	15	35
Middle East and North Africa	39	29	32
Eastern Europe	41	16	43

Source: World Bank, *Monitoring Environmental Progress*, 63.

Anyone who wishes to cite individual country wealth data from this material as part of ongoing research or for any other reason must attach a disclaimer to distinguish these data from other country data that are published by the World Bank and that are based on much more solid, detailed, country-specific analyses.

Monitoring Environmental Progress and "Global Approach to Environmental Analyses," which contain individual country wealth numbers, can be inspected as part of the technical documentation underlying *Monitoring Environmental Progress*. This documentation can be accessed through the World Bank home page (http://www.worldbank.org), directly (http://www-esd.worldbank.org/html/esd/env/publicat/mep/mep.htm), or at the CIESIN Web site (http://www.ciesin.org); or by sending a request to Arundhati Kunte, World Bank, 1818 H Street, N.W., Rm. S3-059, Washington, D.C. 20433, U.S.A. (fax: 202-477-0968; email: akunte@worldbank.org).

Notes

1. See, among others, Thaddeus C. Trzyna, ed., *A Sustainable World: Defining and Measuring Sustainable Development* (Sacramento and Claremont, Calif.: International Center for the Environment and Public Policy and California Institute of Public Affairs for the World Conservation Union, 1995), and Mohan Munasinghe and Walter Shearer, eds., *Defining and Measuring Sustainability: The Biogeophysical Foundation* (Washington, D.C.: United Nations University and World Bank, 1995).

2. A September 30, 1995 draft of the current monograph was given wide circulation in connection with the World Bank's Third Annual Conference on Environmentally Sustainable Development, "Effective Financing of Environmentally Sustainable Development," held in Washington, D.C., October 4–6, 1995. This monograph presents some of the research that has been ongoing in the World Bank, most importantly, *Monitoring Environmental Progress: A Report on Work in Progress* (Washington, D.C.: World Bank, 1995) and its related technical papers, including "Global Approach to Environmental Analyses" (World Bank, Washington, D.C., 1995). These two works, which contain individual country wealth numbers, can be inspected as part of the technical documentation underlying *Monitoring Environmental Progress.* To access these data, see the electronic and postal addresses and fax numbers in the appendix.

3. See Ismail Serageldin and Andrew Steer, eds., *Making Development Sustainable: From Concepts to Action* (Washington, D.C.: World Bank, 1994), and Ismail Serageldin, Robert Goodland, and Herman Daly, "The Concept of Sustainability," in *Taking Nature into Account: A Report to the Club of Rome,* ed. Wouter Van Dieren (New York: Springer-Verlag, 1995), 99–123.

4. For a full listing of contributors see the acknowledgments in *Monitoring Environmental Progress.* Major substantive inputs were provided by Kirk Hamilton, Claudia Sadoff, David Cassells, Andrew Bond, Christiaan Grootaert, John Kellenberg, John Briscoe, and David Hanrahan, in addition to Andrew Steer, John O'Connor, and myself.

5. A number of efforts outside the World Bank are described in the *Monitoring Environmental Progress* technical notes. Those that we hope can soon draw on a common pool of basic information are the World Resources Institute's *World Resources 1996–97,* the United Nations Development Program's *Human Development Report,* the United Nations Environment Program's prospective *Global Environmental Outlook,* the Earth Council's *Earth Report,* and the indicators program of the Commission on Sustainable Development, along with future editions of *Monitoring Environmental Progress.*

6. The very term *social capital* troubles some distinguished authorities such as Nobel Laureate Robert Solow, who, in conversations with the author, rightly pointed out that to term it *capital,* we must clearly demonstrate understandable processes of accumulation and depletion. This valid concern must be addressed in future research.

7. See, for example, Anne Harrison, "Natural Assets and National Accounting," in *Toward Improved Accounting for the Environment,* ed. Ernst Lutz, A United Nations Statistical Office–World Bank Symposium (Washington, D.C.: World Bank, 1993), 22–44.

8. In the more generally accepted terminology, to recognize the gender dimension, one refers to this category of produced assets as "human-made capital." However, because I will be referring frequently to human capital, as distinct from produced assets, I will use the terms "man-made capital" and "human capital" so that the reader can more easily distinguish the two.

9. For some of those definitions see John Pezzey, *Sustainable Development Concepts: An Economic Analysis*, Environment Paper 2 (World Bank, Environment Department, Washington, D.C., 1992).

10. Brundtland Commission (World Commission on Environment and Development), *Our Common Future* (New York: Oxford University Press, 1987), 43.

11. As evidence of the use of the ESD triangle as an organizing principle for environmental information, see Kirk E. Hamilton, "Organizing Principles for Environment Statistics," in *Proceedings of the 48th Session of the International Statistical Institute* (Cairo, 1991). In fact, this ESD triangular framework was independently developed and applied by others outside the World Bank, such as Statistics Canada.

12. Serageldin and Steer, *Making Development Sustainable*, 30–32.

13. Serageldin, Goodland, and Daly, "The Concept of Sustainability," 99–123.

14. See, for example, Peter Bartelmus, C. Stahmer, and Jan van Tongeren, "Integrated Environmental and Economic Accounting: Framework for an SNA Satellite System," *Review of Income and Wealth* 37 (2) 1991: 111–48; and Yusuf J. Ahmad, Salah El Serafy, and Ernst Lutz, eds., *Environmental Accounting for Sustainable Development*, A United Nations Environment Program–World Bank Symposium (Washington, D.C.: World Bank, 1989).

15. For original writing on expanded wealth accounts, see A. Scott, "National Wealth and Natural Wealth," *Canadian Journal of Economic and Political Science* 22 (3) (1956): 373–78.

16. For background reading see David W. Pearce and G. Atkinson, "Capital Theory and the Measurement of Sustainable Development: An Indicator of Weak Sustainability," *Ecological Economics* 8 (1993): 103–08.

17. However, scarcity of environmental goods has been recognized for some time as a new subject matter for economic thinking. See, for example, Roefie Hueting, *New Scarcity and Economic Growth* (The Netherlands: Agon/Elsevier, 1980). The Dutch version was published as early as 1974 (same publisher).

18. The problems of measuring natural capital have been emphasized in many works. See, among others, Steer and Lutz (1994), and Ahmad and others (1989), Lutz (1993), and El Serafy (1991, 1993).

19. See, in particular, Lutz, *Toward Improved Accounting for the Environment*.

20. See World Bank, *World Development Report 1991: The Challenge of Development* (New York: Oxford University Press, 1991), 148–49.

21. See World Bank, *World Development Report 1993: Investing in Health* (New York: Oxford University Press, 1993).

22. See World Bank, *Averting the Old Age Crisis* (New York: Oxford University Press, 1994), and *World Development Report 1995: Workers in an Integrating World* (New York: Oxford University Press, 1995).

23. See Central Bureau of Statistics of Norway, "Natural Resources and the Environment 1992," Report 93/1A (Oslo-Kongsvinger, 1992).

24. Robert D. Putnam with Robert Leonardi and Raffaella Y. Nanetti, *Making Democracy Work: Civic Traditions in Modern Italy* (Princeton: Princeton University Press, 1993).

25. See Robert D. Putnam, "The Prosperous Community: Social Capital and Public Life," *The American Prospect* (Spring 1993): 35–42.

26. Richard Rose at the Institute for Development Studies at Sussex University in the United Kingdom is studying the transformations of Eastern Europe and the former Soviet Union from an institutional perspective. Efforts at scaling these transformations could be relevant to the definition and measurement of social capital.

27. Robert Klitgaard at the University of Natal in the Republic of South Africa is exploring the relations between many variables and civil strife to develop hypotheses about social capital.

28. John O'Connor is developing an ingenious approach to this issue using long-term shifts in price relativities. Francis Fukuyama has recently published *Trust: The New Foundations of Global Prosperity* (New York: Free Press, 1995).

29. Accepting that they remain largely complementary and that critical limits, or thresholds, must be observed for each kind of capital.

30. See Serageldin, Goodland, and Daly, "The Concept of Sustainability," 99–123.

31. Eric Rodenburg, Dan Tunstall, and Frederick van Bolhuis, "Environmental Indicators for Global Cooperation," GEF Working Paper 11 (Global Environment Facility, Washington, D.C., 1995). The Global Environment Facility and World Resources Institute have developed a rough nonmonetary measure of a country's natural capital, the natural capital indicator (NCI). This NCI refers to the noncommercial portion of a country's natural resources, represented by the biological resources in land, water, air, and coastal zones (including the exclusive economic zone), subject to data availability. The goal is to capture values that are not likely to be reflected in conventional economic indicators. The NCI is based on a country's remaining natural areas (including forests, coastal zones, natural wetlands, relatively unmanaged rangelands, protected areas, protected watersheds, and any other areas that are left or managed in a natural state), adjusted by the ratio of actual biodiversity and the global average biodiversity for a country of a given size.

32. Fulai Sheng, *Real Value for Nature: An Overview of Global Efforts to Achieve True Measures of Economic Progress* (Gland, Switzerland: World Wildlife Fund for Nature, 1995).

33. Robert Repetto, Raoul Solorzano, and others, "Accounts Overdue: Natural Resource Depreciation in Costa Rica" (World Resources Institute and the Tropical Science Centre of Costa Rica, Washington,

D.C., 1991), and Robert Repetto and others, "Wasting Assets" (World Resources Institute, Washington, D.C., 1991).

34. See K. Hamilton, "Green Adjustments to GDP," *Resources Policy* 20 (3) (1994): 155–68. For background reading see D. W. Pearce and G. Atkinson, "Capital Theory and the Measurement of Sustainable Development: An Indicator of Weak Sustainability," *Ecological Economics* 8 (1993): 103–08, and *Monitoring Environmental Progress*, chapter 7.

35. Note, however, that we do not address the issue of urban land. While small in total quantity, urban land is of very high value and will probably increase in importance. In the Egyptian delta, for example, urban encroachment on valuable agricultural land is an important issue.

36. The 50 percent valuation factors in the costs of extraction, transport, and milling.

37. This is the same approach used by the Central Bureau of Statistics of Norway. See note 23.

38. For details see World Bank, "Global Approach to Environmental Analysis," 16.

39. For an excellent discussion of the difference between precision and accuracy in this context, see Robert Constanza, Silvio Functowicz, and Jerome Ravetz, "Assessing and Communicating Data Quality in Policy-Relevant Research," *Environmental Management* 16 (1) (1992): 121–31.

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Headquarters
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.
Telephone: (202) 477-1234
Facsimile: (202) 477-6391
Telex: MCI 64145 WORLDBANK
MCI 248423 WORLDBANK
Cable Address: INTBAFRAD
WASHINGTONDC
World Wide Web: http://www.worldbank.org
E-mail: books@worldbank.org

European Office
66, avenue d'Iéna
75116 Paris, France
Telephone: (1) 40.69.30.00
Facsimile: (1) 40.69.30.66
Telex: 640651

Tokyo Office
Kokusai Building
1-1, Marunouchi 3-chome
Chiyoda-ku, Tokyo 100, Japan
Telephone: (3) 3214-5001
Facsimile: (3) 3214-3657
Telex: 26838

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