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Author(s): Atkinson, Giles; Hamilton, Kirk

Abstract: Discusses the need for a suitable set of indicators to assess progress toward sustainable development. Environmental indicators; Performance indicators; United Nations' development of an Integrated System of Environmental and Economic Accounting; Natural resource balances. INSETS: Performance indicators: An example; Valuing pollution in the national accounts.

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ACCOUNTING FOR PROGRESS: INDICATORS FOR SUSTAINABLE DEVELOPMENT

The call for countries to pursue policies aimed at sustainable development was first made by the Brundtland Commission in 1987.[1] It was forcefully repeated at the Earth Summit five years later with the adoption of Agenda 21, a wide-ranging program for sustainable development requiring action at the local, national, and international levels. In response, many governments have pledged their commitment to this program. Whether these pledges will become reality is another question, however. To assess progress toward sustainable development, a suitable set of indicators is clearly needed.

A number of possible indicators have been suggested, all of which come under the general umbrella of "green accounting." In response to the need for better environmental information, indicators such as air quality indices and water quality classifications have proliferated.[2] Policymakers cannot use such information directly, however, because it is voluminous, difficult to aggregate, and unrelated to other policy variables. As a result, the task of putting existing environmental information into a more useful form remains. In this sense, then, green accounting is less a particular set of indicators than a framework for organizing relevant data.

In line with the focus on sustainable development, appropriate indicators have to reflect economic as well as purely environmental concerns. Prominent in this effort is rigorous resource and environmental accounting, to which both the Brundtland Commission and Agenda 21 gave impetus. Agenda 21, in fact, explicitly called for the creation of integrated environmental and economic accounts to complement the United Nations' System of National Accounts (SNA), which provides the framework for many countries' national income (gross domestic product) accounting.

This article examines some recent attempts at green accounting and the issues they raise, beginning with simple environmental indicators and then looking at efforts to "green" the national accounts themselves. It draws two main conclusions: First, efforts to measure sustainable development would be enhanced by expressing indicators of environmental change in monetary terms. Second, linking physical information about the environment to the economic data in the national accounts would be highly useful for policymakers.

ENVIRONMENTAL INDICATORS

The Organisation for Economic Cooperation and Development's (OECD) "pressure-state-response" framework has been particularly influential in the development of environmental indicators. This framework focuses attention on three key variables: the pressures on the environment (including underlying pressures such as population change, economic growth, structural change, and public concerns, along with proximate pressures such as land use changes and waste emissions); the state of the environment itself (especially the extent of pollution and waste); and society's responses (government policies, measures taken by individuals and business, environmental activism, and so forth).

Traditionally, environmental indicators have been largely descriptive and not explicitly tied to policy concerns. Recently, however, the Netherlands' Ministry of Housing, Physical Planning, and Environment developed a set of performance indicators specifically designed to measure progress toward the goals of Dutch environmental policy.[3]

Indicators, of course, can be based on a number of themes. In the Dutch case, the chosen themes are climate change; acidification; eutrophication; dispersion of pesticides, toxins, and radioactive substances; disposal of solid waste; and disturbance from odor and noise.[4] For each theme, a number of physical measurements are combined according to their relevance to particular environmental problems or the overall theme itself. This provides the means to aggregate individual measures with respect to a given theme (see the box on page 19).

The Dutch have also set sustainability targets for each theme. These targets are usually based on the assimilative capacity of the environment (such as the ability of soil to dissipate acidifying pollutants). By comparing actual performance with these targets, policymakers can get an idea of their progress. Performance indicators also offer a way of aggregating across themes. That is, one can sum the percentage deviations for the various environmental problems (climate change, acidification, etc.) to obtain an indicator known as an integrated environmental pressure index. This index stood at 1,195 in 1991, down from a peak of 1,346 in 1985. Because there are six component themes, the target for the index is 600. To meet this target, the index must fall 50 percent by 2000. Eutrophication and disposal of solid waste were the themes farthest from their target values in 1991.

Constructing aggregate environmental indicators of this sort requires selecting one weighting scheme out of many possible ones. For the purpose of highlighting a few key themes for policy, the Dutch approach of weighting each theme's deviation from its goal equally is useful. Some problems, however, are of interest in their own right (e.g., nitrogen oxides, which contribute to both acidification and ground-level ozone). In addition, while there is a scientific basis for aggregating within themes such as climate change, there is no such basis for the overall integrated environmental pressure index. A measure of this type is thus something of a Holy Grail among indicators--a single number whose movements indicate whether, and to what extent, overall environmental quality is increasing or decreasing. Yet in terms of motivating interest in environmental problems, such a measure may have an important role to play.

A major drawback of many environmental indicators is that they fail to reflect economic and social impacts? While the pressure-state-response framework does consider economic pressures and various responses to them, the linkages are fairly informal and economic impacts are not considered at all. This drawback is particularly serious in the case of human health, where pollution is becoming a key concern. The World Bank, for example, estimates that for every 1,000 people in sub-Saharan Africa, nearly 600 "disability adjusted life years" are lost each year.[6] A significant proportion of this loss stems from environmental pollution. For this reason, it is crucial

that green accounting enable policymakers and the public to gauge the magnitude of environmental impacts.

One way to resolve this problem would be to tie environmental indicators to the existing national income accounts. But what would such a revision actually entail? The national accounts in use today were developed in the 1940s, largely as a response to the widespread unemployment of the previous decade and the need for an empirical guide to government intervention in the economy.[7] Even though the SNA has evolved somewhat over time, it has consistently been concerned with measuring economic activity. Furthermore, the only goods and services that get counted are those that pass through the market, along with certain government services like education.

The SNA sets an international standard for national income accounting, including the ways in which gross domestic product (GDP) is defined and measured. The key elements of the SNA are the income and expenditure accounts, which measure current economic activity, and the national balance sheet accounts, which record the opening and closing stocks of assets (both financial and tangible) over the accounting period.

Although national income accounts are often very detailed, the growth rate of GDP is generally regarded as the single most important economic indicator. This factor is used in conjunction with other important economic variables, such as the inflation and unemployment rates, in modeling and forecasting short-term economic activity. Longer-term questions such as improvements in the quality of labor, capital accumulation, and technological progress are addressed by examining changes in GDP over relatively long periods of time.

Because both short-term and long-term analyses concentrate on measurable economic activity, they only address broader quality-of-life questions indirectly. The same is true of the way in which the national income accounts treat environmental resources. To the extent that there is commercial activity associated with an environmental asset (such as tourism or hunting), the value added by this activity is part of national product. But the underlying asset, the pristine lake or wilderness, is not valued explicitly.

Environmental policies that use market instruments are reflected in the regular accounts directly, however. For instance, pollution taxes are included in indirect business taxes, and emissions permits (which are intangible assets on firms' balance sheets) are counted as investment. Broader environmental policies, on the other hand, are not reflected in these accounts.

Environmental concerns are not the only item neglected by the accounts--social concerns are only reflected indirectly, if at all. The social indicators that have evolved since the 1970s, which tend to focus on health and educational attainment, are designed to give policymakers a direct indication of changes in social well-being.[8] The most prominent such indicator developed so far is the Human Development Index (HDI), which is a sophisticated average of economic, health, and educational attainment measures.[9] Table 1 on page 20 shows how various countries ranked according to this index in 1992. Overall, the HDI has been successful in getting countries to adopt policies to foster literacy and better health.

Conceivably, the HDI could be expanded to include environmental concerns, and indeed, the compilers of this index have made some (so far unsuccessful) attempts to do this.[10] Environmental ends would probably be better served by other means, however. Social indicators have not had a significant impact on the way we think about economic progress, and the same fate could well befall a greener HDI. To be sure, the widespread commitment to sustainable development by governments and international institutions offers grounds for optimism. But the very nature of sustainable development, with its close linkages between the economy and the environment, argues for an approach that better represents those linkages.

GREENING THE NATIONAL ACCOUNTS

All things considered, greening the national accounts appears to offer the most powerful way to monitor government commitments to the environment and sustainable development, and many countries are taking steps in this direction. Nevertheless, no country is currently planning to alter the underlying structure of its accounts, only to provide green adjuncts or satellite accounts. Nor is there much uniformity to these efforts owing to the experimental nature of the work and differences in policy concerns among countries.

To ensure international comparability, the united Nations has developed an Integrated System of Environmental and Economic Accounting (SEEA)[11] analogous to the SNA. SEEA is designed to provide a satellite account to serve as an adjunct to---but not a modification of--the current national income accounts. This approach is highly complex, however, involving disaggregating the standard accounts to highlight environmental relationships, linking physical and monetary accounting, imputing environmental costs, and extending the definition of production in the SNA.

Altogether, there are four main types of green satellite accounts, which are distinguished by their focus on resource and pollutant flows, natural resource balances, environmental expenditures, or green accounting aggregates. Because each has its own policy uses, it will be worthwhile to examine them in detail.

Resource and Pollutant Flows

Resource and pollutant flow accounts may be thought of as physical extensions of the (monetary) input-output (I-O) accounts. Like the I-O accounts, they record flows between different sectors of the economy, including transactions between producers as well as those between producers and the ultimate consumers. The flows comprise inputs such as energy and outputs such as wastes and emissions of greenhouse gases.[12] With their links to the conventional I-O tables, these accounts lend themselves naturally to policy modeling. For example, they can be used to assess the incidence of (current or prospective) environmental regulations and taxes on such variables as production, profits, and employment.

Measuring the burden of policies is an important element of policy design. For example, it is often claimed that environmental protection decreases the rate of economic growth and thus increases unemployment. Modeling exercises, however, indicate that well-designed and implemented environmental policies can have beneficial economic effects.[13] By allaying fears about competitiveness and jobs, such exercises could remove an important obstacle to increased environmental protection. The link between resource and pollutant flow accounts and policymodeling is most striking in Norway. The central statistical office's active role in economic analysis, research, and modeling makes it a natural bridge between Norway's Ministry of Finance and its Ministry of Environment in addressing environment-economy linkages. Furthermore, the nonadversarial relationship between data providers and policy analysts is a definite strength.

Resource and pollutant flow accounts can also provide a lot of valuable information about the magnitude of policy response required in a given situation, particularly in the case of market-based instruments such as pollution taxes. For example, the greenhouse gas emissions accounts compiled by Canada's statistical office have been particularly useful in determining the level of carbon tax needed to achieve the country's target emissions under the Framework Convention on Climate Change. Other important social and economic questions, including the distributional consequences of carbon taxes, can also be addressed by means of these accounts.[14] Similarly, the accounting system used by the German statistical office could be valuable in formulating policies toward waste (including regulations on recycling and a possible waste tax) that affect

competitiveness and income distribution.

Such resource and pollutant flow accounts can also be useful in assessing the environmental impacts of international trade. Trade issues tend to be complex, in part because they are so diverse, including the resources and pollution embodied in ordinary goods as well as transboundary pollution and trade in hazardous substances.[15] Many of these issues can be quantified by means of appropriate flow accounts, however.[16] A recent study of Brazil, for instance, confirms the widely held suspicion that countries undergoing rapid industrialization tend to suffer from greatly increased pollution.[17] In the 1980s, Brazil adopted an export-oriented industrialization strategy. From 1980 to 1985, however, emissions of water and air pollutants increased by as much as 8 percent, despite reduced activity in the domestic economy. Therefore, although export promotion can have tangible benefits for a developing country, this analysis indicates that in the absence of strict environmental protection, it can also have adverse environmental side effects. The Dutch statistical office is using its accounting framework to examine a closely related issue--the degree to which pollution is embodied in the goods that the country imports.[18] Such an exercise can be carried out both for the current structure of trade and for prospective changes in it.

One charge frequently made against green accounts is that they will never be able to rival economic indicators in the minds of policymakers, However, incorporating resource and pollutant flow accounts into the economic models that governments use for forecasting would make environmental effects such as resource throughput and pollution part of the standard output of such models. Consideration of environmental effects could then become as routine as that of such policy concerns as balance of payments effects.

Natural Resource Balances

Although resource and pollutant flow accounts have a wide range of policy applications, they are not well suited to one particularly important issue: sustainability. Concern about sustainability arises from the belief that future generations are entitled to at least the same level of well-being that we enjoy. Sustainability is closely linked to the way in which wealth is used: A country that is consuming its wealth is eroding its economic base and will not be able to maintain its current standard of living. In this instance, wealth includes natural assets such as oil reserves as well as the (physical and financial) assets produced by humans that appear in standard balance sheets. Corresponding to natural assets, of course, are natural liabilities such as the build-up of pollutants in the environment.

While environmental liabilities are relatively difficult to compute,[19] natural resource accounts are a major feature of many countries' green accounting programs. These accounts are usually in the form of a balance sheet showing the opening and closing stocks of various natural resources and the flows that determine the net changes. Table 2 on this page presents a simplified account of this type. In the simplest of these accounts, physical quantities such as barrels of oil or cubic meters of timber are the units of measurement. The relevant flows are then the quantity extracted less new discoveries (for nonrenewable resources) or the quantity harvested less the natural growth (for renewable resources). More sophisticated accounts use money values as the units of measurement. In these accounts, opening and closing stocks are valued using the prices prevailing at the beginning and end of the accounting period.

Valuing resources presents problems of its own, however. The volatility of world resource prices can lead to large changes in the value of stocks (note the revaluation term in Table 2), leaving the usefulness of resource accounts open to question. However, these problems can be overcome, at least in part, by means of refinements to current methodologies and the accumulation of practical experience. Valuing resource depletion is particularly important for determining the royalties

governments charge for the fight to extract resources owned by the public. Such royalties can be a major factor in economic policy: A recent study of the Philippines, for instance, suggests that levying taxes on resource extraction would raise revenues without inflicting excessive pain on the national economy.[20] Of course, what the government actually does with these tax revenues is of considerable importance to the achievement of sustainable development.

Environmental Expenditure Accounts

The simplest monetary accounts are the environmental expenditure accounts being compiled by the United States, Canada, and the United Kingdom as part of their green accounting programs. These accounts generally comprise capital and operating expenditures (by economic sector and at some level of detail) for the protection and enhancement of the environment. Expenditures for flue gas desulfurization (scrubbing) to control emissions of sulfur dioxide are one example. The most immediate uses of these accounts are to measure the total economic burden of environmental protection, the distribution of costs by sector, and possibly unit abatement costs.[21]

Such environmental expenditure accounts could also be used to lower GDP by the amount of the expenditures for pollution abatement and control, as some have suggested. Proponents of this approach make the intuitively appealing argument that the conventional accounts record the "goods" arising from economic activity while ignoring the "bads" stemming from precisely the same source. For example, the (possibly considerable) environmental damage caused by an oil spill is not reflected in GDP while the costs of cleaning it up are. In other words, oil spills actually contribute to economic growth as conventionally measured. In our view, however, essentially defensive expenditures such as those for pollution abatement should remain part of GDP. What should be deducted instead is the monetary value of the environmental damage itself.

Green Accounting Aggregates

Determining the value of environmental damage is clearly the key step in developing a green alternative to GDP. Indeed, this problem provided the impetus for the pioneering studies of green accounting.[22] What might a green alternative to GDP look like? Most of the proposals are framed in terms of adjustments for two factors: resource depletion and pollution. Because both adjustments entail deductions from GDP, the result is a form of net domestic product (NDP). Accounting for resource depletion is relatively straightforward. For nonrenewable resources, depletion equals the total revenues from the sale of the resources less the costs of extracting them. For renewable resources, it equals the same revenues less costs, with an allowance for the natural increase in the resources in question.

Assigning a monetary value to pollution is considerably more difficult. It is clear, however, that pollution reduces the value of economic assets as well as the quality of the environment. Its impacts on human health, forests and other ecosystems, and buildings and materials are all significant and costly. Unfortunately, the question of valuing pollution at the national level is currently unresolved (some of the technical controversies are examined in the box on this page).

Although numerous attempts to compute a green NDP have been made, no country is actually planning to replace GDP as its main economic indicator. Green national accounts are still conceived as adjuncts for two reasons. First, resource depletion and environmental degradation cannot yet be estimated with as much accuracy as the traditional components of GDP. Second, for all its faults, GDP is a useful measure of aggregate economic activity. Thus, even though conventional accounting may be biased against major environmental and social goals, the experimental nature of green national accounting does argue for a fairly cautious approach.

One ambitious alternative to conventional measures, the Index of Sustainable Economic Welfare

(ISEW),[23] would deduct a number of items from GDP, ranging from the costs of commuting to those of depleting the stratospheric ozone layer. This approach has serious limitations, however. For example, while adjusting GDP for ozone depletion is reasonable in principle, in practice it would be fairly tenuous, requiring analysts not only to put a price on ozone-depleting gases but also to best-guess the physical data themselves.

Better measures of well-being should not merely entail deductions from the conventional measures, however. There are many upward revisions that could be made, such as an adjustment for increases in life expectancy, that both the conventional and alternative approaches have ignored.[24] All the same, the value of such exercises for policy is not clear. It is not particularly useful, for instance, to know whether green national income or the ISEW is lower (or increasing less rapidly) than GDP.

As a result, few countries have committed themselves to the goal of producing a green income aggregate even in their satellite (adjunct) accounts. Nor do any of the proposed alternatives, including SEEA's "eco-domestic product" (EDP), really enable policymakers to monitor progress toward sustainable development. To do that, a measure that reflects saving, investment, and wealth is needed.

The Canadian government was one of the first to embrace sustainability as an explicit goal of environmental policy. Recognizing the difficulty of measuring sustainability, however, the government chose to include natural resources in its wealth accounts as a first step. Even wealth accounting is very much in its infancy, although the World Bank recently published preliminary data on wealth for the major regions of the world as part of its own green accounting program (see Table 3 on this page).[25] These data include not only the value of produced assets (buildings and machines) but also tentative estimates for natural resources and human capital (knowledge and skills).

With some refinements, these estimates will give governments useful guidance in the management of their national "portfolios." Having an accurate measure of total wealth is also essential to formulating effective policies for sustainable development. Indeed, the relative magnitudes of natural, produced, and human capital assets will become an important indicator as governments consider development options.

While the rankings in Table 3 make for some good press coverage, the data remain very limited and subject to significant margins of error. Furthermore, extended time series of such indicators will be needed to determine whether wealth is increasing or decreasing. This suggests that another indicator may actually be more useful for policy-genuine savings.[26] Genuine savings is defined as gross savings less the depreciation of produced assets and the depletion of natural resources and other environmental assets. Its rationale is the same as that used by a business: that assets eventually wear out and have to be replaced, usually by means of funds explicitly set aside for this purpose. The virtue of this indicator lies in the fact that it is much easier to measure changes in wealth than the level of wealth itself. It also has direct implications for sustainable development: If genuine savings are persistently negative, well-being will necessarily decline.

Figure 1 on page 43 shows the genuine savings rates for several regional groups of developing countries.[27] What is most striking is the contrast between East Asia and sub-Saharan Africa: In the former, genuine savings increased almost steadily during the 1980s, while in the latter the opposite was the case. This contrast is dramatically reflected in the growth rates of per capita gross national product in the two regions. Countries in Latin America and the Caribbean were marginal dissavers during the debt crisis of 1982-86. This was largely due to a decline in the gross savings rate; there is no strong evidence that these countries stripped resource assets to pay off their debts. From 1987 onwards, they show a marked improvement in savings.

Of course, many other factors have to be considered in determining whether or not a country's behavior is sustainable, including technological progress and population growth. So analysts cannot rely on genuine savings to the exclusion of other indicators. But where genuine savings are less than 1 to 2 percent of GDP (or, even worse, where they are negative), governments have real reason to be concerned.

To address these concerns, governments can charge royalties to discourage rapid extraction of commercial resources and impose environmental taxes to reduce pollution. Overall fiscal policy, particularly the government's own savings rate (surplus or deficit), is also important because it has a major impact on gross national savings. However, indiscriminate cuts in spending on such items as primary health care and education (which are treated as consumption in the conventional accounts) are likely to reduce social well-being and retard the formation of human capital. This is significant because investment in human capital is one of the surest ways to increase future living standards.[28] Including educational expenditures as part of genuine savings would highlight the importance of this factor.

Genuine savings represent only one means of measuring progress toward sustainability, however. Physical indicators of environmental change will continue to be important in areas such as biodiversity. Such diversity is measurable, at least in principle, and numerous efforts are underway to devise appropriate indicators. The main problem is that there is no natural origin for such a measure. That is, we cannot say what level of biodiversity is required for sustainability, though we can--with some effort--determine whether biodiversity is increasing or decreasing. (Genuine savings, by contrast, does have a natural origin, namely zero.) Even so, it is to be hoped that analysts will create practical diversity indicators in the near future to balance the relatively narrow economic vision of sustain-ability with a more ecological view.

CONCLUDING REMARKS

Early attempts at green accounting focused primarily on devising green alternatives to GDP. Researchers often appeared to be pursuing this goal for its own sake, however, with little attention to the policy relevance of their efforts. This has now changed: More modest efforts to link physical data to the economic data in the national accounts (by attributing pollution and resource flows to production and final demand sectors and putting resource extraction and reserves data into balance sheets) are currently the norm. This has led to numerous policy applications (such as modeling the effects of environmental policy on employment and income distribution) that do not necessarily require monetizing changes in environmental quality. Given this, it is possible that environmental impacts such as waste emissions could eventually become a standard component of the economic models employed by finance ministries.

None of this requires a commitment to a green GDP per se, which would offer few new insights regarding progress toward sustainable development in any case. On the other hand, the improved measures of saving (particularly genuine savings) and wealth discussed in this article are prime candidates for meaningful indicators of sustainable development.

In thinking about green accounting, we would do well to remember that it is still relatively new. Although dramatic progress has been made in compiling reliable data and devising useful indicators, it is still too early to draw conclusions about the success of these efforts. National and international organizations are essentially just experimenting in this area, the United Nations by attempting to standardize definitions and methods and the World Bank by developing macroeconomic measures to enrich the policy dialogue with its member countries. Such measures of sustainability as genuine savings and a more inclusive concept of national wealth may be useful in shaping public opinion both nationally and internationally. Then too, the savings approach may

appeal to ministries of environment and finance because it uses concepts familiar to both, namely assets and accounting balances (albeit expanded to encompass environmental change).

Green accounting's greatest achievement may be bringing ministries of finance, natural resources, and the environment together. Broadening the notion of national wealth may lead governments to put more emphasis on education and primary health care as a means of increasing human resources. Indeed, environmentally caused health problems may provide an impetus for green accounting efforts in the years to come. The past five years can be seen as a period of refining methodology and determining policy relevance. The next five should give us practical experience in using green accounts to guide and monitor environmental and natural resource policies.

NOTES

1. World Commission on Environment and Development, Our Common Future (Oxford, U.K.: Oxford University Press, 1987).

2. See, for example, Organisation for Economic Cooperation and Development, Environmental Indicators (Paris, 1994); and World Resources Institute, World Resources 1994-95 (Washington, D.C., 1994).

3. See A. Adriaanse, Essential Environmental Information: The Netherlands (The Hague: Ministry of Housing, Physical Planning, and Environment, 1993); and A. Hammond, A. Adriaanse, E. Rodenburg, D. Bryant, and R. Woodward, Environmental Indicators (Washington, D.C.: World Resources Institute, 1995).

4. These themes were selected on the basis of public opinion polls. By contrast, the European Union's statistical office (EUROSTAT) used expert opinion not only to select themes but also to rank them.

5. See G. Atkinson, W. R. Dubourg, K. Hamilton, M. Munasinghe, and D. W. Pearce, Measuring Sustainable Development: Macroeconomy and Environment (Edward Elgar, forthcoming).

6. World Bank, World Development Report (Washington, D.C., 1993).

7. J.L.R. Proops, "A Proposed Alternative Approach to Integrating the Environment into the National Accounts," in E. Lutz, ed., Towards Improved Accounting for the Environment (Washington, D.C.: Word Bank, 1993).

8. See Atkinson et al., note 5 above.

9. See, for example, United Nations Development Programme, Human Development Report 1995 (New York, 1995).

10. See, for example, M. Desai, "Greening of the HDI?" background paper for United Nations Development Programme, Human Development Report 1994 (New York, 1994).

11. United Nations, Integrated Environmental and Economic Accounting, series F, no. 61 (New York, 1993).

12. Pollutants can, of course, be related to various themes.

13. The extent of these benefits is often exaggerated, however. For an even-handed account of this issue, see Organisation for Economic Cooperation and Development, Environmental Policy and Employment (Paris, 1996).

14. K. Hamilton and G. Cameron, "Simulating the Distributional Effects of a Canadian Carbon Tax." Canadian Public Policy 20,

no. 4 (1994): 285.

15. See R. Costanza et al., "Sustainable Trade: A New Paradigm for World Welfare," Environment, June 1995, 16.

16. See G. Atkinson and K. Hamilton, Measuring Global Resource Consumption: Direct and Indirect Asset Flows in International Trade (Centre for Social and Economic Research on the Global Environment, University College, London, and University of East Anglia, January 1996); and O. G. Pedersen, "Input-Output Analysis and Emissions of CO[sub 2], SO[sub 2], and NO[sub x]: The Linkage of Physical and Monetary Data" (paper presented to the Tenth International Conference on Input-Output Techniques, Seville, Spain, March 1993).

17. C. E. F. Young, Industrial Pollution and Export-Oriented Policies in Brazil (Centre for Social and Economic Research on the Global Environment, University College, London, and University of East Anglia, 1996).

18. R. Hueting, P. R. Bosch, and B. de Boer, Methodology for the Calculation of Sustainable National Income, Statistical Essays M44 (Voorburg, the Netherlands: Central Bureau of Statistics, 1992),

19. O. Jernelov, Swedish Environmental Debt (Stockholm: Swedish Advisory Council, 1992).

20. W. Cruz and R. Repetto, The Environmental Effects of Stabilization and Adjustment Programs: The Philippines Case (Washington, D.C.: World Resources Institute, 1992).

21. It should be noted, however, that determining environmental expenditures entails a number of definition-al and measurement problems. For example, where a firm adopts a new technology that both raises productivity and lowers emissions of pollutants there is no meaningful way to determine the amount of the "environmental" expenditure.

22. See R. Repetto, W. Magrath, M. Wells; C. Beer, and F. Rossini, Wasting Assets: Natural Resources in the National Accounts (Washington, D.C.: World Resources Institute, 1989); and R. Solorzano et el., Accounts Overdue: Natural Resource Depreciation in Costa Rico (Washington, D.C.: World Resources Institute, 1991). Estimates for Mexico and Papua New Guinea can be found in Lutz, note 7 above.

23. See H. Daly and J. Cobb, For the Common Good (Boston: Beacon Press, 1989). The application of the ISEW concept to the United Kingdom is discussed in T. Jackson and N. Marks, Measuring Sustainable Economic Welfare: A Pilot Index 1950-1990 (Stockholm: Stockholm Environment Institute, 1994). A similar indicator, proposed by Clifford Cobb, is the Genuine Progress Indicator (GPI); see C. Cobb, "If GDP Is Up, Why Is America Down?" Atlantic Monthly, October 1995, 59.

24. See D. Usher, The Measurement of Economic Growth (Oxford, U.K.: Basil Blackwell, 1980).

25. World Bank, Monitoring Environmental Progress (Washington, D.C., 1995).

26. See K. Hamilton, "Green Adjustments to GDP," Resources Policy 20, no. 3 (1994): 155; D. W. Pearce and G, Atkinson, "Capital Theory and the Measurement of Sustainable Development: An Indicator of Weak Sustainability," Ecological Economics 8 (1993); 103; World Bank, note 25 above; and Atkinson et al., note 5 above.

27. These savings rates are averages for the countries in the respective samples. As a result, they are strongly influenced by the experiences of the largest countries, which tend to have the highest absolute levels of saving or dissaving. In addition, not all countries in these regions are included in the samples.

28. See World Bank, note 25 above, chapter 8.

Table 1 Human Development Index rankings for selected countries, 1992.

Country	Ranking
Canada	1
United States	2
Japan	3
United Kingdom	18
Ireland	19
India	134
Ethiopia	171
Mall	172

NOTE: The Human Development Index is an average of economic, health, and educational attainment measures.

SOURCE: United Nations Development Programme, Human Development Report 1995 (New York, 1995).

Table 2 A natural resource account for United Kingdom oil

	Thousands of metric tons		Billions of pounds sterling	
	1990	1991	1990	1991
Opening stock	3,643	3,631	37	18
Extractions	-92	-91	-2	-1
Other volume changes[a]	80	388	2	5
Revaluations	n.a.	n.a.	-19	-11
Closing stock	3,631	3,928	18	11

n.a. Not applicable

a Mostly new discoveries

NOTE: The opening stock is the volume (value) of oil reserves and inventories at the beginning of the year. The closing stock is the corresponding volume (value) at the end of the year.

SOURCE: P. Vaze, "Environmental Accounts: Valuing the Depletion of Oil and Gas Reserves," Economic Trends, no. 510 (1996): 36-44.

Table 3 Sources of wealth by region

Region	Human resources (Percent	Produced assets	Natural assets

	of total)		
Developed countries	67	16	17
Developing countries			
Sub-Saharan Africa	31	17	52
India and China	73	18	9
Other Asian countries	75	13	12
Latin America and the Caribbean	50	15	35
Middle East and North Africa	39	29	32

NOTE: The values shown are first approximations based on crude estimates for individual countries. More refined values would probably differ from these, but the overall patterns would not be affected. SOURCE: World Bank, Monitoring Environmental Progress (Washington, D.C., 1995), 63.

GRAPH: Figure 1. Genuine savings rates by region, 1980-90 NOTE: Genuine savings consist of gross savings less the depreciation of produced assets and the depletion of natural resources and other environmental assets. SOURCE: G. Atkinson, W. R. Dubourg, K. Hamilton, M. Munasinghe, and D. W. Pearce, Measuring Sustainable Development: Macroeconomy and Environment (Edward Elgar, forthcoming).

PHOTOS (BLACK & WHITE): PANOS PICTURES-ROB HUIBERS

PHOTO (BLACK & WHITE): As currently structured, national income accounts reflect environmental assets only when they are related to a commercial activity such as tourism.

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By Giles Atkinson and Kirk Hamilton

Giles Atkinson is a research fellow at the Centre for Social and Economic Research on the Global Environment at University College, London, and the University of East Artgila in Norwich, United Kingdom. Kirk Hamilton is an environmental economist in the environment department at the World Bank in Washington, D.C.

Inset Article

PERFORMANCE INDICATORS: AN EXAMPLE

One of the goals of Dutch environmental policy is to limit the country's contribution to global warming. Global warming is caused by certain greenhouse gases that reflect infrared radiation (heat) back to Earth instead of allowing it to escape into space. Each of these gases has a unique global warming potential (GWP) based on its physical properties and time of residence in the atmosphere. Because carbon dioxide is the most common greenhouse gas, global warming potentials are stated in terms of carbon equivalents (Ceq). This common metric permits analysts to compute an integrated greenhouse gas emissions indicator by summing the quantities of the different gases emitted with each gas weighted by its GWP.
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This indicator can then be compared with the country's target levels of emissions to assess its performance in stabilizing those emissions.

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VALUING POLLUTION IN THE NATIONAL ACCOUNTS

Determining the costs of pollution remains one of the major challenges in moving toward green national accounts. Many national income accountants have suggested that maintenance costs (the costs that would have been incurred to avoid degrading the quality of the environment) are the proper measure. However, there are good reasons why this approach should not be adopted.

First, using maintenance costs is not supported by any theory of income appropriate to the greening of national accounts. (Income is usually thought of as that part of assets that can be consumed without reducing future consumption; maintenance costs are unrelated to this concept.) Second, estimating maintenance costs is difficult because it necessarily involves guessing what would have happened under other circumstances. In terms of ease of estimation, marginal social costs represent a much more practical alternative: Once the quantities of various pollutants have been measured, their impacts on human health. living resources, produced assets, and natural ecosystems can be estimated and valued.

Third, and most serious, using maintenance costs could send the wrong signal to policymakers. This is because the marginal cost of abating pollution decreases as the degree of pollution increases (or, putting this principle in a more familiar form, the marginal cost of abatement increases as environmental quality improves). Using this approach would thus have the perverse result of assigning lower and lower costs to pollution as environmental quality deteriorated. In contrast, marginal social costs increase as pollution increases, giving policymakers the correct signal to take remedial action.

It is not clear why national income accountants favor maintenance costs so strongly. There has been very little debate on the question outside technical circles, however--in marked contrast to the lengthy consultative process that attended the valuation of commercial resource depletion. Because assigning costs to pollution is arguably more important than valuing such depletion, it is to be hoped that the issue will be aired thoroughly before a decision is made.

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