Environmental Accounting for Sustainable Development

edited by
Yusuf J. Ahmad
Salah El Serafy
Ernst Lutz

A UNEP-World Bank Symposium

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The World Bank
Washington, D.C.

Manufactured in the United States of America
First printing June 1989

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Library of Congress Cataloging-in-Publication Data

Environmental accounting for sustainable development:
selected papers from joint UNEP/World Bank workshops
/ edited by Yusuf J. Ahmad, Salah El Serafy, Ernst Lutz.
p. cm.—(A World Bank symposium)
Includes bibliographies and index.
1. Natural resources—Accounting. 2. Environmental
impact analysis. 3. National income—Accounting.
4. Economic development—Environmental
aspects. I. Ahmad, Yusuf J. II. El Serafy,
Salah. III. Lutz, Ernst. IV. United Nations
Environment Programme. V. International Bank for
Reconstruction and Development. VI. Series.
HF5686.N3E58 1989
333.7'14—dc20 89-33458
ISBN 0-8213-1224-3 CIP

Foreword

International organizations are making a substantial effort to incorporate environmental concerns in their regular operations. A great deal of work is now being done to help clarify the linkages between development and the environment. This work will enable us to integrate environmental and resource management concerns more effectively in the economic decisionmaking process. It will be an essential component in our efforts to establish the basis for long-term and sustainable development.

Environmental accounting is a complex and sometimes elusive subject. It is also a tool with great potential, however, a tool that can help ensure that future calculations of national income more accurately represent true, "sustainable" income. The current system of national income accounting has some limitations. Gross domestic product (GDP) figures are widely used by economists, politicians, and the media. Unfortunately, they are generally used without the caveat that they represent an income that cannot be sustained. Current calculations ignore the degradation of the natural resource base and view the sales of nonrenewable resources entirely as income. A better way must be found to measure the prosperity and progress of mankind.

We have witnessed increasing pressure on the environment and the natural resource base. We have come to understand that, where the environment is concerned, "there is no such thing as a free lunch" and that someone will eventually have to bear the "external costs" of production and consumption activities. We must learn to distinguish between true income generation and the drawing down of capital assets by resource depletion or degradation.

This volume reflects the attention given during the past six years by the World Bank and the United Nations Environment Programme, as well as others, to this important topic. We hope it will help bring about a needed change in attitude and perception about this issue.

Barber B. Conable President The World Bank	Mostafa Tolba Executive Director United Nations Environment Programme

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Preface

This volume contains selected papers from a series of workshops jointly sponsored by the World Bank and the United Nations Environment Programme (UNEP). UNEP was created at the Stockholm Conference in 1972. During the past seventeen years, members of its Governing Council have urged UNEP to help clarify the linkages between development and the environment. The council believed that such clarification would help integrate issues of environmental and resource management concern into the framework of economic decisionmaking and thus provide a basis for long-term and sustainable development. In 1982, UNEP's Session of a Special Character, which commemorated the tenth anniversary of the Stockholm Conference, requested the executive director to develop methodological guidelines for developing countries on environmental accounting and its use in development policy and planning.

In February 1983, UNEP convened a consultative meeting under the chairmanship of Yusuf J. Ahmad, assistant to the executive director and director for special assignments at UNEP. The main objective of the meeting was to ascertain whether environmental accounting could be developed as a public policy tool, based on the present state of the art. Robert Goodland was the only World Bank representative at that first meeting. He subsequently provided much leadership and encouraged economists to focus on these critical issues. He and Yusuf J. Ahmad, Salah El Serafy, and Jacques Theys chaired the subsequent workshops, which were sponsored jointly by UNEP and the World Bank.

Numerous participants at the workshops made significant contributions, either by presenting papers or by substantial participation in the discussions. They are too many to acknowledge individually; instead we have had to content ourselves with listing the names and affiliations of all participants in the appendix to the text. Of the more than thirty papers or notes that were presented, we have selected the seven that appeared to us to have provided broad insights or brought out new aspects of a complex and sometimes elusive subject. In addition, we have included three contributions that were written afterward by workshop participants (Chapters 4, 9, and 10). In general, the papers indicate current thinking on the issue of environmental and resource accounting. Readers interested in examining papers not included in this volume are encouraged to contact the particular authors.

The chapters in this volume reflect different aspects and approaches to environmental accounting. They are concerned mostly with financial and economic considerations and the prospects of modifying the U.N. System of National Accounts (SNA) to reflect issues of environmental and natural resource concern.

In publishing this volume we have received encouragement, support, or comments from Ramesh Chander, Vinod Dubey, Stanley Fischer, Robert Goodland, Kenneth Piddington, Ibrahim Shihata, Michael Ward, and Jeremy Warford.

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Abbreviations

CES	Conference of European Statisticians
COFOG	Classification of the functions of government (expenditures)
COIP	Classification of outlays of industries by purpose
CPC	Central product classification
ECA	Economic Commission for Africa
ECE	Economic Commission for Europe
ECLA	Economic Commission for Latin America (also CEPAL)
EPP	Environment Protection Program
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	U.N. Food and Agriculture Organization
FDES	Framework for the Development of Environment Statistics
GDFCF	Gross domestic fixed capital formation
GDP	Gross domestic product
GNP	Gross national product
IARIW	International Association for Research on Income and Wealth
ICOR	Incremental capital-output ratio
INSEE	Institut National de la Statistique et des Études Économiques
ISIC	International standard industrial classification
IUCN	International Union for Conservation of Nature and Natural Resources
MCLA	Monetary Center for Latin America (also CEMLA)
MEB	Materials-energy balance
NDP	Net domestic product
NNP	Net national product
NRA	Natural resources accounting
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
PACE	Pollution and abatement control expenditures
SGDE	Sustainable gross domestic expenditure
SGDP	Sustainable gross domestic product
SNA	U.N. System of National Accounts
SNDP	Sustainable net domestic product
SNNE	Sustainable net national expenditure
SSDS	System of Social and Demographic Statistics
UNEP	U.N. Environment Programme
UNESCO	U.N. Education Scientific and Cultural Organization
UNSO	U.N. Statistical Office
WHO	World Health Organization

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Environmental and Resource Accounting: An Overview

Salah El Serafy and Ernst Lutz

Most production and consumption activities have some effect on the physical environment. As economic and population growth have occurred, they have increasingly put pressure on the environment and the natural resource base. Years ago, when the pressure was still small, economists may have been justified in making no reference to the role played by the environment, both as a resource base and as a "sink" to receive the residues of the production and consumption process. But there is little justification for this now.

Economists have considered the side-effects of production and consumption activities to be "external effects." But such effects are external only if a narrow view is taken, which does not consider the effect on the resource system as a whole. Although this system is generally large, it is nevertheless finite, and in certain respects it is subject to great stress. The realization is growing that, where the environment is concerned, "there is no such thing as a free lunch" and that someone will eventually have to bear those "external costs." If a broader view is taken, environmental costs would be internalized in the production processes. In this connection it is essential to reckon costs and benefits properly and to distinguish clearly between true income generation and the drawing down of capital assets by resource depletion or degradation. This, in general terms, is the subject of this volume.

Shortcomings of the Current National Income Measures

Income accounting, if properly done, is a most useful tool for economic analysis and policy prescriptions. It can indicate the level of economic activity, its variations from year to year, the size of savings and investment, the limits society can consume out of its current receipts, factor productivity, industrial structure, comparative performance, and many other things. Development planners, economists, and politicians thus make frequent use of the national income measure of gross national product (GNP) and its variants, such as GDP (gross domestic product) and NNP (net national product) for a variety of purposes. GDP, the most commonly used variant of aggregate income, is essentially a short-term measure of total economic activity for which exchange occurs in monetary terms within a given year. It is valuable mostly for indicating short- to medium-term changes in the level of economic activity, and it is particularly useful for demand management and stabilization policies. As calculated at present, however, it is less useful for gauging long-term sustainable growth partly because natural resource depletion and degradation are being ignored. Furthermore, GDP is often used inappropriately as an indicator of "welfare," frequently without any caveat about its shortcomings for that purpose. The concept of welfare is much broader than a monetary measure of income. It covers many dimensions of subjective well-being other than those that involve market transactions or that can be measured in monetary terms, particularly for people whose basic material needs have been met.

As most economists know, there are several controversial issues concerning national income accounting as currently being practiced, such as the treatment of leisure, household and subsistence production, other nonmarket transactions, and the services of long-lived consumer durables. This chapter will not deal with any of those issues; instead it addresses certain environmental and natural resource issues as they relate to the proper measurement of income and variations in assets. GDP, as measured at present, does not adequately represent true, sustainable income because of two shortcomings. These concern the treatment of environmental protection costs and the degradation and depletion of natural resources. The fact that these issues are not properly dealt with in the current U.N. System of National Accounts (SNA) is a serious flaw from an accounting point of view. As a result, policy advice based on measurements produced under the SNA can be faulty to the extent that GDP does not adequately reflect environmental and natural resource erosion.

The Necessity of Measuring Sustainable Income

True income is "sustainable" income. This is a key point stressed by Daly (Chapter 2) and El Serafy (Chapter 3). True income can be thought of as the maximum amount that can be consumed in a given period without reducing the amount of possible consumption in a future period. This concept encompasses not only current earnings but also changes in assets: capital gains increase income; capital losses reduce income. The essence of the concept of income has been stated by Sir John Hicks as the maximum value that a person can consume during a time period and still expect to be as well off at the end of the period as at the beginning (Hicks 1946, p. 172). Prudent economic management requires that governments know the maximum amount that can be consumed by a nation without causing its eventual impoverishment. It is important, therefore, that national income be measured correctly to indicate sustainable income. Adjustments of the SNA appear to be necessary in the two areas noted above, since these are currently not dealt with satisfactorily: the so-called "defensive expenditures" to protect or restore the environment and the depletion and degradation of natural resources.

Defensive Expenditures

Action is often taken to defend the environment against encroachment by economic activity, and the SNA treats its cost as generating income. Defensive expenditures can be large or small, depending on where the boundaries are drawn. This volume considers only defensive expenditures against the unwanted side-effects of production and consumption (such as pollution) but not those relating to national security, even though similar arguments would apply to them. The most obvious category to be included under defensive expenditures is the cost of environmental protection activities. Another possible category would be car repair and medical expenses as a result of traffic accidents. Leipert listed other costs that might be included and recently measured the defensive expenditures for the Federal Republic of Germany (Leipert 1986 and 1987).

It does not make sense to incorporate expenditures incurred to redress some or all of the negative consequences of production or consumption activities in the stream of income generated by economic activity. It has therefore been proposed that such outlays should not be counted as final expenditure, as is currently the case, but rather as intermediate expenditure.

A conceptually different approach can be taken by considering resources such as water, air, soil, and so forth as natural capital. When such capital is drawn down or degraded, this should show up as consumption in the measurements of national income whether or not defensive expenditures are actually being incurred to correct for the negative effects and restore the drawn-down natural capital. The difference between the defensive expenditures actually incurred and the depreciation of the environmental capital would be reflected at the level of net domestic product (NDP). This approach has been proposed by Harrison and outlined in more detail in Chapter 4. A similar conceptual approach has been proposed by Peskin (Chapter 10), who proposes the introduction of a nature account in addition to the standard accounts for households, industry, and government. Aside from the difficulty of reaching a consensus as to how the environmental or natural capital is to be treated conceptually, the greatest difficulty lies in actually estimating the level of environmental services and damages.

Measuring Pollution within the SNA Framework

Pollution—that is, the discharge of wastes in ways that raise the cost of later activities, harm people, or reduce the enjoyment they get from their surroundings—is an important area in which the national accounts could be used to improve environmental policymaking. Blades (Chapter 5) distinguishes four aspects of pollution and considers the extent to which it is possible and useful to measure them within the framework of the national accounts. These aspects are the output of pollutants, the damages of pollution, the costs of abatement, and the benefits derived from it.

Although it may be feasible to use national accounts to measure the output of pollutants, the information so obtained may be too general to be useful for environmental policymaking. Chapter 5 notes that although there are conceptual and practical difficulties in estimating the total costs of pollution damage, it would be possible and helpful to identify some of the main costs that are already included in the national accounts but are not shown separately at present. The costs of pollution abatement are a part of defensive expenditures. They have been measured in several countries and have been incorporated in macroeconomic models to show the effect of abatement policies on prices, output, and employment. In this area the national accounts would be a valuable tool for environmental policymaking, and Chapter 5 considers in detail the conceptual and practical problems of measuring abatement costs. Finally, although it would be interesting to measure the "market valuation" of the benefits of pollution abatement, the practical difficulties involved are enormous, and it would generally not be feasible to incorporate such data in the national accounts on a regular basis.

Measuring the Difference between Environmental Standards and Actual Behavior

Hueting (Chapter 6) discusses several ways to deal with defensive expenditures and lists the pros and cons of the various options. Since he is skeptical about the usefulness of the willingness-to-pay-method, he prefers that environmental standards be determined by considerations of health and sustainable development. The costs of achieving such standards would then be estimated. These costs would show how far a country has drifted away from sustainable economic development. Although the approach has intuitive appeal, determining the costs would obviously be difficult given the uncertainties about the linkages between production and consumption activities and the environment.

Generally speaking, the issue of the treatment of defensive expenditures for national accounting assumes greater significance the higher the degree of industrialization of the country concerned. The issues of depletion and degradation, which are considered below, are not directly related to the level of industrialization, however, although they seem to be particularly relevant to countries that base their economic activities on the exploitation of natural resources.

The Depletion and Degradation of Natural Resources

There is an evident asymmetry in how the SNA treats man-made assets and natural resources. Man-made assets—buildings and equipment, for example—are valued as productive assets and are written off against the value of production as they depreciate. Natural resource assets are not so valued or adequately accounted for in most instances, however, and their loss produces no charge in the national accounts against current income to reflect the decrease in potential future production. If a country is exhausting its renewable or nonrenewable resources, its current income will thus be inflated by the sale of natural assets that will eventually disappear. Differences in recording under the SNA may arise depending on whether a resource is publicly or privately owned. Private companies tend to take a long view of the natural assets they own, and many make provision for the decrease in the capital stock of natural resources, and in certain countries tax legislation permits such provisions to be excluded from taxable income. No such exclusion is effected in developing countries in which natural resources are exploited by the public sector.

Underlying this asymmetry is the implicit, as well as inappropriate, assumption that natural resources are so abundant that they are costless or have no marginal value. Historically they have been regarded as free gifts of nature—a bias that provides false signals for policymakers. This approach ignores the depletion of valuable resources and confuses the sale of commercially marketable natural assets with the generation of income. Thus it promotes and seems to validate the idea that rapid economic growth can be obtained by exploiting a resource base that may be rapidly diminishing. The growth can be illusory, and the prosperity it engenders transitory, if the apparent gain in income means permanent loss in wealth, that is, if at least part of the receipts is not redirected into new productive investments. As income is inflated, often consumption is also, and the country concerned gets complacent about its economic performance; as a result the adjustment in economic policy gets delayed by the seeming prosperity. In this regard, proper income accounting is an aid to better decisionmaking, but, of course, it does not guarantee that improved decisions will actually be made.

Existing natural capital of geological (nonrenewable) and biological (renewable) resources as well as of "flow" resources (such as water and air) is needed for industrial and agroindustrial production. New geological discoveries, as well as recycling and conservation, do not reverse the depletion of known stocks. The newly discovered stocks themselves come from a finite stock of resources, and they merely extend the time span over which depletion can continue. Depletion of renewable natural resources can have serious indirect effects by reducing the sustainable flow needed for industrial inputs and ecosystem services.

Similarly, crop production at the expense of soil erosion cannot be sustained. Only careful husbandry of environmental capacities can ensure sustainable and potentially larger flows of income in the future. The optimistic argument that human ingenuity is bound to find substitutes for the natural resources being depleted may be generally valid, but it would be imprudent for society to base its behavior on such optimism and would be wrong for economists and accountants not to take rational precautions in case this does not occur.

Two main conceptual approaches to deal with the depletion or degradation of natural resources have been proposed: the depreciation approach and the "user cost" approach. The principle of depreciation of man-made capital can be applied straightforwardly to the consumption of capital embodied in renewable and nonrenewable resources (Daly, Chapter 2; Harrison, Chapter 4). Since geological and ecological information on depletion or degradation comes in physical units, this must be priced or valued in some way before some adjustment can be made to GDP to arrive at a corrected net product. Valuation could be based either on the principle of replacement cost, where replacement is possible, or on (the discounted value of) willingness to pay. Present conventions would value the depleted or degraded resources at current prices where available. If such a correction were effected, the gross product would remain unchanged, but the net product would be adjusted to reflect the depreciation of environmental capital that has occurred during the accounting period.

Because the depreciation approach would leave GDP unadjusted and because it would wipe out from the net product the entire proceeds from natural resource sales, the user cost approach (see Chapter 3) has been proposed as a way of properly taking account of depletion of mineral resources. Possession of a natural resource conveys on its owner an income advantage that is denied to those without a natural resource, and it is not satisfactory to arrive at a measurement of zero net income, as produced by the depreciation method. The user cost approach avoids the difficulties of putting a value on the stock of the resource, but it relies on the conscious assessment of current extraction rates in relation to the total available stock, measured in physical terms. Depending on the rate of depletion and on a discount rate, the revenue from the sales of a depletable resource, net of extraction cost, can be split into a capital element, or user cost, and a value added element, representing true income. The capital element represents asset erosion, and it has been proposed that it should be hypothetically (El Serafy 1981) or actually (Ward 1982) reinvested in alternative assets so that it continues to generate income after the resource has been totally exhausted. Unlike the depreciation method, this would seek to alter the reckoning of GDP itself, not just of NDP. This method would be in harmony with accounting principles and would use current market prices for valuation purposes, but it would require a rule-of-thumb discount rate for converting the capital sales into an income stream. It is also rooted in a proper understanding of the economic meanings of "value added" and "rent," which should not be confused with asset sales.

How the net revenue can be split into user costs and true income is explained in Chapter 3. One needs first to decide on a discount rate, r, say 5 percent. Second, one has to determine the number of periods, n, over which the resource is being liquidated. This can simply be read from the ratio between total reserves and whatever amount is extracted in the current period. Then the formula developed by El Serafy (1981) is used to calculate the ratio of true income, X, to net receipts (exclusive of extraction costs), R:

$$X/R = 1 - \frac{1}{(1 + r)^{n+1}}.$$

R-X would be the "depletion factor" (or user cost) that should be set aside and allocated to capital investment and excluded from GDP, while X would represent true, that is, sustainable, income.

This method is flexible enough to handle changing levels of extraction, movements in the discount rate, and alterations in reserve estimates. Such alterations would include new discoveries, which would change the reserve-to-extraction ratio. In the above formula this is denoted by n, that is, the life expectancy of the reserve measured in years at the current period's extraction rate. The method is not concerned with valuing total reserves, but only with the fraction of the resource being liquidated in the current accounting period, which is valued at current prices. That fraction relies entirely on physical quantities, since the price is the same in the numerator and denominator. The method can be adapted to deal with mineral extraction under conditions of deteriorating quality of the product and rising costs of extraction. Resource owners usually mine the richer deposits first, leaving inferior deposits for later periods, thus inevitably raising the cost of future extraction.

This method, like all accounting methods, does not indicate an ex ante optimal rate of depletion, but merely mirrors decisions already made by the resource owner about liquidating his natural resource. The owner usually determines his extraction rate in the light of many factors, including his expectation of future price changes. If he decides to extract 20 percent of his reserves in one year, then n in the above formulation is equal to 5; the income content of his net receipts, using a 5 percent discount rate, would be 25 percent; and the user cost to be reinvested is 75 percent. If, however, he extracts only 10 percent of his reserves, that is, plans to exhaust his resource over ten years, then he needs to set aside for reinvestment 58 percent of his net receipts, and will thus enjoy 42 percent as current income. The correction needed to reckon "true" income out of natural resource sales is higher the nearer the resource is to exhaustion, and lower the longer its life expectancy at current extraction rates. Only a 1 percent reduction would be necessary in net receipts to arrive at "true" income using a 5 percent discount rate if the resource is being liquidated over 100 years. The choice of the discount rate materially affects the calculation. A high discount rate, which depresses future against current valuation, raises the ratio of "true" income in current receipts. But alternative investments must be found in which to sink the depletion factor ($R-X$) so that it can yield that much as a return.[1]

Resource Accounting

For resource accounting, data need to be collected on renewable and nonrenewable natural resources primarily for the purpose of planning their long-run exploitation in pursuit of sustainable economic activity. Several industrial countries, including Canada, France, Japan, Norway, and the United States, have developed resource accounts that are tailored to their available resources and policy priorities. Some of the important features of the French approach to resource accounting are described below.

Instead of the term "resource accounting" the French use the expression "patrimonial accounting," which could be described as "accounting of the national environmental heritage" (Theys, Chapter 7). This is broader than resource accounting because it includes, for example, cultural heritage in addition to natural resources. The French resource accounting approach is intended ultimately to relate economic growth to the quantities of natural resources that have to be used up or imported to make economic growth possible. Such a system would also help to optimize the economic value of available natural resources, determine the fraction of GDP that should be set aside for the efficient protection of the environment, and orient economic growth so that it does not threaten ecosystems.

When fully developed, the system would be versatile and serve various ends. It would optimize the use of natural resources as factors of production (for example, inversion of a quantitative input/output table that would indicate the intermediate use of natural resources in the productive process); it would describe the economic aspects of resource use (such as which resources would be marketed and in what quantities and values, how to improve the productivity of processing industries to optimize the use of natural resources, and what the opportunity costs are of alternatives); it would treat resources as "environmental goods" (taking into account changes in the quality of the environment, the costs and benefits of environmental policies, and the economic consequences of alternative environmental policies); and it would take stock of the national environmental heritage and define the long-term implications of its transformations, so that it could be preserved for future generations. Since resources to develop such a comprehensive system are necessarily limited, stress is placed on satisfying the needs of the policymaker. Although it would be easier to collect environmental data in the form of flexible reports on the state of the environment and country profiles, the need for developing a system of environmental accounts is paramount, so that the information is standardized, exhaustive, summed up in physical and monetary terms, and comparable in time and space. The long-term goal is to match the standards already reached by national (economic) accounting, which make the SNA such a powerful planning tool for short-term economic management.

The French approach is only one among several being pursued in industrial countries (for example, Norway has been using resource accounts for several years; see Alfsen, Bye, and Lorentsen 1987). The French approach is to build up balance sheets of resources and to monitor their change from year to year, with emphasis on measurements in physical terms. Physical measurements are clearly essential, and without them accounting in monetary terms is impossible. Built into the French approach is the assumption that a comprehensive physical inventory system must be in place before any changes can be proposed in national accounting methodology. This is a point of view shared by many, but there are many others who would want to see national accounting methods adjusted gradually as measurements become available.

Linking Environmental and Resource Accounts to the SNA

The current version of the SNA, which has been in effect since 1968, does not contain an explicit environmental dimension. The ongoing SNA revision was mandated by the U.N. Statistical Commission to simplify and clarify the existing system rather than to propose radical changes. The Commission desired to maintain consistency in time series, even if the series contained conceptual shortcomings.

Among environmentalists and economists with environmental and resource concerns, there are several schools of thought about the best approach to the accounting problem (Norgaard, Chapter 8). Some advocate environmental accounting in physical terms and have little interest in establishing any linkage with the SNA. Their aim is to use indicators of physical change to influence public opinion and environmental policies. At the other end of the spectrum are those who feel that environmental accounting would not have an adequate effect unless the accounts are monetized and integrated into the SNA, which would produce an adjusted national income that is more sustainable.

We believe that environmental accounting in physical terms is essential, particularly as this would cover collecting data that indicate the direction and rate of change in the quantity or quality of a resource. At the same time, we recognize that "monetization," to the extent possible, is important as well and that a linkage with the SNA and an adjustment of the current income concepts and measurements are urgently needed. Given the current state of the art, however, we believe that more conceptual and empirical work is necessary before GDP and NDP in the core of the SNA can be replaced by more sustainable GDP and NDP. That is why we, as an interim step, encourage the construction of satellite accounts, linked with the SNA, in which the adjustments would be made (see Chapter 12). In other words, by having satellite accounts, the user could compute sustainable GDP and NDP (SGDP and SNDP) in them. This half-way solution would not represent a threat to the historical continuity of GDP but has a fair chance of being adopted. If it is adopted, national accountants may take the issues discussed here more seriously and might eventually be willing to adjust the core of the SNA itself.

Bartelmus (Chapter 11) discusses various options for linking or integrating environmental and resource issues with or into the SNA. His chapter was commissioned by the workshop organizers to summarize the views and approaches expressed at the workshops.

Constructing Environmental and Resource Accounts for Developing Countries

In order for resource concerns to be reflected ultimately in the SNA and in policymaking, it is necessary to make progress now at an operational level so that government officials, national accountants, and economists alike can see how to include environmental and resource concerns in the calculations. But it is clear that the development of environmental and resource accounts will take time. This fact, however, should not keep statistical and planning officials in developing countries from initiating relevant work now, especially on minerals or forestry, where data to a large extent are already available. In the case of Indonesia, Peskin (Chapter 9) argues that a local research effort should start right away, supported initially with periodic consultant inputs. Ideally not only environmental, but also other important nonmarket factors should be considered in an expanded accounting structure. This idea is elaborated in Chapter 10.

Repetto and others (1987) have applied resource accounting to fuel and forestry resources in Indonesia. For forestry they estimated harvesting, deforestation, and degradation net of regrowth and suggested that it be treated like depreciation of man-made assets, that is, they proposed reducing the NDP by the estimated depletion. A similar approach was followed for valuing the depletion of fuel reserves (but see reservations about this and an alternative proposal in El Serafy, Chapter 3). Another empirical study (Magrath and Arens 1987) estimated the cost to the economy of soil erosion in Java. The annual amount estimated was US$350 million to US$415 million, which is slightly less than 0.5 percent of GDP. More than 95 percent of this cost is the on-site cost of declining productivity. These two studies have made valuable contributions, but it is clear that further empirical work is needed (see Chapter 12).

A Variety of Approaches, but a Common Theme

A variety of approaches for amending the SNA are proposed by various authors in this volume. This, however, should not detract from the central theme argued by all of the authors: in their present form the guidelines for income calculation under the SNA leave out important aspects of economic development that should be brought into the accounts. These guidelines now produce readings of levels of activity and growth over time that can lead to faulty policy advice. Such readings frequently exaggerate income and thus encourage consumption and promote habits of behavior that cannot be sustained over the longer term.

An interesting argument over "desirable and practicable" adjustment is highlighted by the approaches regarding depletable resources of Harrison (Chapter 4) and El Serafy (Chapter 3). Both are in fundamental agreement about what constitutes sustainable income and what does not. Harrison would work within the existing framework of the SNA by preserving the definition of final demand used at present but would include consumption of natural capital as a parallel entry to consumption of man-made capital, with appropriate adjustments to NDP. Further, she argues that income measures should exclude all capital consumption and therefore that net products should be used to indicate the level of economic activity and its development over time. El Serafy, by contrast, would redefine the distinction between intermediate and final demand by arguing that the sale of natural capital must not be viewed as generating value added and that at least part of that income should be excluded from GDP itself, as well as from the net product. Thus the GDP measurement could continue to be used extensively, as is now the case, to describe performance and guide economic policy.

Norgaard (Chapter 8) is skeptical about the economists and accountants concerned about the environment ever being able to agree on a set of corrections that would simply rectify and fill in gaps in the existing SNA to produce one aggregate figure expressed in monetary terms. He claims that the existing SNA contains contradictions because it is based on conventions and reflects consensus rather than being built on deductive reasoning. He does not view sustainability as implicit in the definition of income, which both Daly and El Serafy do, but as an "ethical" goal, representing a "separate social objective of development strategies." He believes the undervaluation of the concerns of future generations reflects the nonparticipation by future generations in the capital markets of today.

A more conventional view would ascribe such undervaluation to the use of too high a discount rate, which reduces the value of future net benefits almost to nothing the more distant the future. Since future generations will never be able to participate in today's capital markets, the surest way of reflecting their preferences is to use lower discount rates. Norgaard is raising questions regarding the economic approach to the "sustainability of development," which is based on accounting that relies on market valuations. He espouses "methodological pluralism" in the belief that a multiplicity of perspectives would ensure that "all values are respected to the extent possible," so that decisionmakers have information alerting them to "as many aspects of environmental and resource phenomena as possible." Norgaard, however, does not spell out how such alternative value systems can be established or used; nor does he speculate on the sort of solutions they would produce.

There are other areas in which the workshop participants have expressed different points of view, but the main message this volume hopes to convey is the urgent need to recognize the shortcomings of the current measures of income and to work toward a more sustainable concept and measurements—a common thread in all the contributions included here.

Note

1. J. M. Keynes (1936) first introduced the concept of "user cost" in relation to capital equipment. He defined it as the "maximum net value which might have been conserved . . . if it [the equipment] had not been used." He described this concept as constituting "one of the links between the present and the future." (See chap. 6 and its appendix of his *General Theory*.) Project analysis of depletable minerals has also made use of the concept of user cost at the micro level (see, for example, Schramm 1986).

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2

Toward a Measure of Sustainable Social Net National Product

Herman E. Daly

Sustainable Income

The central criterion for defining the concept of income has been well stated by Sir John Hicks:

> The purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning. Thus when a person saves he plans to be better off in the future; when he lives beyond his income he plans to be worse off. Remembering that the practical purpose of income is to serve as a guide for prudent conduct, I think it is fairly clear that this is what the central meaning must be. (1946, p. 172).

The same basic idea of income holds at the national level. Income is not a precise theoretical concept but rather a practical guide to the maximum amount that can be consumed by a nation without eventual impoverishment. We know that we cannot consume the entire gross national product (GNP) without eventually impoverishing ourselves, so we subtract depreciation and get net national product (NNP), which is usually taken as income in Hick's sense. The central defining characteristic of income is *sustainability*. The term "sustainable income" ought therefore to be considered a redundancy. The fact that it is not is a measure of how far we have strayed from the central meaning of income and, consequently, of the need for correction.

But could we really consume even NNP year after year without impoverishing ourselves? No, we could not, because the production of NNP requires supporting activities that are not biophysically sustainable, and the measurement of NNP overestimates the maximum net product available for consumption. Consequently, NNP increasingly fails as a guide to prudent conduct by nations.

Two adjustments to NNP are needed to make it a closer approximation to Hicks' concept of income and a better guide to prudent behavior. One adjustment is simply to extend the principle of depreciation to cover consumption of natural capital stocks depleted through production. The other is to subtract defensive expenditures, or regrettable expenditures necessary to defend ourselves from the unwanted side effects of our aggregate production and consumption. Regrettable defensive expenditures are in the nature of intermediate goods, costs of production rather than final product available for consumption. To correct for having counted defensive expenditures in NNP, their size must be estimated and subtracted to arrive at an estimate of maximum sustainable consumption, or true income.

To summarize, let us define the corrected income concept, "sustainable social net national product" (SSNNP), as net national product (NNP) minus both defensive expenditures (DE) and depreciation of natural capital (DNC). Thus,

$$\text{SSNNP} = \text{NNP} - \text{DE} - \text{DNC}.$$

This definition entails no interference whatsoever with the current structure of the U.N. System of National Accounts (SNA). There is no loss of historical continuity or comparability. Two additional accounts are introduced, not for frivolous or trendy reasons, but simply to gain a closer approximation of the central and well-established meaning of income. No attempt is made to deal with the controversial issues of national income accounting, such as inclusion of leisure, disutility of labor, household production, and services of long-lived consumer durables. The relation of income to welfare is not addressed.

Since NNP is a familiar concept, it remains only to discuss briefly the new accounts: defensive expenditures (DE) and depletion of natural capital (DNC), which are by no means novel ideas, but are not yet included in as part of an extended SNA.

Defensive Expenditures

The explosion of the populations of human bodies, of artifacts of all kinds, and of the populations of plants and animals exploited for human use that has happened in the past fifty years might better be called an "implosion," since it has occurred in a finite environment. The term implosion suggests a compressing together rather than an expanding apart, a process of congestion, mutual interference, and self-canceling collision. Defensive expenditures reflect this increasingly prevalent phenomenon of mutually interfering, self-canceling activities.

The category of defensive expenditures can be large or small depending on where the boundaries are drawn. Christian Leipert of the International Institute for Environment and Society in Berlin has suggested five broad categories of defensive expenditures.

- Defensive expenditures induced by the overexploitation of environmental resources in the general course of economic growth, such as the costs of all environmental protection activities and expenditures for environmental damage compensation.
- Defensive expenditures induced by spatial concentration, centralization of production, and associated urbanization, such as increased commuting costs, housing, and recreation costs.
- Defensive expenditures induced by the increased risks generated by the maturation of the industrial system, such as increased expenditures for protection against crime, accident, sabotage, and technical failure.
- Defensive expenditures induced by the negative side effects of car transport, such as traffic accidents with associated repair and medical expenses.
- Defensive expenditures arising from unhealthy consumption and behavioral patterns and from poor working and living conditions, such as costs generated by drug addiction, smoking (both active and passive), and alcohol.

These categories are neither exhaustive nor mutually exclusive and are naturally somewhat arbitrary. Category 1 might, in our classification, fit better under DNC. But it represents a start at subtracting expenditures that do not reflect any increase in the net product available for consumption without eventual impoverishment.

Depletion of Natural Capital

This is entirely analogous to the depreciation of man-made capital. In fact, Keynes justified the concept of user cost for man-made capital by analogy with the more self-evident case for charging user cost for natural resources. The obvious categories of natural capital are geological (nonrenewable) and biological (renewable). Both, of course, are depletable. Depletion of geological capital is necessary for industrial and agroindustrial production. New geological discoveries do not reverse the process of depletion, but they do extend the time span over which the depletion can continue.

Depletion of renewable natural capital is in some ways a more serious matter because reduced stocks or populations of plants and animals will lead to a reduction in sustainable flow of resource inputs and ecosystem services. Only by a future investment (reduction in consumption) could the larger sustainable flow be reestablished, and even that is often not possible. Even in commercially exploited populations that are above the level of maximum sustainable yield and therefore would yield more with a smaller stock, the consumption of the stock diminution is not a sustainable source of income, but rather capital consumption.

Geological and ecological information on depletion comes in physical units and must be priced or evaluated in some way before it can be subtracted from NNP. This will no doubt involve some arbitrary conventions. Valuation might be based either on the principle of replacement cost or on willingness to pay, whichever is less, in order to be "conservative." It is not clear that any greater arbitrariness would be involved than already exists in current estimates of depreciation of man-made capital, especially if one counts obsolescence or "moral" depreciation as well as physical.

Income, as Hicks emphasized, is not a theoretically precise concept, but rather a practical guide to prudent behavior. Surely some reasonable allowance, however imprecise, for depletion of natural capital and some correction for the double counting of defensive (intermediate) expenditures are required if the income concept is to remain a guide to prudent behavior by nations, which is its fundamental reason to be. The two adjustments are in keeping with the central idea of income and involve no disruption of the existing SNA. The need for such adjustments has already led independent scholars to begin work on measuring defensive expenditures and the depletion of natural capital. What remains is to give official status and formal recognition to these adjustments aimed at keeping the income concept as a reliable guide to prudent behavior in a world that has changed significantly since national income accounting was first institutionalized.

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3

The Proper Calculation of Income from Depletable Natural Resources

Salah El Serafy

Recognition is growing that income is not being accurately calculated for economies based on natural resources. Some would even say that, for these economies, national accounting methods produce misleading calculations. They lead to measurements that neither faithfully describe economic performance ex post, nor can they be used as a basis for useful policy proposals. For such economies, current accounting practices exaggerate income, encourage unsustainable levels of consumption, and obscure the necessity to implement greatly needed policy adjustment. The problem is relevant to practically all countries where nonrenewable resources are being exploited and where renewable resources are being run down without being restored. But it is most acute where such resources are being exploited in the *public* sector, either directly or through foreign interests.

In the more industrialized countries, where exploitation typically occurs in the private sector, tax allowances for depletion tend to correct the calculation of the "value added" believed to be generated by such activities. Such correction of course is effected as depreciation, reducing the gross product by an element to cover depletion. The correction is frequently not exact, but it is a step in the right direction. This process is being helped by the fact that when properties containing marketable natural resources, such as subsoil deposits, exchange hands, their market value tends to reflect their natural-resource content. By contrast, no such correction is made in most of the developing countries, whose economies depend in varying degrees on the exploitation of their natural resources, such as mineral extraction or the commercial logging of forests to make timber and paper. This problem, therefore, is one of paramount importance for the developing world.

The practice in these countries follows the United Nations System of National Accounts (SNA), which treats revenue derived from the sale of natural resources as current income, or rent, that is available for consumption. If the revenue accrues to the public sector, it can be used just like revenue from any other source, such as the proceeds from income taxes. Given their short perspective, the politicians in charge of such economies often do not want to be reminded that the revenue derived from liquidating their country's natural assets is neither recurrent nor sustainable. And many a developing country rejoices in having its leadership praised for illusory rapid economic growth, apparently high rates of saving and investment, and deceptively stable or near-stable price levels brought about by import surpluses.

Such apparent prosperity is bought at the cost of asset erosion—a sure recipe for future economic decline. Thus natural resources are exported and used up to prop up a truly unbalanced, but seemingly comfortable, external balance. An overvalued exchange rate inevitably develops, and relative prices are upset as a "Dutch Disease" syndrome sets in, whereby the prices of nontradable goods and services rise in relation to those of tradables.[1] Consequently, the economy's capacity is reduced to produce and export the products of nonnatural-resource-based activities that could provide badly needed employment and (sustainable) future income. Any comparative advantage the country may have gets sacrificed during a period of ephemeral prosperity and illusory growth. This is particularly true where the exhaustion of the resource is imminent. Needless to say, the citizens of these countries find it only too easy to adjust to a higher level of consumption.

When the bonanza ends and the natural resource is almost exhausted, standards of living have to fall, and intolerable pressures develop on the external balance. Quite often the country finds itself saddled with a high external debt, which it contracted in the prosperous years when it had overestimated its capacity to borrow and its creditors had mistakenly assumed that the prosperity would continue. The government then finds itself in an impossible situation in which there are no margins left to provide a cushion for urgently needed policy adjustment that should have been initiated years before. The halcyon period of plenty will have come to an end, and all the putative economizing that had been done during those years is seen in retrospect to have been false and futile. Defective accounting had led economic behavior and policy analysis astray.

The fundamental principle that is flouted by applying conventional national income accounting to depletable resources is the separation that must be maintained between income and capital. This principle tells us that if you liquidate your assets and use the proceeds for consumption, you are living beyond your means, and in doing so you are undermining your ability to create future income. The accounting profession was born, in the late Middle Ages in the city states of the Mediterranean basin, largely to separate from the proceeds accruing to merchants that part which they could use to finance their families' current needs. Those merchants had to guard against consuming their capital, which was the source of their continued well-being. From its infancy the accounting profession specifically has addressed this task. In present-day language the accountants were asked to define sustainable levels of *consumption*, and they could do so only by attempting to *keep capital intact*.

The same principle was taken up by Adam Smith, who saw capital as a means "to increase the productive powers of labor" and as an asset whose maintenance was imperative, since it "is always repaid with great profit, and increases the annual produce by a much greater value than that of the support which such improvements require." *The Wealth of Nations* (Smith 1776) states that:

> The gross revenue of all the inhabitants of a great country, comprehends the whole annual produce of their land and labor; the neat revenue, what remains free to them after deducting the expense of maintaining; first, their fixed; and, second, their circulating capital; or what, without encroaching upon their capital, they can place in their stock reserved for immediate consumption, or spend upon their subsistence, conveniences, and amusements. Their real wealth too is in proportion, not to their gross, but to their neat revenue.

The SNA, in failing to distinguish between *unsustainable* receipts, derived from the sale of natural assets, and *sustainable* income, produced by the factors of production, disregards the fundamental Smithian concept of "neat revenue," which should guide the consumption and assessment of the wealth of the revenue recipient.

The distinction between capital and income has remained crucial throughout the development of economics. In the present day, Hicks paraphrased this principle into a definition of income as that amount which a person can consume during a given period and still be as well off at the end of the period as at the beginning.[2] More specifically, we are told in no uncertain terms that:

> . . . if a person's receipts are derived from the exploitation of a wasting asset, liable to give out at a future date, we shall say that his receipts are in excess of his income" (Hicks 1946, p. 187).

Natural resources are certainly "wasting assets" if they are nonrenewable (for example, minerals), or, if they are renewable (for example, forests exploited for timber, fisheries, or agricultural soil), are not *actually* renewed through careful maintenance, thus causing the receipts from their exploitation to give out in the future. Ignoring this elementary fact makes a mockery of what has been passing as economic analysis and policy prescription for economies based on natural resources (and in particular, those based on minerals), in which no effort has been made to compensate for draining the national wealth by depleting these resources. Maintaining capital intact is not a marginal issue. It is central to all economic behavior and analysis, and it is a poor economist indeed who is unable to tell capital from income.

Conceptual Background

The confusion of capital and income, which has been the standard approach to income calculation in this area and which derives support from the SNA, is becoming increasingly untenable. This chapter offers a way to estimate the true income content of the proceeds from mineral sales. The treatment of income from renewable resources such as forests, which have to be maintained through replanting, or fisheries, which have to be restocked, is more straightforward. Where such replanting or restocking is effected at technologically acceptable rates that would keep capital intact, these activities could be charged against the gross returns from the natural resource to obtain the net value added generated; this is similar to the way capital consumption is treated in national accounts. Soil erosion also belongs to the same category of a natural resource whose depletion can be offset by restoration, and the cost of restoration should be charged against the gross product of the soil to obtain a true estimate of the net product.

But quite often, particularly in poorer countries, the resource is not restored to the same level of activity. As a result the value added that appears to be generated contains capital elements that should be removed. In this case those who estimate national income should impute a capital consumption charge based on technically acceptable criteria against current receipts to obtain the true income from these activities. For soil erosion, some estimate may be necessary of the declining power of the soil to produce, and this can be based, for example, on declining land yields over time. This chapter, however, addresses only the problem of estimating income generated from depletable, nonrenewable resources.

My thinking on this topic began to be shaped by a sense of discomfort over what I thought to be an inappropriate use of economic concepts when the pricing of petroleum began to attract the attention of economists in the early 1970s. To my mind the oil market had long been an oligopsonistic market, dominated by powerful multinational conglomerates. Economic analysis had contributed little to understanding how prices were determined in that sort of market, beyond the traditional models of oligopoly theory, which concentrated on how equilibrium was reached rather than on the level of prices produced by it. Later, when oligopsony in the petroleum market gave way to an apparent monopoly allegedly instituted by the Organization of Petroleum Exporting Countries (OPEC), the price increases were too facilely attributed to the powers of the exporters' cartel.

It was curious that many analysts overestimated the competition prevailing in that market before 1973 and underestimated it afterward, emphasizing OPEC's monopoly power. It was even more curious that many analysts in the 1970s appeared to think that if free competition were to prevail, competitive equilibrium would indicate a price equal to the marginal cost of *extraction*, which was—and still often is—referred to as *production*, and that it was only because of the alleged cartelization of supply that the price was able to rise above that cost.[3]

This construction was later challenged by those who were aware that the price of an irreplaceable natural resource, such as petroleum, should perhaps contain a user cost or capital element, representing the erosion of the resource. Even under free competition, the marginal cost of extraction could not possibly indicate an equilibrium price level, since the cost of extraction is tantamount to the cost of asset liquidation and cannot determine the value of the very asset being sold. Hotelling had to be resurrected and used with great dexterity by an important economist like Solow for a more convincing explanation of petroleum price increases before the economic profession could be persuaded.[4] But it has not been completely persuaded, and doubters still abound.

Parallel to the microeconomic confusion about the pricing of natural resources, other inaccuracies have also been perpetrated and have distorted thinking about macroeconomics in countries where the exploitation of depletable natural resources is significant. If the marginal cost of extraction was the only cost, then any surplus accruing to the sellers was pure rent and represented value added to be included in the gross domestic product (GDP). This certainly is implied by the accounting practices currently being used under the SNA. Based on these practices, the expansion of economic activity as a consequence of accelerating the liquidation of subsoil assets is applauded as good economic performance and is confused with the growth that comes from labor, capital formation, technological progress, and efficient organization. The revenue accruing to countries that deplete their natural resources in this way is reflected in increased saving rates and investment coefficients and in improved parameters, such as incremental capital-output ratios (ICORS), which shed deceptively favorable light on the economic performance of such economies. Policy advice based on these calculations becomes dulled at best—and downright wrong at worst.

The concept of rent in this situation is profoundly misused and totally misapplied. In the perception of the classical economists the rent that qualified as value added derived from the indestructible powers of nature.[5] Such revenue is clearly sustainable where the powers of nature to reproduce it are not impaired, and it can therefore legitimately be counted as income. The surplus, net of extraction costs, emanating from liquidating natural resources, however, has little kinship with either rent or quasi-rent as defined by Marshall (1920).

There seems to be no alternative to bringing the capital nature of such exploitation into the open and integrating this in all economic thinking and measurements, not just to gauge welfare adequately, but to save the discipline of economics from disrepute. Even noneconomists have on occasion rightly perceived that mineral extraction revenues are not wholly current income. A small and underdeveloped country such as Libya could thus legislate as early as 1963 (when it first began to extract petroleum in commercial quantities) that at least 70 percent of petroleum proceeds had to be allocated to development. The perception was strong in that very poor country that this unique wealth truly belonged to future generations and should not be squandered on consumption, as would be implied by treating its sales as current income. To recall Hicks's standard definition, current income is that part of receipts which, if devoted to consumption, would leave the earner no worse off at the end of the accounting period than at its beginning.

Weakness of the Depreciation Approach

Like other economists of the same bent, I thought first of using the "capital consumption" or "depreciation" approach to treat income from depletable mineral resources. As the resource is depleted by the quantity of extraction during the year, the amount of depletion, valued at current prices, can be deducted from the gross proceeds, just as, for example, the depreciation of capital equipment used for manufacturing is subtracted from the gross value added by manufacturing activities. The mineral extraction earnings can still be reckoned in GDP, provided that the value of the depletion is deducted from it for calculating *net* income. The problem of the exact valuation of capital consumption in this case appears to be of secondary importance. Much more important is to try to make *some* adjustment. Various methods are already used to treat inventories and other capital assets used up in the process of production. Shortcuts, approximations, and arbitrary estimations are used throughout national income calculations, and no special harm can come from adding the depreciation of natural resources to the list.

On reflection, however, I moved away from this approach, both for practical as well as conceptual considerations. First the conceptual. It is wrong to describe as current production that which is not current production. GDP is an important measurement and is much more in use than NDP (net domestic product). Even if NDP and its national parallel NNP are correctly measured, the whole apparatus of GDP with its structure, input-output relations, and changes over time would remain incorrectly calculated if revenues from depletable resources are counted as value added in GDP.

It is not by chance that the gross product, rather than the net product, is the preferred quantity for macroeconomic analysis. It is often used as a denominator for crucial macroeconomic ratios, with the nominator being money supply, exports, imports, external debt, debt service, savings, capital formation, and so forth. As Hicks has suggested, the concept of net income is usually eschewed because it is always arbitrary. It relies on estimates of depreciation and inventory use that are a mixed bag of historical costs and estimation based on accounting conventions, tax laws and allowances, and insurance company practices, as well as subjective valuation by economic agents who do the reckoning and who have a variety of expectations about the future (Hicks 1981, chap. 9). *If an income correction is to be made, it should apply therefore to the gross product itself, and it is not enough to effect the adjustment at the net product level.*

Another reason why I discarded the depreciation approach to rectifying income accounting for depletable resource activities is the fact that countries with marketable natural resources are evidently better off than those without such resources, and they can enjoy a higher and sustainable standard of living than the latter by virtue of their resource endowment. Such an advantage should be reflected in calculating the income of both groups. If we deduct from the gross receipts from mineral sales in any one year an amount equal to the depletion along the lines described above, the value of *net income* from this activity becomes zero. Where a country derives 100 percent of its receipts from, say, petroleum extraction—an extreme case of a Saudi Arabia—the depreciation approach (ignoring the multiplier effect of ancillary activities related to extraction as well as the contribution of other sectors to value added) would give us a GDP of 100 and a NDP of zero—a measurement that is not particularly edifying. For the gross product this approach would not make any adjustment and would simply eliminate the net product altogether. Such a measurement of net income would belie the observable fact that having subsoil mineral deposits to exploit gives their possessors an *income* edge over those who do not have that advantage.

Conversion to a Permanent Income Stream

Mineral deposits and other comparable marketable natural resources are assets. Sales of assets do not generate value added and should not be included in GDP. They do generate liquid funds, however, which can be put to alternative uses. A country may choose to spend the proceeds (net of extraction costs) on consumption or investment or any combination of the two. But this is neither here nor there. From an accounting point of view, however, an income content of the net receipts can be estimated. This income content should be part of GDP since it represents value added. The argument for this proceeds as follows.[6]

If an owner of a wasting asset is to consume no more than his income, he must relend some part of his receipts so that the interest on it will make up for the eventual failure of receipts from the wasting asset in the future. This proposition, which can be found in Hicks (1946, chapter 14), suggested the need to convert the mineral asset concerned into a perpetual income stream. The *finite series of earnings from the sale of the resource, say* a ten-year series of annual extractions leading to the extinction of the resource, has to be converted to an infinite series of *true* income, such that the capitalized values of the two series are equal. From the annual earnings from sales, an income portion that can be spent on consumption should be identified; the remainder, a capital element, should be set aside year after year and invested to create a perpetual stream of income that would provide the same level of true income, both during the life of the resource as well as after the resource has been exhausted. The two constituent portions of current receipts need to be defined: the income portion and the capital portion. Under certain assumptions, which are neither too restricting nor too unrealistic, the ratio of true income to total receipts is:

$$X/R = 1 - \frac{1}{(1 + r)^{n+1}}$$

where X is true income, R the total receipts (net of extraction cost), r the rate of discount, and n the number of periods during which the resource is to be liquidated. $R-X$ would be the user cost or depletion factor that should be set aside as a capital investment and totally excluded from GDP. On the expenditure side, this depletion factor would represent a disinvestment that should be set against capital formation in new assets, so that total expenditure would still be equal to the true income. If all of the receipts were devoted to consumption and if new capital formation fell short of the depletion factor, the accounts should show a negative value for capital formation, thus reflecting the disinvestment that had occurred in the accounting period.

The ratio *X/R* depends only on two values: the reserves-to-extraction ratio, that is, the life expectancy of the resource measured in years, and the discount rate. A country that liquidates its mineral reserves over fifty years needs to set aside for reinvestment a smaller portion of its receipts than another that liquidates its reserves over twenty years, and thus it can count a larger portion of its receipts as *income*. Similarly, if the receipts set aside can be invested at a higher interest rate, say 10 percent, a higher portion would be reckoned to income than if the interest was 5 percent. According to this formula, with a discount rate of 5 percent, a country that liquidates its natural resource over ten years can consider as income only 42 percent of its annual receipts, while another with a fifty-year horizon can reckon as much as 92 percent of its annual receipts to current income. At a 10 percent discount rate the former's current income would be 65 percent of the receipts and the latter's 99 percent, which would require almost no correction to GDP estimates as currently made.

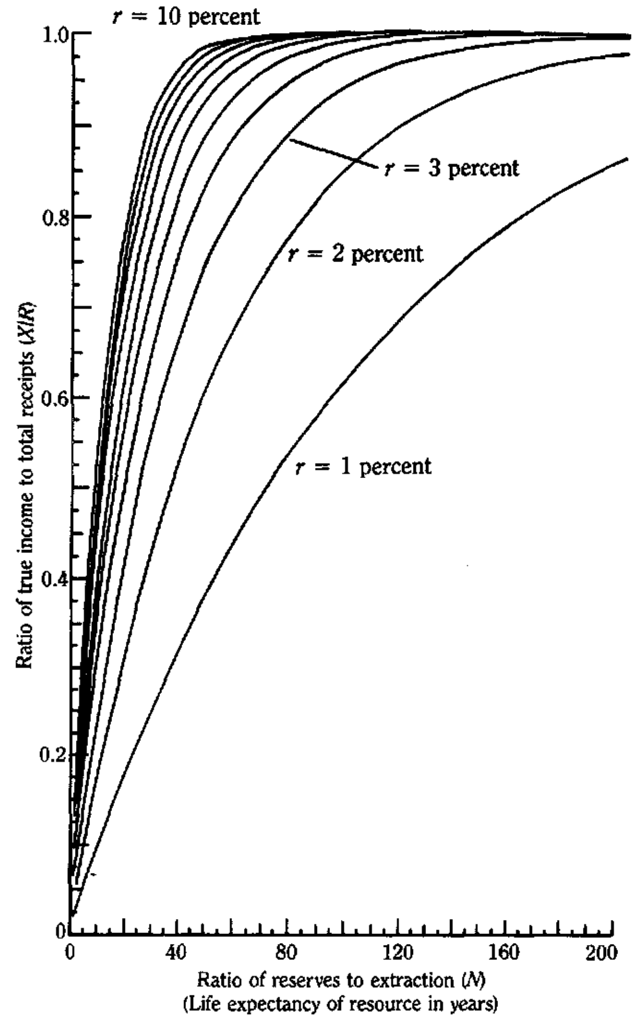
Figure 3-1 shows the ratio *X/R* (the portion of total receipts that is true income) as a function of the life expectancy of the resource, *N*, measured in years, at ten alternative discount rates, decreasing from 10 to 1 percent. The same relation is given in Tables 3-1 and 3-2. Table 3-1 shows the income content of mineral sales at eleven alternative discount rates from 0 to 10, for resource life expectancies of 1 to 100 years. This is shown as percentage shares of the receipts that are currently being treated under the SNA as if they were wholly income. Table 3-2 is the complement of Table 3-1 and presents the user cost content of the annual sales, expressed also as a percentage of total receipts, for the same discount rates and life expectancies. This percentage represents the capital element that, I believe, should be excluded from GDP as a depletion factor.

The calculations show that the present practice of counting mineral sales proceeds as current income implies that the fraction

$$\frac{1}{(1 + r)^{n+1}}$$

equals zero in the previous formula. For only then would $X/R = 1$. This would be obtained, irrespective of the discount rate, by having $n = \infty$; or alternatively, where n is finite, by having a very high value of the discount rate so that r tends to infinity. Such a high rate of discount implies a very strong time preference of the resource owners and is tantamount to setting a very low value on the utility of the resource to future generations. Current practices for calculating GDP according to the injunctions of the SNA are thus seen to be built on one of two untenable premises or a combination of both: that the natural resource being liquidated would last forever and that the welfare of future generations does not matter.

Figure 3-1. ***Income Content of Mineral Sales at Various Life Expectancies and Discount Rates***



Note: r = alternative discount rates.

Clarification of the User Cost Approach

In defense of this approach, the following points should be clarified and emphasized.

- A discount rate must be chosen. This decision has to be arbitrary, but the arbitrariness of the discount rate is not in principle any different from the arbitrary estimation methods used extensively under the SNA. A rate

Table 3-1. ***Income Content of Mineral Sales (X/R)***
(percent)

Life expectancy of the resource (N) (years)	Discount rate (r)										
	0	1	2	3	4	5	6	7	8	9	10
1	0	2	4	6	8	9	11	13	14	16	17
2	0	3	6	8	11	14	16	18	21	23	25
3	0	4	8	11	15	18	21	24	27	29	32
4	0	5	9	14	18	22	25	29	32	35	38
5	0	6	11	16	21	25	30	33	37	40	44
6	0	7	13	19	24	27	33	38	42	45	49
7	0	8	15	21	27	32	37	42	46	50	53
8	0	9	16	23	30	36	41	46	50	54	58
9	0	10	18	26	32	39	44	49	54	58	61
10	0	10	20	28	35	42	47	52	57	61	65
15	0	15	27	38	47	54	58	66	71	75	78
20	0	19	34	46	56	64	71	76	80	84	86
25	0	22	40	54	64	72	78	83	86	89	92
30	0	27	46	60	70	78	84	88	91	93	95
35	0	30	51	66	75	83	88	91	94	96	97
40	0	34	56	70	80	86	91	94	96	97	98
50	0	40	64	78	86	92	95	97	98	99	99
60	0	46	70	84	91	95	97	99	99	99	100
80	0	55	80	91	96	98	99	100	100	100	100
100	0	63	86	95	98	99	100	100	100	100	100

Note: Figures are rounded to the nearest digit.

Table 3-2. ***Capital Content (or "User Cost") of Mineral Sales (1 − X/R)***
(percent)

Life expectancy of the resource (N) (years)	Discount rate (r)										
	0	1	2	3	4	5	6	7	8	9	10
1	100	98	96	94	92	91	89	87	86	84	83
2	100	97	94	92	89	86	84	82	79	77	75
3	100	96	92	89	85	82	79	76	73	71	68
4	100	95	91	86	82	78	75	71	68	65	62
5	100	94	89	84	79	75	70	67	63	60	56
6	100	93	87	81	76	71	67	62	58	55	51
7	100	92	85	79	73	68	63	58	54	50	47
8	100	91	84	77	70	64	59	54	50	46	42
9	100	90	82	74	68	61	56	51	46	42	39
10	100	90	80	72	65	58	53	48	43	39	35
15	100	85	73	62	53	46	42	34	29	25	22
20	100	81	66	54	44	36	29	24	20	16	14
25	100	78	60	46	36	28	22	17	14	11	8
30	100	73	54	40	30	22	16	12	9	7	5
35	100	70	49	34	25	17	12	9	6	4	3
40	100	66	43	30	20	14	9	6	4	3	2
50	100	60	36	28	14	8	5	3	2	1	1
60	100	54	30	16	9	5	3	2	1	1	0
80	100	45	20	9	4	2	1	0	0	0	0
100	100	37	14	5	2	1	0	0	0	0	0

Note: Figures are rounded to the nearest digit.

of 5 percent or thereabouts can be chosen as approximating what the classical economists used to call a natural rate of time preference. This could be changed periodically, say every five years, guided by changes in the long-term market rates.

- Under the proposed formula, the setting aside of part of the proceeds for reinvestment is only a metaphor. The owner may dispose of his receipts any way he chooses. But he should be made aware of the fact that his true income is only a fraction of his total receipts. Proper accounting should convey this fundamental message.
- Equally metaphorical is the process of calculating the yields from investing the set-aside part of the proceeds at the chosen interest rate. As stated previously, the rate should approximate an available market parameter that would indicate prudent behavior for the asset liquidator and would guide his decisions about extraction. Thus he may decide to delay extraction if the market interest rate, available for financial investment, appears lower than the rate at which his resource would appreciate if left in the ground. But he need not in practice sink his funds in physical or financial assets at that interest rate. However, he would be wise to seek such a rate as a minimum yield on his new investments. The so-called Hotelling Rule states that if he left his natural resource alone, it would appreciate at the market discount rate because of its growing scarcity.
- Likewise, the extraction schedule, assumed to be at a constant rate over some time horizon, is also a paradigm and is used only for making the calculations. The owner has a given resource. He may extract it for two years or twenty. Every period he may decide to alter his plans, depending on current prices and the expectations thereof, by increasing or decreasing the annual extraction rate. He is at liberty to do so. All the formula needs is the ratio between the total reserves and the amount extracted in the current period. Suppose an owner, who had been planning to liquidate his reserves over a ten-year period, decides to accelerate extraction because of an expected decline in future prices (reckoning that, since his market share is small, he can do this with impunity, that is, without depressing prices) and now decides on a five-year horizon. All that is necessary is to use the new ratio of reserves to extraction, and this can be decided period by period and changed every year if need be.
- The same applies to the discovery of new deposits—or a downward adjustment in reserves—usually a tough nut to crack. The new discovery does not have to be counted as income, as some have suggested. All that is necessary, if this approach is followed, is to alter the reserves-to-extraction ratio (N) in the calculations, that is, if it is decided to keep the extraction schedule as before. In this case, the discovery will reflect itself in higher income than before, as shown by moving from left to right on the x-axis in Figure 3-1. However, the owner may very well keep the reserves-to-extraction ratio unchanged by raising his annual extraction when he realizes that the reserves are larger than he had thought. This will also translate into higher income.
- It is not necessary to estimate the absolute value of the total mineral reserves or to resort to what is known as "wealth accounting." Neither is it necessary to predict future prices. The owner of the resource does all the predictions necessary, and these are reflected in his annual extraction, which the accountant has to relate to the size of the total reserves in order to estimate income. By implication, it is assumed that the unit value of the total resource is the same as the current price. Such valuation, appearing in both the numerator and denominator of the formula given earlier, cancels out, and what remains is the ratio between two physical quantities: the size of the reserves and the annual extraction, that is, the number of years remaining before the resource is exhausted. Speculation about the future course of prices, however, does occur, and this, as mentioned above, affects the rate at which the resource is liquidated, but this is not the accountant's problem.
- The problems of the terms of trade or of changed technology that might lead to drastic changes in the valuation of the resource are not addressed here. Such changes have to be acknowledged by the income accountants when they occur. The focus of this approach is on the *volume* of extraction in the accounting period as it relates to the total *volume* of the reserves. In the manner of national accounting, the market valuation of the product is taken as given and is used merely to weight the volume in order to assess the activity's contribution to GDP.
- The proposed method could be applied immediately to mineral deposits that are more or less ascertainable, such as petroleum, for which the industry estimates proven reserves and publishes these estimates regularly.[7] But even for petroleum, and certainly for metals, owners tend to mine richer and more accessible deposits first, which means that later extractions involve progressively higher extraction costs. Rising extraction costs can undermine the sustainability of the activity as much as the physical exhaustion of the resource. When market prices fall below extraction costs, many previous sellers, still sitting on large deposits, find profitable operation impossible. Estimation of the volume of reserves therefore should be adjusted *downward* by a factor that would reflect the rising future cost of extraction. Shortcuts for such adjustment need to be devised case by case.
- It is important to remember that the issue here is *national* income accounting. Even if the identified global reserves of a mineral get adjusted upward, the fact remains that the reserves of individual countries inevitably are depleted as they are exploited. National income accounting should reflect this individual national aspect of the activity.

Conclusion

Although the user cost approach appears radical in that it seeks to alter the calculation of GDP under the SNA for certain activities, it is economical and practicable. It is an effective way of impressing on developing countries that depend on the exploitation of subsoil deposits that natural resources are being exhausted as they are exploited. The method proposed is in harmony with standard economic concepts. The national income accounting practices set out under the SNA distort these concepts when applied to depletable resources. They falsely call rent that which is not rent, and include in value added that which is not value added. A second-best alternative would be to use the depreciation approach, deducting a depletion factor from an inflated GDP to reach a corrected NDP. The user cost proposed in this chapter would be the correct measurement of this depletion factor, not the "full-value" depreciation, which, as argued above, would wipe out all the activity from the net product.

The correction ought to be made in the *flow* accounts of the SNA at the GDP level. It is not enough to record depletion in balance sheets, reconciliation, or satellite accounts. This approach would make it unnecessary to attempt to show in such accounts absolute values of total reserves and their annual changes—values that would be as arbitrary as they would be unedifying. Its adoption would lead to the proper understanding and measurement of the special economic activity of depletable natural resource exploitation, and consequently to better policy analysis.

Appendix. Splitting Receipts into Income and Capital

In this chapter, receipts from the sales of a depletable natural resource are *net* of extraction cost. The extraction cost contains elements that do not directly generate value added, such as materials used up in the process of extraction, but would normally also contain payments to factors of production, which should be included in GDP in the usual way.

A time series of expected net receipts R from the sale of a resource that, as a result of exploitation, will come to an end in a future year n contains a true income element X, where $X < R$, such that if $R - X$ (the capital content) is invested year after year at interest rate r, the accumulated investment would continue to yield the same level of income X.

It is necessary to identify X/R, that is, the proportion of net receipts that can truly be called income, and its complement $1 - X/R$, the capital element, also as a proportion of net receipts. The capitalized value at interest rate r of the finite series of receipts R should equal the capitalized value at the same interest rate of the infinite series X. The capitalized value of the finite series R, accruing in equal amounts over a period of n years, would add up to:

$$\sum_0^n R^* = R \frac{\left[1 - \frac{1}{(1+r)^{n+1}}\right]}{1 - \frac{1}{1+r}}.$$

The infinite series X would add up to:

$$\sum_0^\infty X^* = \frac{X}{1 - \frac{1}{1+r}}.$$

Setting $\sum_0^n R^* = \sum_0^\infty X^*$ and multiplying by the denominator in both quantities,

$$X = R\left[1 - \frac{1}{(1+r)^{n+1}}\right]$$

$$X/R = 1 - \frac{1}{(1+r)^{n+1}}$$

$$1 - X/R = \frac{1}{(1+r)^{n+1}}.$$

In this information it is assumed that the receipts R accrue at the beginning of each accounting period. If, alternatively, they accrue at the end, the fraction X/R would be $1 - \frac{1}{(1+r)^n}$. It is also assumed that the relative prices of the resource and the goods and services on which the stream of income will be spent do not change. If there is reason to believe, for instance, that such goods and services will appreciate over time relative to the resource, the capital element to be set aside has to be larger (and the income content smaller) to make it possible to maintain a constant income stream in real terms. The converse is true if there is reason to believe that the resource would appreciate relative to the goods and services that would make up future income. But these are refinements that could be incorporated in the method suggested and would not affect much the results obtained. The method proposed, with the implicit assumption of constant relative prices, seems adequate if the direction in which relative prices will change is uncertain.

Notes

1. The term "Dutch Disease" originated in the 1960s to refer to the adverse effects on Dutch manufacturing of natural gas discoveries. Generally speaking, increased revenues from a natural resource encourages spending on nontraded goods and draws resources out of the traded, nonnatural resource sector, thus stifling diversification and retarding development of nonnatural resource exports. See, for example, Corden (1984).

2. See Hicks (1946), p. 172. See also Keynes (1936), chapter

6, on "The Definition of Income, Saving and Investment," and that chapter's "Appendix on User Cost."

3. OPEC admittedly met regularly to agree on the prices at which its members would sell oil. But such prices cleared the market without any quotas imposed to regulate supply. Not until 1982, however, did OPEC behave like a cartel, with individual quotas indicated for its members, but like all cartels this attempt to maintain prices in a declining market palpably failed.

4. See Solow (1974), in which he recalled Hotelling's pathbreaking article, "The Economics of Exhaustible Resources," *Journal of Political Economy* 39 (April 1931):137–75.

5. "[T]he original and indestructible powers of the soil" as formulated by Ricardo (1821).

6. I had been thinking along these lines for some time and first expressed my views on this topic in a paper delivered in March 1979 to the staff of the OAPEC in Kuwait (El Serafy 1979). I elaborated these views and proposed a method for estimating income from depletable natural resources in a later paper on absorptive capacity, presented in 1980 to an energy conference organized by the University of Colorado. The concern at the time was that the so-called "capital surplus" economies, which exported petroleum, had too low an absorptive capacity. It was felt that if that could be increased, it would, through increased imports, restore equilibrium to the petroleum buyers' balances of payments. I attacked this approach because it reflected the short-term interests of petroleum consumers and not that of the owners of this scarce resource and of humanity at large. See El Serafy (1981). An appendix to that paper entitled, "How Much of Petroleum Receipts Can Be Reckoned to Income?" proposed the formula shown in the appendix to this chapter.

7. Occasionally estimating reserves would raise controversy, but this should not inhibit approximations that can be later revised. In the words of the late Sir Dennis Robertson, "it is better to be approximately right than precisely wrong!"

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Introducing Natural Capital into the SNA

Anne Harrison

During the past ten to fifteen years public reaction to environmental issues has broadened from a concern for preserving endangered wildlife and aesthetically pleasing landscapes to the realization that the whole process of economic development depends on the utilization of natural resources. In extreme cases, such as in Sub-Saharan Africa, the physical and economic survival of millions of people depends critically on the management of both the quantity and quality of land and water resources.

When environmental economists wish to demonstrate their concern in quantitative terms and to illustrate the effect of alternative scenarios, they find the present System of National Accounts (SNA) (United Nations 1968) to be inadequate for a number of reasons. The problems are both of omission and commission. On the one hand, many activities undertaken by women in developing countries, such as finding and carrying water and fuelwood, are excluded from the present measures of gross domestic product (GDP). On the other hand, major projects to rehabilitate polluted rivers or otherwise restore degraded environmental resources are included in GDP, and increases in this type of activity lead to increases in GDP.

Steps to redress some of these shortcomings are in hand. Various specialized statistical systems have been, or are being, developed to address questions in specific areas, and the environment is no exception. Physical resource accounts are being developed to show, in volume terms, inputs and outputs of physical processes, including natural resources as well as manufactured products. The "Framework for the Development of Environmental Statistics" (United Nations 1984), for example, attempts to show the interaction among environmental, economic, and social statistics. Various proposals have been, and are being, examined to develop an aggregate that includes the "desirables" that the SNA omits and excludes the "undesirables" that the SNA includes.

Such alternative statistical systems could form satellite accounts to be used in conjunction with the revised SNA. To the extent that such systems are greater elaborations of specific detail and rearrangements of existing items and inclusion of others, no conflict should arise. However, given the claim of the SNA to provide a comprehensive framework under which all such satellite accounts can be developed, it is important to establish an appropriate interface with environmental matters in the process of reviewing the SNA.

From an environmental perspective, neither exhaustible resources such as mineral deposits nor permanent resources such as land and water should be treated as free gifts of nature. Although land and water seem at first to be free, these resources are not automatically self-renewing, and although humanity may have power to renew them, it has a much greater power to destroy them. Economic activity necessarily interacts with nature, and allowance must be made for the existence of environmental programs, which husband and maintain these permanent resources, and for the lack of such programs, which leads to the destruction of natural resources.

The presence or absence of such programs is therefore an economic decision that directly affects the potential economic activity in subsequent periods, just as a decision on the rate of depletion of nonrenewable resources does. In both cases, therefore, there is a strict parallel with the decision to create and maintain man-made capital, and environmentalists argue that the SNA should record these resources as alternative forms of capital. The question, therefore, is how much present practices under the SNA would change if these resources were treated as natural capital. The main purpose of this chapter is to answer this question.

Exploitable Resources

Much of the past discussion by resource economists has concerned the treatment of nonrenewable resources, such as mineral deposits. In fact, similar arguments also apply to natural forests used for timber and to natural fish stocks. Since both of these are renewable, even if not actually renewed on a realistic time scale, it is convenient to consider all three cases as exploitable resources.

In the production accounts of the present SNA, when an exploitable resource such as oil is extracted and sold, only the direct costs associated with its extraction, including labor, are deducted from its market value, and the whole of the difference is treated as gross operating surplus. Net operating surplus differs from this only to the extent that fixed man-made capital is consumed. Although the process of oil extraction is treated as production, neither the value of newly discovered reserves nor changes in the value of reserves because of changes in world prices is treated as production.

This results in the rather anomalous presentation of information about stocks. The value of the unexploited oil at the start of the year appears in a balance sheet for the industry and the nation, as do the start-of-year values of man-made capital assets, but, since all changes to the value of exploitable resources between the start and end of the year are explained in the reconciliation account, this occurrence in the balance sheet is like a memorandum item. If exploitable resources were treated as natural capital, part of what is now treated as gross operating surplus in the production account would appear as consumption of natural capital, and net operating surplus would be decreased by this amount. A matching entry would appear in the balance sheet of natural capital assets.

The question arises of what value is appropriate to attach to the exploitable resource before its exploitation. Daly (Chapter 2) and others suggest that, in addition to the direct cost of extraction, an entrepreneurial return (calculated perhaps as a standard markup on the direct costs) should also be deducted from the value of the oil at the wellhead and that the residual would represent the subsoil value. This straightforward approach has the appeal of simplicity and economic sense. Variations in world prices would lead to matching variations in subsoil values and would determine when a deposit was commercially viable and when not; the latter being when the subsoil value fell to zero or below. In certain circumstances exploitation might continue even if this value were negative, for example, because the direct costs could not be averted. In such a case, the entrepreneurial return would have to absorb the operating loss, and on the balance sheet the value of the reserves would be given as zero.

More complicated alternative valuations for mineral extraction have been proposed. For example, El Serafy (Chapter 3) suggests determining an income stream with the use of a discounted cash flow analysis of expected earnings from the deposit over its expected lifetime.

Permanent Resources

Another type of expenditure of concern to environmentalists is related to the preservation of land, water, and clear air. This is generally described as defensive expenditure, although further categorization is instructive, and income as well as expenditure needs to be considered. In contrast to the exploitable resources discussed above, these resources will be referred to as permanent resources.

Before considering how to deal with issues related to permanent resources, it is helpful to review the SNA guidelines on the treatment of man-made capital. Two types of expenditures associated with capital occur on a yearly basis. The first is the consumption of fixed capital (depreciation), which is an allowance to permit the replacement of the capital asset at the end of its useful life. Over the economy as a whole the value of the consumption of fixed capital in a year is the value of all man-made assets that were used up in that year and that have to be replaced if the level of man-made capital stock at the start of the year is to be kept intact. The second is the current expenditure necessary to repair and maintain the capital stock. The SNA distinguishes between current and capital repairs: "expenditures on current repair and maintenance make good breakages in fixed assets and keep them in proper working order, while outlays on capital repair and alteration lengthen the expected normal lifetime of use of fixed assets or increase the productivity of these good significantly" (para. 6.123).

This distinction may be blurred in practice, however. Although current maintenance may not directly extend the life of an asset, the lack of maintenance may shorten it, and, in practice, estimates of the lifetime of assets assume regular maintenance. There is thus a relation between the levels of current maintenance and capital consumption. Indeed, for a specific group of assets, including roads and dams, the SNA states: "it may be considered that expenditures on repairs and maintenance are sufficient to maintain the asset in its original condition" (para. 7.20); this is considered as justification for making no provision for consumption of these fixed assets. This provision has already been questioned in the SNA revision process, and it is likely to be changed in the new SNA manual.[1]

In several poorer developing countries, for example, the retrenchment of government expenditure has led to the neglect of road maintenance. Eventually new capital projects have been necessary to replace roads, and these involve capital expenditure that would not have occurred if there had been adequate current maintenance. Thus it is suggested that if maintenance is not adequate to keep roads in their original condition, then the capital consumption of these assets should be estimated. Although not yet discussed in detail, the appropriate value of the capital consumption would seem to be that of the "missing" maintenance.

How do these practicalities carry over to the proposal to treat natural resources as capital assets? Expenditures associated with permanent resources can be of two related, but rather different, types. The first are expenditures intended to prevent the degradation of natural resources, and the second are to redress degradation that has already occurred. Preventive expenditure clearly parallels current maintenance and, in particular, the current maintenance of roads. If all industries ensure that land, air, and water are not degraded, these natural resources remain in their original condition, and the preventive expenditure is clearly current.

Basically, such preventive expenditures may be made in one of three ways: by industry itself (either voluntarily or in response to government legislation), by government and funded by taxes levied on industry according to its pollution potential, or by government and funded by general revenue. In the first case, expenditures by industry to prevent pollution would be classified as intermediate expenditures. In the second case, since the payment to government is related to the service provided, this activity of government should be treated as a public enterprise. Payments to government should not be treated as taxes, but as fees for services, and thus should also be classified as intermediate inputs. (Government provision of waste disposal services to industry is already treated as a public enterprise in some countries.) In the third case, when government funds pollution control out of general revenue, this appears as a final expenditure.

Some resource economists argue that all such preventive expenditure should be excluded from GDP and therefore wish to categorize even government-funded programs as intermediate expenditure, but this proposal is inconsistent with accounting definitions. The distinction between intermediate and final expenditure is determined by whether the product is resold to another economic agent, not by the nature of the product. For welfare or other analyses, specific activities may be excluded because of their nature. In addition to environmental protection costs, such candidates as defense expenditures and crime and drug "industries" have been put forward for exclusion. The derivation of an alternative measure of a restricted set of activities by deducting from (and possibly adding to) those included in GDP using normative criteria is a legitimate and arguably desirable development. But it does not make the case either for suppressing GDP as a measure of all economic activity regardless of desirability or for changing the accounting basis for discriminating between intermediate and final expenditure.

Even the alternative presented here—that when preventive expenditure is undertaken by industry or by government on a charge-back basis, it is intermediate expenditure—is oversimplified and misleading. The preventive expenditure consists of the purchase of labor and of goods and services, which in turn have labor input. Therefore initiating a preventive expenditure program does increase the value added, and thus GDP, even if it is first recorded in the accounts as intermediate expenditure. Indeed, the fact that increasing pollution prevention would increase employment opportunities is often cited by environmentalists as an argument for initiating such programs. Under the present SNA, all alternatives lead to the conclusion that initiating a pollution prevention campaign, however funded, increases GDP.

It is suggested here, however, that no such apparent increase in GDP should be shown. The consequence of treating natural resources as capital assets is that degradation of those natural assets is treated as capital consumption and should be included in GDP. This treatment would exactly parallel the present situation of the treatment of roads described above. The new SNA proposal is that GDP should include either the cost of maintaining roads in their original condition or the consumption of man-made capital of the same amount. This recognizes that the present practice, in which there is no maintenance, leads to GDP being understated by the amount of this missing capital consumption. For the environment, therefore, it is proposed that if preventive expenditure is incurred and no pollution results, GDP is correctly measured. But if such programs are needed because pollution is increasing, but they are not being initiated, then GDP is underestimated by the cost of the programs. A simple numerical example of the alternatives is given in Table 4-1. This illustrates the case in which a country at present has a GDP of 100 with consumption of man-made capital of 10. The effect of environmental degradation is 5, which

Table 4-1. ***Effect on GDP of Introducing an Environmental Protection Program***

	Present SNA		*Proposed revision*	
	Without program	*With program*	*Without program*	*With program*
GDP	100	105	105	105
Consumption of man-made capital	10	10	10	10
Consumption of natural capital	—	—	5	0
NDP	90	95	90	95

— Not applicable.

is exactly redressed by introducing an environmental protection program.

This highly simplified example highlights the consequences of the proposed treatment and of preserving the existing position on natural capital. Net product measures are the same in both systems, which shows that the introduction of an environmental protection program leads to an increase in NDP. Under the present SNA there is an increase of equal size in GDP, whereas under the proposal described here there is none. But this is achieved by increasing the present valuation of GDP without the program to allow for the consumption of natural capital.

At first it may seem counterintuitive that the degradation of permanent resources leads to an increase in GDP. This reflects the common lack of awareness that the "gross" in GDP means "before allowance has been made for consumption of capital." Common usage overlooks this part of the definition or assumes that the allowance for depreciation is fairly constant over time, so gross and net product measures move in line with one another, and gross can be used as a proxy for net without undue distortion. This assumption has proved misleading for many poorer countries where new capital is not acquired as fast as the old is exhausted. In environmental terms the assumption is equivalent to assuming that the environment is not degraded, and it is the obvious refutation of this that is the origin of the present concern. An objective of the present review of the SNA must be to ensure not only that GDP and NDP are properly measured, but also that the concepts are clearly explained to facilitate better-informed and more appropriate commentary and analysis.

An important use of GDP is for comparisons over time or between countries. Although there may be reluctance to increase past estimates of GDP to allow for the consumption of natural capital, the alternative is also disturbing. Without this revision, countries introducing environmental protection programs will show increases in both GDP and NDP. The worse the environmental degradation that is being reversed, the greater this increase will be. Under the proposal above, only NDP will increase, and the gap between gross and net product will narrow, in accordance with both the economic and accounting interpretation of gross and net. The entries for this capital consumption as well as for man-made capital would also be included in the balance sheet and would show the cumulative effect on the resources available to the nation of continued environmental degradation or of its restitution.

Valuation of the Consumption of Natural Capital

Assuming that the theoretical proposal above is accepted, there remains the question of how consumption of natural capital should be measured. Consumption of man-made capital, although not without its own difficulties of measurement, can be calculated at a disaggregated level based on different lifetime assumptions for different types of assets in different industries. For the consumption of natural capital such an approach is neither possible nor appropriate. Industry is not the only degrader of the environment, and it may be impossible to attribute the degradation to individual industries.

Consider, for example, the case of three factories, all discharging effluent into the same river. It is possible that the river could absorb the effluent from any one but not all three or that the combination of different effluents caused the problem. In such cases attribution of the cause of the pollution among the three factories would be difficult and not especially instructive. Degradation may also be caused by final consumers, for example, by the car exhaust of households or government. It may also occur not as a result of activity within the country, but as an involuntary import from a neighboring one. For all these reasons, therefore, it seems appropriate that a single adjustment in money terms to the SNA definition of gross product measures would be adequate. This might be seen as analogous to the adjustment for imputed banking services, which is made in total only and not attributed to individual industries.

For the national accounts for a year, it is the changes during that year in the environmental endowments that need to be captured, not the deviation from an absolute state of perfection, and these annual changes can be measured, for example, by air and water quality indexes. The cost of making improvements could then be estimated. Although the measurement and valuation of the consumption of natural capital may have to be approximated and simplified, these inexactitudes may be no less tolerable than those already encountered in such areas as the ownership of dwellings, the valuation of subsistence output, and the derivation of holding gains and losses on intangible assets.

Environmental Enhancement Programs

In this discussion it has been assumed that there is a prima facie case for including adjustments for the consumption of natural capital in all countries, although for some countries where no environmental degradation occurs the appropriate adjustment may be zero. Another factor to consider, although it may apply irregularly and to only a few countries, is how to treat major programs to reverse the degradation that has already occurred. Such programs are most likely to be funded by government, but there is no reason in principle why they should not be funded by industry or by private nonprofit institutions. Whoever undertakes the expenditure, it clearly would enhance the natural resources and would increase the availability of such assets in the future. This underlines the case for treating the assets as capital and the expenditure as capital expenditure.

Treating environmental enhancement programs as capital expenditure is a logical consequence of introducing the consumption of natural capital as an adjustment between gross and net product measures, since they are in effect negative capital consumption. It was argued above that the measurement of natural capital consumption should be based on annual changes in quality indexes of environmental endowments. If such an index shows an improvement over the year, the value of natural capital consumption for that resource is zero, but the value of the improvement, which is by our definition the value of the enhancement program, should enter the accounts as the same broad type of expenditure, that is, as capital rather than current. Some misattribution of capital expenditure may go undetected if the program does not make a positive improvement but only mitigates the degree of degradation in the environment. If the data sources were rich enough, adjustments for these situations could be made, and separate adjustments could be made for different types of natural resources. Since the proposal is to adjust for the consumption of, and enhancements to, natural resources at the national level, however, aggregation of the effects across projects and resource types will still ensure consistency in the flow accounts and balance sheets at the national level.

It may be argued that natural resources are not in themselves economically productive assets and therefore that expenditure to enhance them should not be treated as capital. However, not all items included in gross domestic fixed capital formation (GDFCF) in the present SNA are economically productive. Schools and universities produce better educated people, but they will be more productive only if employment opportunities exist that utilize the extra education gained. It is not unknown for such institutions simply to increase the number of educated unemployed, although the GDFCF is not decreased to reflect this. Nor should it be. Schools and universities are means of improving the human capital stock. The deployment of that capital is a separate issue. Some man-made capital assets are purely defensive, such as the Thames barrage, a mechanical barrier across the River Thames to hold back water during high tide and adverse winds to prevent London from being flooded. Some serve obviously noneconomic functions, such as a new cathedral or a spy satellite. The range of assets to be included in GDFCF in the new SNA is due to be reviewed, and a distinction in classification between productive and nonproductive assets might be very desirable. But even on present grounds a case can be made to treat major environmental enhancement programs as capital formation.

These sorts of programs are not mentioned in the present SNA. It is difficult to be categorical about present practice, but it seems that the implicit recommendation in the SNA to treat such expenditure as current is generally followed. In line with the discussion above, such government programs, even if treated as current expenditure, will at present lead to increases in GDP but will not be separately identifiable. The proposal being made here is that major environmental rehabilitation programs should be classified as capital expenditure and identified as enhancement of natural resources, regardless of who funds them. In supplementary analyses a more limited class of capital expenditure, including only "productive" capital, however defined, may be used, paralleling the derivation of the more restricted measures of "desirable" activities described in the discussion of preventive expenditure.

Unplanned Occurrences

The sections above dealt with current and capital expenditures in relation to the environment and in the context of planned activities. The environment and subsequent economic activity, however, are also greatly affected by a natural disaster, such as an earthquake, or a man-made disaster, such as a major chemical spillage. The proposals described above could encompass the effect of such unplanned occurrences. A disaster would cause consumption of natural capital to increase and net product measures to fall. This would be offset in part by any significant expenditure to restore the situation, which would count as enhancement of natural capital from what it was after the disaster. The same is true of the effect on natural resources in one country of degradation (planned or unplanned) originating in another country.

Sustainability and the SNA

Apart from the intrinsic information to be contained in environmental accounts, there are two further benefits that this initiative has brought to national accounting. The first has been to focus attention on the difference between net and gross product measures, since even when the distinction relates only to man-made capital, there are numerous occasions when national income on a net basis would be a more appropriate indicator than the ubiquitous GDP. The other benefit is more diffuse but arguably more important in the longer term. The present SNA has depersonalized economics by concentrating on production processes and associated technologies. Environmentalists have brought attention back to the question of how people live and the quality of life, which is associated with an understanding that respect for life is intimately and inevitably bound up with respect for the environment. In statistical terms this gives a new opportunity to bridge the present separation between economic and social statistics by articulating the interaction between environmental development and human development through the economic production process. It is this integration of natural, man-made, and human resources that provides the framework for defining sustainable development.

Environmental economists are still working to agree on a definition of sustainable income. But central to it is the point, recognized by Hicks, that if assets are consumed without being replaced, one is worse off at the end of the period than at the start, and that consumption in the period covers not just income but also an element of wealth.

The present SNA contains three measures of GDP—from the income, output, and expenditure sides—all of which are identical in value. It may be possible to determine measures of sustainable income and sustainable output that are equal in the aggregate but not in their disaggregated parts. For example, if income from a mining activity is used to fund alternative productive activity when the mineral resources are exhausted, the output from mining is not sustainable even if total output and total income are. But there is no necessity for the income in a later period to be at exactly the same level as in the previous period. Which level of income is to be used as the basis of sustainable income? Is it the sustainability of income or income per head that is of interest? Is sustainability an absolute or a relative concept?

The answer to these questions must depend in part on the needs of analysts. It may well vary from one application to another and may depend on assumptions about future technological change and other subjective predictions. Given this uncertainty, such work seems at present a candidate for satellite accounts rather than total integration with the SNA. However, a substantial link could be established by adopting "sustainability factors." These factors would be nothing more than the ratio of capital stock at the end of the period to capital stock at the beginning, adjusted for price change when necessary. Hicks's definition of income—"what you can consume in the period and be as well off at the end as at the beginning"—is equivalent to saying that new capital must be at least as great as capital consumed during the year so that the capital stock at the end is at least as great as at the start. In this case a sustainability factor would have a value of one or greater. A value less than one implies that too much capital has been consumed and that the consumption level is not sustainable indefinitely.

Despite the simplicity of the definition, this concept of a sustainability factor has several advantages. It can be applied at detailed levels as well as in the aggregate. Sustainability factors for man-made capital could be disaggregated by asset and industry, and, even at the detailed micro or project level, sustainability factors for environmental resources could be calculated separately for various categories of land, for water, and for air. Further, since the factors are independent of price effects, they can be based on the same sort of quantified information used to calculate the consumption of natural capital as proposed above. Indeed their compilation would be a logical step in deriving estimates of consumption of natural capital. Such measures could also be applied in areas of human capital by measuring, for example, the ratio of the number of trained doctors in the country at the end of a period to the number at the start. Further variations on the basic ratio are also possible. For long-term planning, periods longer than a year might be used; in other cases assets per head of population might be the basis of the ratio.

Not only would the adoption of a set of sustainability factors that can be calculated easily and without ambiguity form a bridge between the main SNA and the satellite environmental accounts, they would highlight directly the difference in value and interpretation of measures of gross and net product. Provision of, and reference to, a set of such factors can only help to spread the understanding of the concepts of the national accounts and raise discussion in the popular media to a more informed plane. This consequence would benefit both national accountants and environmentalists and would be an important step on the road to the introduction and acceptance of more elaborate concepts of sustainable income and product.

Summary of Recommendations

If satellite accounts for the environment are to complement the SNA, the basic accounting conventions in the two systems must agree. In particular, the distinction between final and intermediate expenditure and the extent of capital consumption that is the difference between gross and net domestic product must be agreed on if the two systems are to be harmonized. The proposals made in this chapter to reach this harmonization imply the following changes for the SNA.

a. It would be necessary to introduce a balance sheet for natural resources.

b. Part of what is at present treated as gross operating surplus for exploitable resources would be treated as consumption of natural capital and would appear as such in the production account.

c. An adjustment for the consumption of natural capital would be calculated and applied as a single adjustment of the economy as a whole.

d. Both of the adjustments in b and c would be deducted from net product measures as now defined.

e. Projects designed to enhance environmental resources significantly would be classified as natural capital formation. This attribution would be appropriate whether the expenditure was undertaken by government or industry.

f. The estimates of consumption of natural capital from b and c and for enhancement of natural capital from e would both carry over to the balance sheet.

g. Sustainability factors should be introduced that show for all capital—man-made, natural, and human—the ratio of stock at the end of the period to that at the beginning. This would help develop more comprehensive measures of sustainable income in the longer term and to emphasize the practicality and desirability of using net rather than gross product measures where this is appropriate.

Note

1. The present SNA was published in 1968 and is now in the course of review, which started in the early 1980s and is expected to lead to a revised version in 1991. The review process consists of a series of three or four meetings a year, each on a specific topic and attended by experts from both developing and developed countries and representatives of the international organizations concerned with collating and publishing economic statistics.

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Measuring Pollution within the Framework of the National Accounts

Derek W. Blades

The national accounts could make a useful contribution to environment statistics in the important area of measuring certain aspects of pollution. Pollution is taken to mean the disposal of waste solids, liquids, gases, heat, and noise in ways that harm people or reduce their enjoyment of their surroundings. It is helpful to distinguish two sides of pollution: the *act of polluting*, such as by discharge of noxious gases or fluids into the environment, and the *abatement of pollution*, which covers government monitoring of pollution levels as well as measures taken by industry and households to reduce the output of pollutants. This discussion covers two aspects of the act of polluting (the output of pollutants and pollution damage) and two aspects of the abatement of pollution (the costs and the benefits of pollution abatement).

The Output of Pollutants

Since pollutants may be regarded as a particular (unwanted) type of industrial output, it seems natural to study the generation of pollutants by an extension of the conventional input-output table. Table 5-1 summarizes a model proposed by Ayres and Kneese (1969), which shows the overall effect of economic activity on the environment. It is based on the materials balance principle: goods that are taken out of the environment circulate through the production-consumption cycle and are returned to the environment in a changed, but not diminished, form.

Matrix A is a conventional input-output table displaying the commodity composition of intermediate consumption by industries. Matrix B shows the amounts of various natural resources used in production, including "free" resources such as air and water. Matrix C shows the amounts of waste products eventually discharged into the environment.

To date only one attempt has been made to apply such a model. This was developed by Victor (1972) for the Canadian economy and has been used to determine the output of pollutants associated with one dollar's worth of final demand for various commodities. The data requirements for matrixes B and C are clearly very heavy, particularly since they involve information that is not usually collected in industrial surveys. In addition, however, there are at least two other reasons why relatively little interest has so far been shown in this approach.

First, matrixes B and C contain various units of volume, such as gallons of water or cubic feet of nitrogen in matrix B and millicuries of cesium or tons of sulfur dioxide in matrix C. Thus the entries cannot be aggregated to produce meaningful totals, and the relative importance of various inputs and outputs can be measured only in an arbitrary fashion. The second problem concerns the operational value of the model. The kind of data that policymakers need about the output of pollutants is highly site-specific. The information that the pulp and paper industry uses x gallons of water and emits y tons of chlorine is not in itself very helpful. Such data have operational significance only when they can be related to information about the particular sites where pulp and paper mills are located. In short, matrixes B and C are of limited interest for most policy purposes because the data they contain are too generalized to be applied to local problems.

Pollution Damage

Pollution causes damages, such as sickness and premature death, stunted growth of crops, disappearance of wildlife, or corrosion of metals and masonry. The national accounts reflect some of the costs of some of these damages in, for example, increased health expenditures by

Table 5-1. *The Effect of Economic Activity on the Environment*

	Industries	*Final demands*	*Total*	*Waste discharged to the environment*
Commondities	A			C
Primary inputs			•	
Total				
Environmental commodities	B			

households or government, lower labor productivity, higher costs of food production, and increased outlays for repairing and maintaining buildings, but they are not explicitly shown as costs of pollution damage. Would it be possible to do so? Table 5-2 shows an input-output table that could serve as a framework for showing explicitly some of the costs of pollution damage that are included in the national accounts but hidden at present.

The columns headed DC indicate costs from pollution damage. Columns A and B are intermediate costs incurred by industry in, for example, cleaning polluted water for human consumption or industrial use and protecting buildings and equipment from atmospheric pollution. Column C would include the costs of repairs to government buildings because of air pollution and—a large item in many countries—the costs of medical services connected with pollution-linked diseases. Household expenditures on these medical services would be shown in column D, which would also include such costs as insulation to protect houses from traffic noise, air-filtering equipment, and water filters to remove chemicals from drinking water.

Finally, column E includes capital outlays by producers and government in connection with pollution damage. These would include part of the cost of replacing buildings and equipment whose lives have been shortened by pollution.

Columns A through E contain only a small part of the total cost that could be attributed to pollution damage. In a study by the United Kingdom Atomic Energy Authority (1971) the costs of air pollution were deemed to include, in addition to medical expenses, the value of production lost through illness and death, the loss of imputed income of housewives and students, and the social costs of premature death and illness. The social costs, which were by far the largest part of the total, were based on a value of £1,000 for each year of life lost and on the ranges of legal compensation awarded for sickness. The valuation procedures used for these various costs are often very arbitrary and subject to great uncertainty. Just how uncertain may be judged from the results of studies on the costs of air pollution in the United States published annually by the Council on Environmental Quality. For 1968, estimates of the cost of air pollution damage ranged from \$8.1 billion to \$20.2 billion, and for 1970 from \$7.0 billion to \$12.3 billion. Saunders (1977, p. 51) observed that "the range of uncertainty surrounding such estimates is enormous. It may be suggested by the skeptics that the usefulness of such figures . . . is in the sphere of public relations rather than of social science."

The costs discussed above in connection with Table 5-2 are less open to criticism on these grounds, since they are already included in the national accounts; they only need to be separately identified. While the difficulties of doing this should not be minimized (often the costs of pollution-related damage cannot be easily distinguished from the costs of normal wear and tear), it seems worthwhile to try to identify some of the major costs of

Table 5-2. *Input-Output Table Isolating Pollution Damage Costs*

	Producers						*Government consumption*		*Private consumption*		*Gross fixed capital formation*		*Stocks*	*Exports*	*Totals*
	1		*2*		. . .	*Total*									
	DC	*Other*	*DC*	*Other*	. . .		*DC*	*Other*	*DC*	*Other*	*DC*	*Other*			
Commodities															
1	A		B				C		D		E				
2															
Total															
Indirect taxes					. . .										
Factor incomes					. . .										
Rest of world															

Note: DC = pollution damage costs.

pollution damage. These might include, for example, the costs of treating pollution-linked respiratory diseases for persons living in large towns and the estimated costs of protecting buildings and machinery from atmospheric pollution.

Costs of Pollution Abatement

The third aspect of pollution to be considered concerns the costs borne by industries, and to a lesser extent by government and households, to reduce the output of pollutants. Elsewhere in this volume, these costs are described as "defensive expenditures." The columns headed PA in Table 5-3 show where these costs are currently included in the national accounts, although they are not now distinguished separately.

Columns A and B show purchases of intermediate and primary inputs for pollution abatement. These represent the current operating costs incurred by industry for this purpose. Column C shows government spending for pollution abatement, mainly in connection with monitoring pollution levels. Household purchases of goods, such as catalytic converters to reduce emissions of noxious exhaust gases from vehicles or less-polluting equipment and supplies for home heating, are shown in column D. Finally, column E shows business and government investment outlays that are mainly for pollution abatement.

Input-output tables of the kind outlined in Table 5-3 have been quite widely applied. Models developed for the United States and the Netherlands are described in OECD (1974), models for Italy and the United States are outlined in Pearce (1976), and three different models for Japan are described in OECD (1977). They have been used to assess the effect of abatement policies on variables such as price levels, consumption, investment, production, employment, and the trade balance.

Data on pollution abatement outlays by government could be obtained from a functional classification of government expenditures. The United Nations "Classification of the Functions of Government" (COFOG) identifies outlays on both monitoring and abatement. Data on pollution abatement expenditures by households, mainly in connection with vehicles and home heating, are usually obtained from producers rather than directly from households. There are some conceptual problems in defining abatement expenditures by households that also apply to expenditures by industries. These problems are considered below.

To date the most rigorous, or at least the best-documented, efforts to compile statistics on "pollution abatement and control expenditures" (PACE) by industry have been made in the United States by the Bureau of Economic Analysis. The problems have been discussed by Cremeans (1974 and 1977).

First, there is what has been described as the baseline problem. This is the difficulty of establishing a baseline from which to measure the extent of pollution abatement activities. Long before the environment became a fashionable topic, producers, households, and governments were controlling pollution to some extent. Should antipollution activities be measured from a zero baseline, so that they cover traditional as well as newer abatement procedures, or should the baseline be brought forward to include only recently introduced control procedures? The second approach has been adopted in the United States; in effect pollution abatement is defined as activities, like scrubbing smoke or cooling waste water, which are undertaken because of recent antipollution legislation. The use of a mobile baseline makes the definition of abatement expenditures somewhat fuzzy, but it is probably the only practical approach for data collection. Respondents will have some notion of the extra outlays they have incurred because of recent antipollution legislation, but they would find it very difficult to estimate their costs if they were allowed to cause unlimited pollution, because they have never been in this position.

Table 5-3. *Input-Output Table Isolating Pollution Abatement Costs*

	Producers					*Government consumption*		*Private consumption*		*Gross fixed capital formation*		*Stocks*	*Exports*	*Totals*
	1		*2*	. . .	*Total*									
	PA	*Other*	*PA*	*Other* . . .		*PA*	*Other*	*PA*	*Other*	*PA*	*Other*			
Commodities														
1	A		B			C		D		E				
2														
Total				. . .										
Indirect taxes				. . .										
Factor incomes				. . .										
Rest of world														

Note: PA = pollution abatement costs.

The second difficulty is the problem of joint costs. Some equipment and industrial processes are both good for business and less polluting. In such cases it is not clear how much of the additional cost of the equipment or process should be treated as a pollution abatement expenditure. In the United States survey, respondents are asked for their "best estimates of the cost of that portion of plant and equipment expenditures attributable to special features for [air and water] pollution abatement" (Cremeans 1974, p. 62). Respondents presumably base their best estimate on the costs of alternative models that produce the same output as the equipment actually used but that lack the model's special antipollution features. In the unlikely, but not impossible, event that a new piece of equipment is as productive as an older model but less polluting and less costly, it would be reasonable to attribute a negative cost to the antipollution activity. The U.S. survey does not attempt to identify such cases, perhaps because of the difficulty of making accurate estimates. However, new, less-polluting processes may sometimes be cheaper than older, more-polluting ones. An often-quoted example is the switch by pulp and paper manufacturers from sulfite to sulfate processes. Since the new method is both less polluting and cheaper, the pollution abatement involved has a negative cost.

A third difficulty concerns the respondent's awareness of antipollution costs. For example, if new legislation forbids open-cast mining, the additional expense of shaft mining should be counted as an antipollution cost. In general, however, respondents would probably overlook costs of this kind and would in any event have great difficulty in estimating them. Similar problems arise when antipollution pressures result in demand shifts from more- to less-polluting products. Examples here include the switch to unleaded gasoline, biodegradable containers, and low-phosphate detergents. These goods are all more costly than the more-polluting items they replace, but the producer generally would not regard the extra investment and higher operating costs involved in their production as a pollution abatement cost. Indeed, in the U.S. survey, such costs are explicitly excluded, and manufacturers are supposed to report only the outlays incurred in reducing pollution in their own production processes.

Because of these problems, some critics have suggested that it is futile to try measuring business outlays on pollution abatement. However, this position may be too extreme. In attempting to compile the PACE series, the Bureau of Economic Analysis is responding to a real concern felt by policymakers and business people, who need to know the costs involved in different pollution abatement policies. What is open to question is whether the approach used by the bureau is the best way to meet this need. There are two lessons to be learned from the U.S. experience. First, it may not be useful to compile a time series for PACE statistics. In some years several wide-ranging antipollution laws may be enacted, and, when this happens, it is certainly useful to measure their effect on industrial costs. In other years, however, there may be no new legislation requiring outlays on pollution abatement, and there is then no obvious need for a survey. In short, the aim should be to measure PACE in response to a particular piece of legislation in particular years, rather than to consider a continuous time series.

The second lesson is that the conventional survey approach—mailing questionnaires to a large number of respondents—may not be suitable for PACE statistics. As noted, the U.S. questionnaire requires respondents to estimate some important components of PACE, but there are some pollution abatement costs that have to be ignored because respondents are unaware of them. In these circumstances it may be better to investigate intensively a small number of establishments. The larger sampling errors probably would be offset by the smaller nonresponse errors, and the enumerators could collect information about abatement costs that the respondents do not recognize as such. In addition, serious pollution problems are confined to a relatively small number of industries: home heating, transport, electricity generation, chemicals, paper and pulp, and steel. Thus, an intensive investigation of relatively few establishments may yield accurate data on the bulk of pollution abatement outlays.

Benefits of Pollution Abatement

One of several benefits that may result from pollution abatement is the recovery of usable materials. In practice, such benefits are usually quite small, and, if they can be identified at all, the most convenient way to treat them in a national accounts framework is probably as negative abatement costs. Far more important are improvements in health, enhanced enjoyment from the natural environment, and related benefits that the community at large derives from pollution abatement. There are several ways to value these indirect benefits.

One possible approach is to consider the damages avoided. Thus, if it could be established that a particular type of pollution caused 1,000 dollars' worth of damage, then it could be argued that abating this particular pollution provides benefits worth the same amount. Several authors have indeed assumed that damage costs and abatement benefits are two sides of the same coin. Jaszi (1971, p. 224), for example, doubts the possibility of measuring the *benefits* of environmental protection because he "cannot formulate a question relating to the *damages* of pollution that could be answered by knowledgeable respondents in a meaningful way" (emphasis added). The valuation of goods and services, however, is not generally based on the assumption that the benefits received equal the damages avoided. Clothing is not valued at the cost—in terms of social ostracism or legal penalties—of going around naked, and food is not valued at the cost of starving to death. In conventional national accounts, goods and services are valued in one of two ways. Goods and services that are sold on the market are valued at their market prices, that is, at prices that are assumed to measure the purchaser's valuation of the benefits derived from them, while goods and services that are provided free or at heavily subsidized prices are valued at their cost of production.

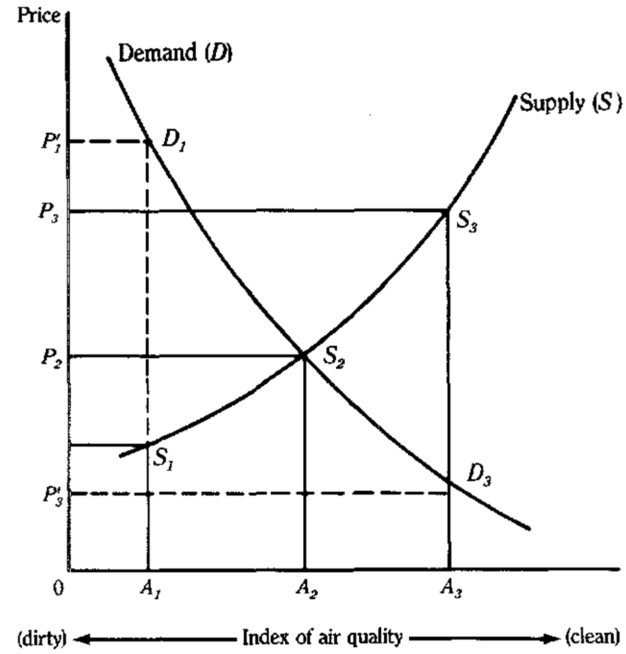
The outputs of pollution abatement—clean air and pure water, for example—obviously cannot be sold on the market. So the natural approach for the national accountant is to value the benefits of pollution abatement as being equal to the costs of pollution abatement. If, as was suggested in the previous section, abatement costs were shown separately in the national accounts, users would have all the information needed to value the benefits of pollution abatement in precisely the same way that the benefits of other public goods—national defense or public administration, for example—are valued.

This simple, orthodox method of valuation may be criticized on the grounds that the market, or the community as a whole, may not necessarily value the benefits of abatement at the costs of abatement. The same objection may, of course, be made against valuing other nonmarketed goods at cost, and several authors have indeed argued that all goods and services in the national accounts should be valued at market prices regardless of whether or not they are actually marketed. Peskin and Peskin (1978) have suggested how this might be done for pollution abatement.

The problem may be demonstrated in Figure 5-1. The demand curve (D) shows how much air cleanliness the market would buy at different prices, while the supply curve (S) gives the price of various levels of air quality, that is, the cost of abating air pollution. If clean air were sold on the market, the amount supplied would be determined by the intersection of D and S. The air supplied would be the moderately clean A_2 type, the public would buy it at price P_2, and the value of purchases—the number that would be recorded in the national accounts under household consumption expenditures—is represented by the area O, P_2, S_2, A_2.

In practice, of course, the level of air pollution is set not by the market but by government fiat. A government sensitive to business pressures might decide on low abatement standards that result in air of the rather dirty A_1 type, while a government dominated by consumer interests might legislate to produce very pure A_3 type air. In the first case, the number that goes into the national accounts (as pollution abatement costs) is represented by the small area O, P_1, S_1, A_1. However, the demand curve indicates that the market would have paid P_1' rather than P_1 for the amount of pollution abatement represented by A_1, so that area P_1, P_1', D_1, S_1 may be taken as a measure of the extent to which the "at cost" valuation of pollution

Figure 5-1. ***Supply and Demand for Clean Air***



abatement understates the benefits of abatement as judged by the market. In the second case, the "at cost" value represented by O, P_3, S_3, A_3 is much higher than the benefits as judged by the market. For most people, type A_3 air is not worth the cost; the market would pay only P_3', and the area P_3', P_3, S_3, D_3 represents the amount by which the "at cost" valuation of abatement overstates the market valuation of the benefits of abatement.

To measure the market valuation of abatement benefits, it is necessary to estimate the demand curve in Figure 5-1. The direct approach of asking people how much they would pay for different amounts of abatement does not appear to have been widely used. One problem is that shrewd respondents may declare no interest in paying for any pollution abatement because they know that since clean air and pure water are public goods, they could never be excluded from enjoying them. This causes the market valuation of abatement benefits to be understated. Another difficulty is that it is not clear whether respondents should be treated as buyers or sellers of clean air and water (Seneca and Taussig 1974). Should they be asked how much they would pay to enjoy a given level of pollution abatement, or how much they would charge polluters for the use of their clean air and water? The latter approach, which is based on the view that the inhabitants of a country have collective property rights in their environment, would generally lead to a higher valuation of abatement benefits. To be realistic, however, it is unlikely that either question could elicit anything but fanciful responses. People are simply not very good at putting prices on things that are never marketed.

In these circumstances, various indirect approaches may be used. For example, the benefits of cleaning a lake may be valued by finding out how much people spend at present to travel to the nearest unpolluted lake. This and other indirect methods used in connection with water pollution are summarized in Kneese (1971). The benefits of reducing traffic noise may be valued by comparing the prices of houses subject to different noise levels. Several studies on airport noises in the United Kingdom are discussed by Pearce (1976).

The results of such studies have been used in some cost-benefit analyses relating to particular problems at particular times. In view of the sporadic nature of such studies and of the controversy that has sometimes surrounded their findings, however, it is unrealistic to suggest that market measures of abatement benefits could be included in annual national accounts statistics within the foreseeable future. Valuation at cost is all that can reasonably be achieved at present.

Conclusions

This chapter has reviewed ways in which national accounts statistics can be used to assess and manage a major environmental concern—pollution. More specifically, it has examined how the national accounts can be used to study four aspects of pollution: the output of pollutants, the damages caused by pollution, the costs of abating pollution, and the benefits derived therefrom.

The use of national accounts to study the *output* of pollutants will have a low priority in most countries. Information on quantities of pollutants emitted must be site-specific in order to be used to monitor pollution levels or to design control measures. National totals for the output of pollutants are of limited value for environmental analysis. It is unlikely that the national accounts can be used to measure the benefits of pollution abatement, at least on a "market" basis. Although it may be theoretically possible to attach market values to the *benefits* of abatement, there are enormous practical difficulties in doing so. For the foreseeable future the only way the national accounts can be used to value the benefits of abatement is through the cost side. This method is used now by national accountants to value other public goods, such as national defense and public administration.

One can take a more positive attitude toward other aspects of pollution. Although it is difficult to define and measure in full the costs of *damages* caused by pollution, it seems feasible to identify some of the costs that are already implicitly included in the national accounts. Examples here include pollution-related medical expenses in the final expenditures of governments and households as well as outlays for pollution-caused repair and maintenance in the intermediate consumption of industries. Although these expenditures constitute only part of the total damages caused by pollution, they would indicate the success of abatement programs in reducing pollution damages over a period of years.

National accounts have been widely used to measure the costs of pollution *abatement*. This is clearly an important use, since policymakers need to know the cost of alternative abatement measures. Although there are some problems in defining and measuring abatement costs, in general the aim should be to measure the abatement costs incurred by particular industries in response to particular pieces of legislation. For this purpose, it will not usually be necessary to construct time series statistics on abatement costs. To collect cost data from industry, in-depth investigation of a small sample of firms may be more effective than conventional survey methods.

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Correcting National Income for Environmental Losses: Toward a Practical Solution

Roefie Hueting

An increase in national income is often called economic growth. It is identified with increased welfare and conceived of as an indicator of economic success. However, this terminology is incorrect for a number of reasons. One of these is that the apparent increase in national income may be accompanied by the degradation of a vital scarce good: the environment. The misconception of terms reflects the belief that things go well, economically speaking, solely when production, as measured in gross domestic product (GDP), increases. This belief also includes the conviction that an increase in GDP is necessary to solve the environmental problem, since this creates room for financing the conservation and restoration of the environment. However, this proposition is questionable to the extent that environmental deterioration is a *consequence* of the prevailing pattern of production growth.

The environment is being endangered because economic policy stresses the increase in production as measured by national income, but it neglects to account for the depletion of natural resources and damage to the environment. This depletion, in turn, endangers sustained economic development. This gave a great impulse to the ideas of Kuznets, who suggested as early as forty years ago that national income be corrected to provide politicians and the public with a better insight into the development of welfare over time (Kuznets 1947, 1948a, 1948b).

A big step in the right direction would be possible if all the factors that influence welfare could be expressed in one common denominator (for example, money). For the environment, this would involve constructing shadow prices for environmental functions (possible uses of the environment), which are directly comparable with the prices of goods and services produced for the market.[1] With the aid of these, the value of the losses of environmental functions could then be established and entered in the System of National Accounts (SNA) as cost items when they occur.

Unfortunately, shadow prices for environmental functions can be constructed only in exceptional circumstances. It is possible in principle to estimate the cost of measures that lessen the pressure on the environment and thus preserve the desired uses of the environment. These so-called elimination costs may be regarded as production costs of an environmental function. With the aid of calculations of the costs of various degrees of elimination, supply curves for environmental functions can be constructed. Only in a few cases, however, is it possible to construct demand curves, because the demand for environmental functions usually cannot manifest itself in market behavior. Therefore, other options need to be considered. But as long as the traditional, uncorrected concept of GDP is used, many caveats need to be kept firmly in mind.

The Need to Use GDP with Proper Caveats

While work is going on to correct the measurement of GDP, one recommendation should be implemented immediately: proper caveats should be used and additional facts should be presented in the yearly publications of the national accounts.

Thus, it has to be stressed that an increase in national income is not identical to economic growth and economic success. Further, production, as measured by GDP, is only one factor that influences the level of welfare. Other factors are the environment (including nature and natural resources), leisure time, income distribution, working conditions, employment, and the safety of the future insofar as it depends on our dealings with scarce goods. The relation between production growth and environment in the past must also be made clear. The burden on the environment is equal to the product of the number of people and the amount and type of activity per person. Sustainable economic development therefore requires that the nature of our activities and the number of our species be adapted to the carrying capacity of our planet; such adaptations may decrease GDP in the short run but will provide sustained economic development in the long run. It should also be kept in mind that the SNA's main value is for short-term macroeconomic analysis. Finally, market prices do not indicate the marginal utility of goods when their production and consumption are at the expense of scarce environmental functions.

In addition to such caveats, as much quantitative information as possible should be provided on the losses of environmental functions and their consequences. To the extent possible this should be done in monetary terms, such as compensation and elimination costs and financial damage. This can be supplemented by information expressed in physical units, such as emissions, concentrations, fragmentation of the countryside, and losses of species. The figures in physical terms can be related to standards for environmental functions and will thus describe their availability or loss. For example, if certain thresholds of emissions and subsequent concentrations are exceeded, the function of surface water as a basic material for drinking water is lost. The information in physical units could be collected in so-called satellite accounts of the national accounts (Theys, Chapter 7).

The recommendations made above—that proper caveats be used and that GDP be supplemented by monetary and physical information on the environment—can and should be implemented immediately. The rest of this chapter reviews three options for correcting GDP.

Correcting National Income for Defensive Environmental Outlays

When national income is calculated according to present conventions, several activities that have a cost character, and therefore ought to be entered as intermediate deliveries, are currently designated as final consumption. Kuznets, one of the great theoreticians of the conception of national income, emphasizes this point (Kuznets 1947, 1948a, 1948b).

To the three classes of expenditures distinguished by Kuznets (expenditure invoked by an urban pattern of living, expenditure inherent in participation in the technically and monetarily complex civilization of industrial countries, and the major part of government activity), the expenditure on measures that compensate for, redress, or guard against losses of environmental functions could be added. These expenditures are currently entered as intermediate deliveries insofar as the measures are taken, and directly paid for, by private firms. When the measures are paid for by the government or private households, or when they are taken by private firms but financed through levies imposed by the government, they are currently treated as final consumption.

However, all these outlays should be entered as intermediate expenditure when a long time series such as that for national income is composed. For the losses of environmental functions are currently not entered as costs at the time they occur, and therefore their restoration or compensation should not be entered as a final delivery at the moment it is undertaken. This procedure cannot be changed because it is impossible to construct shadow prices. It is therefore double counting to enter outlays for compensating these losses or for eliminating them as final consumption. Expenditure on preventing and compensating environmental losses does not contribute to the quantity of consumer goods; these outlays protect or replace scarce environmental goods that were already available. (Some of the disadvantages attributed by Kuznets to the urban pattern of life, such as the greater distance between home and work, may be interpreted as losses of function resulting from spatial competition, and the expenditure on this as the cost of compensatory measures.)[2]

Most authorities in this field, including most participants in the UNEP–World Bank workshops on environmental accounting, favor either merely isolating the defensive outlays for the environment or isolating and correcting for these items in an alternative presentation of national income alongside the current one. In both cases, the time series would not be interrupted. The current figure would remain intact for analytical purposes, but the interaction between production and the environment would be better understood, and the ability to provide information in physical units and to collect these data in satellite accounts would, of course, not be hampered at all.

The approach of isolating and correcting, however, seems preferable. The politicians and the public, who are now given only one figure of income, would then realize that part of the increase in national income consists of an increase in cost, since defensive environmental outlays are increasing (Leipert 1987). If the income correction was made, however, several clarifications would have to be made in the introduction of national accounts publications.

- The correction is only partial, since the greater part of environmental losses are neither restored nor compensated.
- The mutations in both the current and corrected figures of GDP do not represent economic growth or the course of welfare over time.
- Reallocation by shifting the production and consumption package on behalf of the environment (for example, more bicycles and public transport and fewer private cars

because of the pressure of physical restrictions and levies) constitutes a sacrifice. This is not reflected in the SNA, insofar as the pattern of consumption that is thus produced differs from the first choice, which was made without regard to environmental considerations. The shifts will often lead to a check on production growth. This is automatically reflected in the SNA but is not visible.

• Isolation and correction form part of a broader field of defensive outlays (see Hueting 1980; Kapp 1963; Kuznets 1947, 1948a, 1948b, 1954; Leipert 1986a, 1986b; Mishan 1984; and Tinbergen 1985).

Complementing Corrections for Defensive Outlays through Surveys

The possibilities for preferences for the current and future use of environmental functions to manifest themselves in market behavior are very limited (Hueting 1980). Therefore efforts have been made to trace these preferences by asking people how much they would be prepared to pay to wholly or partially restore lost environmental functions and to conserve them. Much research is being done on willingness to pay.[3] However, this method does not always provide reliable estimates for many reasons.

• Information on the significance of environmental functions is deficient in many cases. This is especially so for the functions that determine the future quality of the environment. For these (life-support) functions there is often the risk that interrupting complicated processes, for instance, ecosystems, may lead to serious overshoots and collapse, and the chance that technologies not yet invented or operational may cope with those risks. Many people may not be able to weigh these risks and chances, and thus to answer how much they are prepared to pay for avoiding them. According to the biological literature, the possibility that overshoots and collapse may occur if the growth pattern of production (and population) is not changed constitutes the most important part of the environmental problem (see, for example, Odum 1971). If individuals are not aware of the importance of an environmental function, the survey method is pointless.

• There is a considerable difference between saying that one is willing to spend money on something and actually paying for it.

• The questioning method in fact tries to approach the value of a collective good as if it were a private marketable good (by trying to find some points on the demand curve). In a market the bidder knows fairly well what quality and quantity can be acquired by different bids. In a collective situation, however, this is not possible, because it is not known how much other people are going to bid. Without a considerable amount of additional research it is also not known how much money is required to attain different quality standards for the environmental functions.

• In order not to make the questioning unjustifiably vague, some research on environmental accounting has to be done beforehand. For clear air, clean water, and so forth are not homogeneous goods from an economic point of view, as water and air have quite a few different economic functions. If the persons being questioned are to have a clear picture of the issues, they must be given information on the significance of the different functions, the consequences of their loss, and the measures and costs involved in their restoration. All together this constitutes a huge amount of information, which would not be easy to survey. Although the willingness-to-pay method might be justified for one or two factors affecting the immediate living conditions of people asked, it is most probably not a sound base for correcting national income for all environmental losses.

• People may be interested in the effects of their bids, together with the (unknown) bids of others, on, for instance, employment levels and consumption patterns. For answering legitimate questions about this, studies such as the scenario study mentioned below have to be elaborated, and the results have to be presented to the persons questioned. This hardly seems feasible. Again, what might be justified on a micro scale is most probably not justified on a macro scale.

• Asking people how much they are prepared to pay suggests that conserving the environment always requires extra provisions that must be paid for. In quite a few cases, however, conservation is a matter of refraining from doing things rather than of doing them, and this saves rather than costs money. Thus, not building a road through a mountainous area that is vulnerable to erosion is cheaper than building it, cycling is cheaper than driving, wearing a sweater and using an extra blanket is cheaper than raising the temperature, and confining the consumption of lettuce to the summer season is cheaper than eating it throughout the year. People who realize this may modify their answers because of such considerations.

• Some people will probably be convinced that it does not matter what they bid because their bid will not influence environmental policy at all, and this conviction will influence their bid.

• Some people may think they have a "right" to a healthy and safe environment and will probably react accordingly by not making a bid at all.

• Some people will probably have their doubts about the participation of others (the Prisoner's Dilemma from game theory) or prefer to wait and see (the Free Rider Principle from the theory of collective goods).

• The environment is an important collective good. But it is not the only one. Dikes, public administration, and the army are too, while police and education have clear collective properties. To be sure of not exceeding budget restrictions, people also have to be questioned about how much they are prepared to pay for the other collective goods of the society. This hardly seems feasible. Again, what might be justified for one or two separate environmental agents on a micro scale may be impossible on a macro scale.

• The willingness-to-pay method also measures the consumer's surplus. In national income the total value of the goods is found by multiplying the quantity of each good by its respective price and then adding together the resulting amounts. Using this procedure, the consumer's surplus is not expressed in the level of national income. Thus, a doctor who saves a patient's life creates a value that, whatever one may think about its exact size, is certainly higher than the value added recorded in national income. The intra-marginal utility of goods, which is ignored in national income, will approach an infinite value, because it includes the utility of the first unit of food, drink, and so forth. For this reason the results of willingness-to-pay research are not suitable to be used in conjunction with the figures of national income. An additional objection to incorporating the consumer's surplus in the willingness-to-pay approach is that the results reflect the income distribution more directly than do the prices of market commodities; the differences between rich and poor in the weights of the "votes" become greater when the consumer's surplus is included. The occurrence of differences in weights of "votes" is often defended by the argument that the contribution to the national package of goods and services by the rich is greater than by the poor: their incomes are higher because of the greater relative scarcity of their abilities. This argument is not valid with regard to the environment, because it is not produced by humanity.

Because of the limitations mentioned above, the willingness-to-pay method does not present a firm enough basis for correcting national income for losses of scarce environmental functions. A correction based on this method may lead to inaccurate estimates of environmental decline.

Complementing Corrections for Defensive Outlays through Standards for Sustainable Economic Development

It can be concluded from the above that the correction of national income is highly desirable. But shadow prices for environmental losses that are directly comparable with market prices (on which national income figures are based) can be constructed only exceptionally, because the intensity of the preferences for the present and future availability of environmental functions can mostly not be measured. For this problem there is a well-defensible practical solution. This consists of supplementing the corrections for defensive environmental outlays with estimates of the expenditure on the measures required to meet physical standards for the availability and quality of environmental functions (including nature and natural resources).[4] The standards can in turn be based on the prerequisites of health and a sustainable economic development, that is, development with sustainable yields. This seems the most natural guideline for setting standards for environmental functions. Standards and the measures based on them may refer to the occupation of space, the use of soil, the availability of stocks of natural resources, the composition of products, the consumption of raw materials and energy, the emission of pollutants, and the concentration of chemical and other agents.

The standards can be related to environmental functions. Thus it is possible to formulate the way in which a forest should be exploited to attain a sustainable use of its functions. These functions could include being a source of wood, regulator of the water management, preventer of erosion, buffer of carbon dioxide and heat, regulator of the climate, gene reserve, object of study for ecological research, supplier of natural products for the local population, and source of income from tourism. The estimated expenditure on the measures required to meet those standards then indicates in monetary terms how far a nation has drifted away from its (supposed) end or standard of sustainable use of its forest resources.

Likewise it is possible to formulate the way in which surface and groundwater should be exploited to arrive at a sustainable use of its functions. These functions could include water for drinking, for agriculture, for cooling, for flushing and transport, for industrial processes, for recreation, for navigation, in the natural environment, and for waste dumping. The estimated expenditure on the measures required to meet those standards would indicate in monetary terms how far a nation has drifted away from a sustainable use of its water resources. The same holds true for the use of air, soil, and space.

The measures may range from selectively cutting trees, reforesting, building terraces, draining roads, maintaining buffers in the landscape, and selectively using pesticides and fertilizers to building treatment plants, recirculating materials, introducing flow energy, altering industrial processes, making more use of public transport and bicycles instead of private cars, and using space so that plant and animal species have enough room to survive. When put into practice, these measures will lead, in one way or another, to different—sustainable—production and consumption patterns. It follows from the earlier sections in this chapter that the level of welfare will not decrease if people prefer to maintain a sustainable development rather than to risk the overshoots and collapse inherent in the present production and consumption patterns. Whether this is the case cannot be proved or disproved, because in many cases it is impossible to construct shadow prices for environmental functions.

Table 6-1. ***Comparison of Traditional and Environmental Scenarios***
(1980 = 100)

Aspects	*Traditional growth scenario*	*Environmental scenario*
Plant and animal species	Further deterioration by, among other things, increased productivity in agriculture, more use of space, and more use of persistent compounds; only measures against pollution have been taken	Checked deterioration or even improvement
Emissions		
Air pollution		
Sulfur dioxide (SO_2)	154	24
Nitrogen oxide (NO_x)	130	76
Particulate matter	310	58
Hydrocarbons	266	48
Carbon monoxide (CO) (total)	29[a]	31
Processes	—	75
Stationary	—	48
Transport	36	21
Carbon dioxide (CO_2)	—	83
Lead	44	0
Water pollution		
Mercury	53	29
Cadmium	79	36
Other heavy metals	109	57
Persistent organic compounds	—	70[b]
Phosphates	81	29
Oxygen demand	35	17
Thermal load	139	44
Solid waste	152	108
Harbor sludge	—	100
Energy related	1,400	467
Gypsum	210	90
Industrial slag	358	136
Chemicals	91	64
Radioactive waste		
Laboratory waste	100	100
Nuclear energy waste	300	0
Reprocessing waste	598	0
Fissionable material	633	0
Energy input	123	81
Coal	505(605)[c]	292
Uranium	463(0)[c]	0
Landscape	Further deterioration (see plant and animal species)	Checked deterioration or even improvement
Livability of cities	—	Improvement
Production		
GDP	164	127
Agriculture	181	135
Industry	321	177
Services	181	145
Available income per capita	116	104
Unemployment	82	83
Employment	110	111
Tax burden	98	103

— = Not available.
a. This figure is not consistent because the carbon monoxide emissions of processes and stationary sources are missing.
b. Very rough estimate.
c. If nuclear energy is not used, coal input increases.
Source: Hueting 1987.

The expenditure necessary to carry out these (and similar) measures can be estimated. The sum of the amounts found would indicate in monetary terms how far the nation has drifted away from a sustainable economic development. This indicator can be used in conjunction with the figures of the national income, which, after correction for defensive outlays, shows how far the nation has proceeded in raising the level of production.

No measures can be formulated for irreversible losses. If plant and animal species become extinct, no restoration measures are possible. The same probably holds for the total loss of the topsoil of a mountainous area. An arbitrary value then has to be assigned to these losses, of which one can say for certain only that the value is higher than zero.

A more or less similar problem seems to arise for nonrenewable resources. Once oil has been exploited and exported or used, it is gone forever. This loss constitutes a cost for the country, since oil reserves are finite. If no alternatives are developed, the generation that experiences the depletion (or a sharp rise in the operating costs) of the resource will suffer a severe economic loss. Since the prospect of a safe and prosperous future for one's children and one's children's children is a normal human need, the diminution of the reserves of nonrenewable resources such as oil constitutes a cost here and now.

The depreciation of nonrenewable resources can be valued by estimating the costs involved in the development and practical introduction of alternatives such as solar energy, substitutes for minerals, and recycling methods.

An example of a practical application is a scenario study elaborated for the Netherlands (Hueting 1987). This study scans the effects on the level of production and employment of the transition to a sustainable economic development between 1980 and 2000. The conditions or standards for such a development and the measures to meet these conditions or standards were formulated by specialized scientific institutes. The estimated costs of these measures were entered into the econometric model, which then scanned the effects on production and employment. The results were contrasted with the results of a scenario based on a traditional growth policy, elaborated alongside the environmental scenario. Thus, comparison of the outcome of the two scenarios can indicate the differences between a policy aiming at sustainability and one aiming at increasing the national income according to the present pattern. Because the environmental scenario makes an important step in the direction of a sustainable economic development over the whole field of production and consumption, comparison of the results of the two scenarios also gives a rough impression of what may be expected if GDP is corrected according to standards for a sustainable economic development.

The main results of the study are shown in Table 6-1. The total net expenditure (or cost of forgone production) to meet the conditions or standards set in the environmental scenario is equal to the difference in gross national product (GNP) between the two scenarios in 2000. The benefits (in regained and safeguarded environment) are equal to the differences in the environmental indicators in 2000. A similar study is in progress for Taiwan (Hueting 1986a).

An example of a practical application of correcting national income figures, albeit not based on standards for attaining a sustainable economic development, is the study by the Economic Council of Japan, which develops a measure of net national welfare. In this approach the national income figures are corrected not only for actual expenditure on compensation and restoration of environmental functions, but also for the estimated cost of the measures necessary to attain the level of environmental quality prevailing in the base year (in this case 1955). Thus, de facto, a correction of national income figures on the base of standards was elaborated there (Economic Council of Japan 1974, pp. 99ff).

De Groot (1986) can also be mentioned in this respect. In that study the ecological parameters are formulated for the performance and sustainable use of, among others, the functions of water purification, fishery, game animals, and nursery. The Stimulation Programme for Research in Humid Tropical Forest Lands (Tropenbos) is now conducting research on the conditions for the conservation and rational use of forests and forest land resources and on how to bring these conditions into practice (Bax and others 1986; Ross and Donovan 1986; Grainger 1987; Hueting 1986b). Apart from these and other, more integral, approaches, numerous studies notably on the measures and costs involved in reducing emissions of harmful agents have been carried out in quite a few countries. Some health standards have been established for the concentration of harmful agents allowed for various functions of water and air, such as drinking, swimming, and physiological functioning.

From these experiences it seems feasible to correct national income figures on the basis of standards for health and a sustainable economic development. The method has three advantages and four drawbacks or imperfections.

The first drawback is that the results of the approach do not represent individual valuations in the true sense, as has been extensively explained above. For, among other things, the intensity of the preference for a sustainable economic development cannot be measured. This simultaneously implies, however, that the intensity of the preferences for the acceptance of the adverse effects and future risks involved in the present growth pattern of production and consumption, and thus for the growth of GNP, is equally unknown. Both of these aspects should be clearly mentioned when the results of the method are presented in the publications of the national accounts.

Second, the method ignores the loss of welfare suffered by people who have a strong preference for the survival of plant and animal species apart from their role in maintaining the life-support functions of our planet (which is a prerequisite for a sustainable development). These preferences could be compared with the preferences for creating and maintaining art or churches. This might not be considered indispensable for sustainable development and yields, but their loss would constitute a decrease in welfare for those who appreciate them. The same holds true for species that might not be considered indispensable for a sustainable economic development. This too should be mentioned when presenting the results.

Third, no measures can be formulated for irreversible losses. This holds true for any method. Fourth, the method is laborious.

The first advantage to the method is that it seems to provide an acceptable supplement to national income figures by indicating the losses of environmental functions in monetary terms, since shadow prices cannot be constructed.

Second, the method compels the definition of an exact content of the term "sustainable economic development." Without such a content the term remains vague and not operational for economic policy regarding the environment.

Third, the physical data required for comparison with the standards come down to basic environmental statistics that have to be produced anyhow if we are to get a grip on the state of the environment. The formulation of the measures to meet the standards and the estimates of the expenditure involved are indispensable for policy decisions. In other words, the work necessary to supplement national income figures might be laborious, but it has to be done anyway if one wants to formulate a policy on the environment.

Based on the arguments given above, the national income figures should be corrected for the losses of environmental functions (including resources) on the basis of standards for health and a sustainable economic development. This would provide alternative national income figures alongside the existing ones. The differences between the two will show politicians and the public in monetary terms how far the country has drifted away from the course of sustainable economic development.

Notes

1. This chapter uses the concept of environmental functions, which was designed to describe the economic aspect of the environment. For an economic approach, the environment can best be interpreted as the physical surroundings of humans, on which they depend completely in all their activities. Within the environment several possible uses can be distinguished. These are called environmental functions. When the use of an environmental function by an activity is at the expense of the use of another (or the same) function by another activity or threatens to be so in the future, loss of function occurs; losses of function constitute costs. In this situation, which is called competition between functions, the environment has an economic aspect. Competition between functions can be qualitative, spatial, or quantitative. Qualitative competition amounts broadly speaking to pollution: the use of the environmental function "dumping ground for waste" is at the expense of other functions. It is as if there were an intermediate step. An activity introduces an agent (for instance, a chemical, heat, or noise) into the environment, as a result of which the quality changes; this may disturb other uses or render them impossible. In spatial and quantitative competition there is not enough space or matter to meet the existing demand for it. The use of a function also includes the passive use of the function "natural environment" to conserve the actual and potential utilities of ecosystems, now and in the future, and to retain the diversity of species of our planet. Competition between functions can take all sorts of forms. But in most cases it is a question of the environment being used for production and consumption activities at the expense of another desired use (Hueting 1980).

2. This chapter follows the usual procedure of classifying as compensation costs expenditures such as extra provisions for the drinking water supply, building swimming pools when the water has been polluted, or travel costs to natural parks when natural areas in the vicinity have disappeared and of classifying as financial damage such effects as diminished productivity because of damage to crops and accelerated corrosion or devaluation of properties caused by pollution. At the same time, asking people how much they would be prepared to pay to conserve and restore the environment is classified under willingness to pay. Some authors, however, place all of these categories under willingness to pay.

3. An overview of the methods used, including quite a few results (albeit not in the context of correcting national income figures) can be found in Kneese (1984), Ewers and Schulz (1982), and Schulz (1985). For criticism of the method in the environmental field, see Kapp (1972, pp. 17 ff).

4. When the application of all available technical measures is insufficient to meet a standard, the estimates must be supplemented with the market value of the reduction in activities (in addition to the measures) necessary to meet the standard.

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Environmental Accounting in Development Policy: The French Experience

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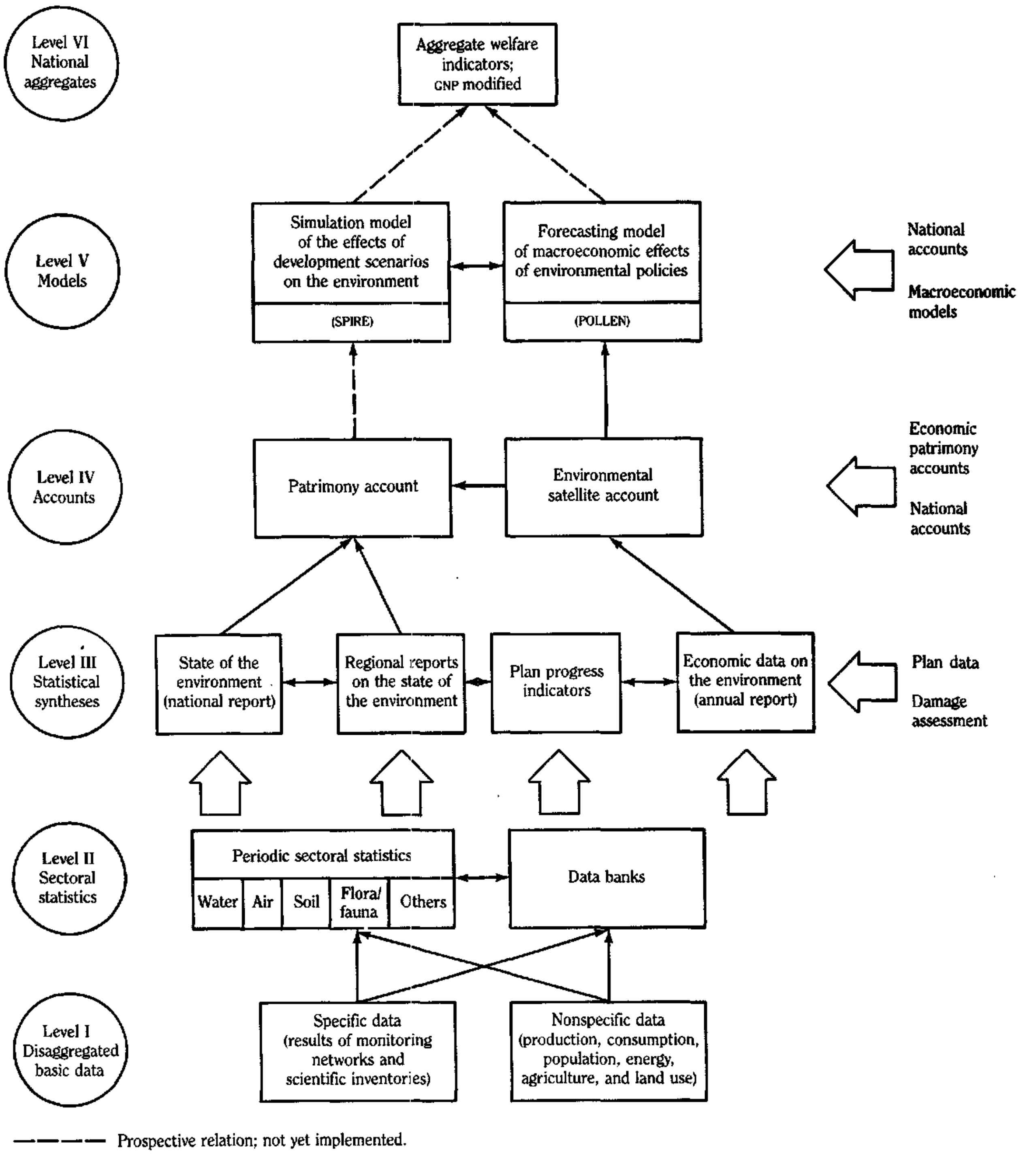
The French experience might be a valuable guide in evaluating the outlook for environmental accounting, because original concepts have been developed and a wide range of statistical tools tested there during the past decade. The French example thus makes it possible to take rapid stock of the many different approaches taken by the developed countries, for which it has proven to be an exemplary testing ground. In a period of economic crisis, the concern to incorporate the environment more effectively in economic policy has in recent years led France to promote the establishment of "natural patrimony accounts," which are similar to Norwegian "resource accounts."[1] However, it would be giving a distorted view of reality to isolate these patrimony accounts from the overall environmental information system. Their part in the planning process, and the very methods by which they are drawn up, are meaningful only in this overall framework.

The French Stratified System of Information

Information currently available on the environment in France is formally organized into a hierarchical system that comprises six levels, ranging from field data (which are extremely fragmented) to global indicators of the quality of life and pollution (Figure 7-1).

- Level I includes a large number of heterogeneous data, either specific to the environmental field (results of scientific inventories or monitoring networks) or nonspecific (socioeconomic data). The quality of this information can vary considerably because there is no adequate system of standardization; for example, attempts to institutionalize ecological balance sheets in business firms have failed thus far.
- Level II comprises composite yet sectoral statistics on water, atmosphere, land, noise, and so forth; these are generally by-products of administrative activity. During the past several years, statistical and documentary data banks have been added that cover such areas as industrial risk, marine pollution, regional flora and fauna, and the cost and efficiency of nonpolluting technologies.
- Level III features comprehensive studies published periodically or compiled from a wide range of sources: national (and, more recently, regional) reports on the state of the environment, indicators of progress in meeting the national economic plan, or a compilation of economic data. These studies bring together in a single document all existing information on environmental expenditure, damage costs, and the macroeconomic effect of environmental policy.
- Level IV contains actual environmental accounting. On the one hand, there are patrimony accounts, which will be discussed later and which are usually expressed in physical terms. On the other hand, there are satellite accounts, which are meant to organize primarily monetary data. Peripheral to the national accounting system (whose accounting nomenclatures it borrows), satellite accounting is designed to assess national environmental expenditure, its funding, and its beneficiaries. As yet, only a few categories of this system have actually been set up: water, waste, national parks, and hunting.
- Level V includes two models, since the accounts in Level IV alone are not sufficient to be used as a basis for forecasting or simulations. The first model (POLLEN) is designed to estimate the effect on such issues as production, prices, and foreign trade of various environmental policies. The second (SPIRE) operates in the opposite direction and is used to assess the pollution or resource extraction levels linked to various development strategies or alternate production and consumption processes.

Figure 7-1. *The French Environmental Data System*



• Level VI concerns quality-of-life indicators. As yet, France has made no attempt—unlike the United States and Japan—to supplement gross national product (GNP) with one or several additional representative indexes of national welfare or wealth. Indeed, using a multicriteria methodology, some work has been undertaken to assess the overall development of local living conditions. However, these efforts are still experimental.

Naturally, all of these levels are linked in varying degrees to external information systems, such as research results in publications on the cost of damages caused by pollution, general macroeconomic theories on which the operation of the SPIRE and POLLEN models depends, and demographic and economic statistics that are used to supplement reports on the state of the environment and to build up basic data. More recently, a connection was established between the natural patrimony accounts drawn up by the Ministry of the Environment and economic patrimony accounts established by the National Institute of Statistics.[2] These interfaces all represent areas in which the environment could potentially be incorporated in a general policy framework.

The structure described above is not the result of a preestablished plan, but of an empirical combination of sets of data compiled to meet specific needs over time. The various levels have developed in a quasi-independent manner. Initially, models were constructed and indicators were developed very rapidly and relied heavily on nonspecific data (on production activities) and experts' statistics. Over the years, statistics collected in the field (for example, the results of monitoring networks) began gradually to replace estimates, thus facilitating a broader dissemination of comprehensive documents, such as reports on the state of the environment. In the late 1970s a partial reorganization of data based on accounting principles and data banks was envisaged. Subsequently, statistics were compiled on a regional basis and field data were standardized.

The development of this data base explains in part why today these various levels are not regarded as forming an integrated system. The drawbacks of this type of step-by-step process are a certain amount of duplication, wastage, and a lack of connections between different bodies of data. The advantage is that each component is adjusted to the specific requirements for which it was designed. In this connection it would be interesting to determine whether empiricism—and the associated wastage—are unavoidable, or if the developing countries can be spared this stage of a trial-and-error approach in order to be able to proceed directly to the accounting stage.

An Accounting System for Natural Assets: French Patrimony Accounts

Despite the diversity of available data, there was no instrument through which the conditions of the long-term regeneration of nature could be taken into account within the overall framework of economic development. For this reason, in 1978 France decided to design an accounting system to assess both quantitatively and qualitatively the state and the development of the natural patrimony, as well as the causes and effects of its evolution. The authorities opted to establish accounts expressed in both physical and monetary units, which would be independent of national accounts but connected to them by various links.

Underlying the concept of an environmental accounting system is a long-standing criticism of the inadequacies of GNP and economic aggregates as welfare indicators; this also exists in several other developed countries. Bertrand de Jouvenel (1966) officially proposed that the national accounts include environmental services, the cost of pollution, and resource extraction. He did not want to abolish existing structures, but to append supplementary components suitable for long-term use.

It became clear, however, that a simple adjustment of the existing system would not be sufficient. That is why, after the existing environmental data systems were first critiqued, it took ten years before a decision was made to establish the patrimony accounts. Much data on the environment is available, but it is poorly integrated into the planning system because it is fragmented. It is also difficult to compete with a system of economic data shaped by decades or centuries of accounting practice.

What is needed to develop environmental accounting is a process similar to the one forty years ago, which produced the System of National Accounts (SNA). Such a process would develop a consistent framework that reflects the complexity of the relationship between humanity and nature as clearly as possible; would create a standardized language, which may be adopted by economists, environmental managers, and scientists alike; and would devise a streamlined set of indicators to serve as a basis for decisionmaking.

Assessing nature in all of its dimensions. The French accounting system attempts to include all components of nature that can be quantitatively or qualitatively changed by human activity. Components that lie outside the realm of human influence (such as geomorphology, solar rays, or magnetic fields) are thus excluded. Defined this way, natural patrimony can be considered as:

- A collection of isolated components: nonrenewable components (such as metallic ore or fossil fuel), environmental media (soil, water, and the atmosphere), and living organisms (such as animals or plants)
- A set of ecosystems, that is, relationships between components within specific systems (such as forests, groves, heaths, grasslands, wet areas, and coastal ecosystems)
- A set of territories, that is, spaces delineated either geographically (such as mountains or coastal land), institutionally, or abstractly (such as grids or observation networks).

Naturally, these groups are not analyzed separately, but in terms of their relationships with other natural components (hence the importance of the concepts of ecosystems and cycles) and, most important, with human activities. The above categories are henceforth supplemented by the category of "agent" (individuals or institutions using the natural environment) and a summary classifica-

Table 7-1. *Structure of a Central Account for a Resource*

Component category	*Initial stock*	*Increase*	*Potential resource*	*Development restitution*	*Available resource*	*Harvesting and extraction*	*Other effects of human activities (pollution)*	*Final stock*
1								
2								
3								
4								
.								
.								
.								
N								
Total								

tion of the relationship between people and nature, such as extraction, pollution, nondestructive use of the environment, access, land use planning, development, and selection. For obvious reasons, the categories chosen for agent accounts are derived from those used in national accounting systems (such as business firms, households, government services, and foreign firms or entities).

Compared with similar experiments, the most original feature of French patrimony accounts is that the natural environment is analyzed according to each of its basic functions: economic, ecological, and social. This functional approach is in fact essential when it comes to revealing natural potential and qualitative damages resulting from market and nonmarket activities. It explains to a large extent why patrimony accounts have been developed independently from national accounts; the main objective is to demonstrate not a net profit or loss from the exploitation of nature, but tradeoffs between the economic, ecological, and social functions of natural resources. Nomenclatures of the French Natural Patrimony Accounts are given in the appendix to this chapter.

The rigor of an accounting approach. Patrimony accounts do not purport to be an organized and periodical inventory of information alone, as are, for example, reports on the state of the environment. As already indicated, they represent a commitment to the notion that the relationship between people and their environment can be effectively portrayed in accounting terms.

This concept first appears in the systematic construction of an account for each component, such as raw materials, the physical environment, living organisms, and ecosystems. This account describes the available stock of the component at the beginning and end of a given period (initial and final stock), as well as the factors that may have brought about any changes: increases or decreases in stock from natural causes and the destruction or development caused by humanity. Such an account, called the central account, is an itemized balance sheet (see Table 7-1 and a practical example in Table 7-2).

One of the advantages of the accounting approach is that the coherent picture it offers accurately reflects the loops and relations. In theory, each change in one part of

Table 7-2. *Example of a Central Account: Growing Stock of a Commercial Forest, 1969 to 1979*
(thousands of cubic meters)

Resource/asset	*Broadleaf*	*Coniferous*	*Total*	*Use*	*Broadleaf*	*Coniferous*	*Total*
Volume of growing stock in 1969	980.1	6,526.5	7,506.6	Natural reduction (mortality)	5.6	21.0	26.6
Natural growth of initial stock	401.9	2,583.5	2,985.4	Accidental reduction (breakage and windfall)	9.7	481.2	490.9
Natural growth by reproduction (recruitment)				Resource extraction (commercial felling)	92.0	1,474.0	1,566.0
				Self-consumption	13.6	395.0	408.6
				Adjustment	−29.4	+1,239.2	1,209.8
				Volume of growing stock in 1979	1,330.7	5,758.0	7,088.7
Total	1,422.2	9,368.4	10,790.6	Total	1,422.2	9,368.4	10,790.6

the accounting system should produce an equivalent change in accounting terms. This interaction is most clearly illustrated in the ecological sector accounts and linkage accounts, which analyze the relationship between nature and the components, and agent accounts, which sum up the linkages with the natural environment of a given agent.

An objective of the central accounts is to aggregate data to the extent possible. At first glance, this objective would seem to contradict the use of highly differentiated physical units of measurement (such as surface area, cubic meters of wood, number of species, and tons of coal) or of qualitative indicators. This obstacle is partially overcome by creating equivalent classes at the assessment level according to three main functions: economic, ecological, and social. This method can be applied using monetary units where justified, but also energy and biomass equivalents when possible. Although this system has attempted to produce aggregate data, the concept of a single natural patrimony development indicator—similar to the major aggregates used in national accounting (such as GNP)—has been abandoned.

Flexible application of the framework. The development of central accounts must take into account the specificity and complexity of natural phenomena. The limitations of an aggregate approach have already been shown: in practice it is neither possible to combine the indicators representing each of the three main functions nor to compare the measurements specific to extremely dissimilar categories of resources (for example, forest areas and water volume). Thus, different accounts for each of these three functions were created, and data were aggregated only for the main resource categories (such as water, fauna, flora, and atmosphere). Consequently, vectors, not indicators, must be used. Similarly, the objectives of thoroughness and systems impact accounting would be too costly to use if they were applied to the letter. For this reason it was initially decided to confine the analysis to a few priority sectors (forests, water, soil, land use, and wildlife) and a few basic interactions.

Because the phenomena to be measured are so heterogeneous, the principle of standardization has been partially reassessed in favor of differentiating between component, ecozone, and agent accounts.

- Component accounts deal with subsoil assets, the soil, the atmosphere, water, and the flora and fauna. Material or energy balances are presented at the beginning or the end of a period and indicate changes resulting from nature or human activity.
- Ecozone accounts register the changes in land use and the status of ecosystems. Remote sensing methods are necessary to establish these accounts.
- Agent accounts deal with people and human institutions, which are classified in the categories of the standard national accounts and deal with economic and noneconomic activities.

In the future these accounts will most likely be supplemented by, and connected with, social statistics.

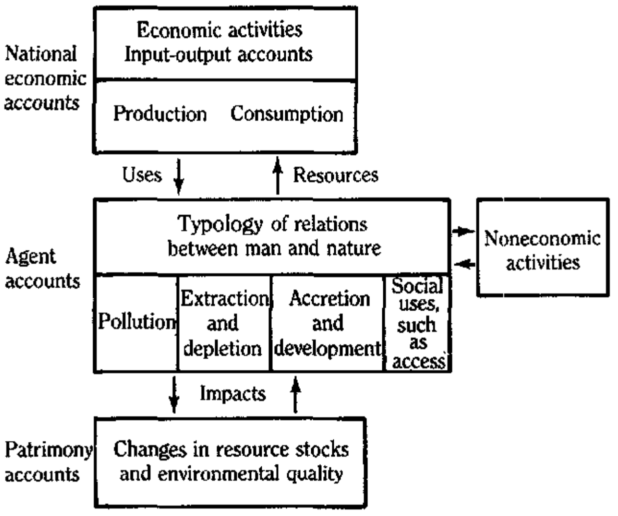
The flexibility of the French system makes patrimony accounts resemble more of a general framework than a rigid system of accounts. This flexibility enables resource managers to remain directly involved in constructing such accounts. This has been the case in France, where research into methodology at the central level has been combined with highly decentralized practical initiatives.

The role of economic assessment. Those for whom the word "accounts" first signifies a monetary balance sheet (or a cost-benefit analysis) could be disappointed by the French approach to patrimony accounting, which concentrates on physical data. In fact, these economic considerations appear on at least three levels.

- The system is designed to lay the groundwork for a genuine physical or "bio- economy." The question at hand is to reveal the relation between the economic and noneconomic functions of nature, to analyze the circumstances in which these functions are reproduced, and to determine how certain underdeveloped natural potential may be transformed into production factors. In a word, patrimony accounting is a key tool in assessing the ecological building blocks of development and is a representation of the concept of sustainable growth.
- Patrimony accounts also have many links or bridges with the national accounting system. Agent accounts, which use categories borrowed from patrimony accounts, serve as a system of passageways through which it is possible to move from classic production and consumption activities to changes in resource stocks or environmental quality (or vice versa), as shown in Figure 7-2. In addition, accounts record expenditures made to repair and develop the natural environment (satellite accounts).
- Last, but not least, it must be remembered that the very purpose of such accounts is to estimate simultaneously the ecological, social, and *economic* value of the natural patrimony. This involves, on the one hand, not only assessing the environmental stock, but also tracing the damaging effect of its conversion. On the other hand, it involves evaluating the extension of services rendered by nature. The entire system is organized with reference to this objective: priority is given to a functional approach, qualitative assessments are introduced following physical analysis, and aggregate indexes are sought.

This being the case, many problems remain unresolved, particularly in the field of monetary assessment. Opinion is divided, especially with respect to the most suitable method of assigning an economic value to resource stocks: using market prices, considering the discounted value of

Figure 7-2. ***Links between Economic, Agent, and Patrimony Accounts***



total anticipated revenues and services, or even measuring opportunity or replacement costs. All of these approaches yield different results, and it is clear that this subject has not yet been fully thought out.

Despite the seeming complexity of the French approach, tangible results have been obtained over a fairly short period and at a relatively low cost (three staff-years and $100,000 in research grants) by focusing attention on a limited number of areas (water, forestry, soil, and wildlife) and by decentralizing the data gathering process. Additional years of study will be required to translate the results of patrimony accounting into changes in the relative price structure of natural resources and into monetary values. Therefore, in the immediate future, the priority has been given to using component accounts in long-term modeling and to building ecological sector accounts through remote sensing.

The Experience of France and Other Developed Countries: A Comparison of Planning Objectives

As a conclusion to the first part of this chapter, it would be interesting to situate the French experience in relation to the general trend of establishing environmental information systems and to compare the various approaches adopted in the light of planning objectives. On examining some of the more representative projects, one is struck by their diversity. Each country seems to have adapted its environmental accounts to its own national needs, institutions, and culture.

American and Japanese proposals are clearly based on the theory of welfare economics: their aim is to modify GNP by assessing in monetary terms the services derived from the environment and the damages borne by it. Norwegian resource accounting, however, is based on an analysis of eco-energy and material balance. This system translates economic activity into flows of matter to energy and vice versa. The Canadian approach draws heavily on the concept of impact studies and applies them at a macroeconomic level. This approach is concerned primarily with the dynamic of ecological systems that have been disturbed by the economic system.

The experience of the Netherlands hinges on the necessity of harmonizing the economic, social, and ecological functions of nature. The French patrimony accounts, although based on this concept of function, share with the Norwegian accounts the aim of attaining a genuine economy of wealth based on an assessment of the potentialities (both monetary and nonmonetary) of using natural assets.

The approaches pursued by different countries reflect several planning concerns and objectives.

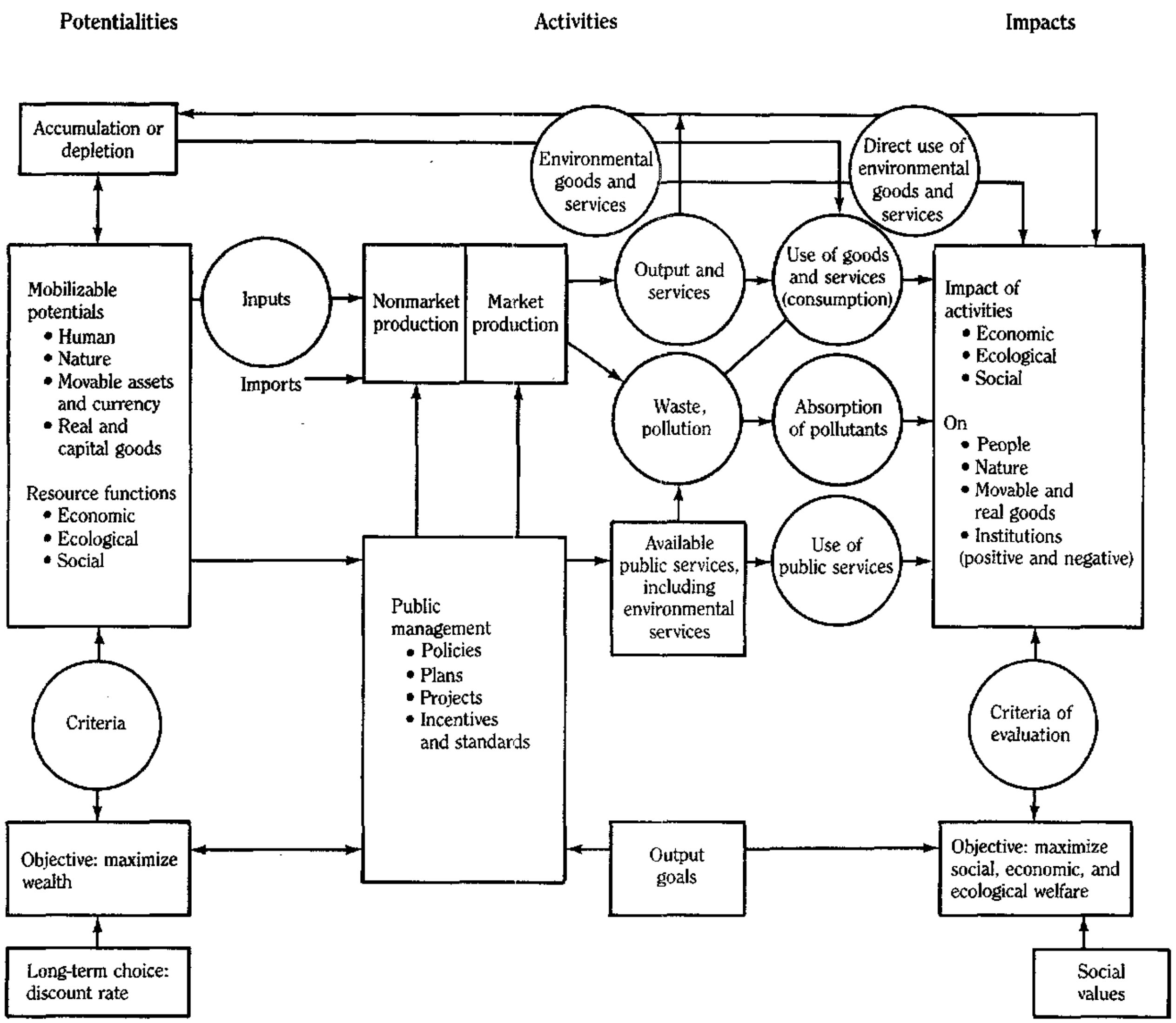
- To diagnose the current (or foreseeable) state of the environment (Canada, France, and Norway)
- To analyze the effect of environmental policies (or the absence thereof) on economic performance and welfare (Japan and United States)
- To assess the value of resources that can be exploited for development as well as the conditions of their regeneration (France and Norway)
- To identify the possible options among the social, economic, and ecological objectives of development, with a view to global negotiation (France and Netherlands).

In conclusion, no natural resource accounting effort so far has made it possible to attain all of these goals simultaneously or to cover the entire range of planning processes (as illustrated in Figure 7-3). Moreover, it is difficult to imagine a system capable of meeting the needs of economists, ecologists, the public, decisionmakers, and environmental managers all at the same time. Developing countries may thus have to choose from the various possible approaches by referring to their own needs, level of development, and environmental management problems. This is discussed below.

Adapting Environmental Accounts to Developing Countries

It is no coincidence that proposals currently put forward about environmental accounting are varied. This heterogeneity simply reflects the varied political concerns, institutional structures, and problems in the developed countries. It also indicates the difficulty of finding a consensus on a theoretical framework that would present clearly the complex relation between the economy and the environment. Therefore, a case-by-case, country-by-country, and perhaps even region-by-region analysis is called for, based on a simplified accounting framework.

Figure 7-3. *Environmental Accounts and Economic Planning*



Note: Some accounts assess the potential and stock of resources (such as in France and Norway), while others measure the effects of environmental damage or improvement (such as in Canada and the United States).

Problems Specific to the Developing World

The first question that naturally comes to mind is the applicability of environmental accounting in the context of the physical problems experienced by the developing countries. It is clear, however, that such accounts will not be created unless they correspond to a perceived economic need.

Economic issues and their implications. Despite the enormous diversity of structures and economic situations in the developing world, there are a few common features that directly affect environmental accounts. First, most people are aware of the critical role that natural resources continue to play in the economic activity of developing countries at all levels (employment, production, export, and consumption). Most developing countries—particularly the poorest—depend on the export of primary commodities or one or two other products for their growth. Resource regeneration and improvement is thus a vital factor in these economies.

Second, the importance of natural resources is made even more apparent if nonmarket activities are considered. Another feature of developing countries is the existence of a traditional sector, dominated by nonremunerated activities including self-production, self-consumption, and barter, alongside a modern sector, which is highly integrated into the international trade system. To date, population growth and the frequent choice of capital-intensive technology have limited the capacity of these countries to absorb the modern sector.

It is therefore the proper functioning of this traditional sector (for example, accessibility of local, nonreplaceable resources) that ensures the basic survival of hundreds of millions of people. The clearest example is noncommercial energy sources (such as firewood and refuse), which account for 50 percent of the developing world's energy consumption. In the People's Republic of the Congo, for example, firewood represents 80 percent of all energy sources and takes up 25 percent of household budgets. During the past decade, its price for village inhabitants has increased tenfold.

Third, this superposition in of heterogeneous economic systems translates directly into an enormous social and geographical inequality. Public works projects, recently constructed modern industrial complexes, and rapid urban expansion are so many enclaves of modernity, which at times stand in strong contrast to the rest of the country. The growing disparities in income, consumption patterns, and lifestyles call into question the usefulness of traditional statistical assessment methods based on averages.

A final factor specific to developing-country economies is their dependence on the outside world. This has also had considerable influence on the introduction of environmental accounts. On the one hand, the importance of export goods, whose value is often set by the international market, and, on the other hand, the weakness of sectors producing directly for the domestic market, sharply reduce the effectiveness of national mechanisms regulating resource supply and demand. Furthermore, given the spread of the nonmarket sector, it is obvious that, in this situation, prices cannot fulfill their traditional role as indicators of scarcity.

There are several implications of these economic issues for environmental accounting.

- There is no doubt that the assessment and development of natural resource potential can have both an economic and ecological interest for developing countries, provided that it leads to the formulation of aggregate indicators and covers both commercial and noncommercial resources (see also Peskin, Chapter 10).
- Given the poor representativeness of monetary assessments, it is necessary, at least initially, to concentrate on physical accounting.
- The existence of extreme inequalities or different situations requires the creation of separate accounts for each homogeneous geographic region or population group.
- Because of the highly polarized nature of development, many cases may well warrant limiting the environmental accounting system to an analysis of a few production and consumption channels or primary commodities.

Physical problems and their implications. It would be inappropriate here to provide a detailed inventory of the environmental problems in the developing world. It is more important to summarize how these problems differ from those experienced in the industrial countries. Environmental concerns in the developed countries have focused largely on pollution risks and the conservation of the natural environment. But despite extensive local damage caused by unchecked industrialization or urban expansion, the greatest environmental threat in developing countries is the disappearance of the resource base on which the survival of millions of people depends. The problems related to resources include shortages of firewood and deforestation, deterioration of arable land and desertification, depletion of the quality and quantity of water and the prevalence of waterborne diseases, reduction in genetic diversity and wildlife stock (wild and domesticated, including fishing resources), and damage caused by natural disasters.

These problems tend to overlap into a chain of cause and effect, which makes partial approaches of limited value. Disturbances in the hydraulic cycle, for example, may be related to erosion, which is in turn linked to deforestation. The destabilization of ecological systems may also be linked to poverty and inequality, the population explosion, legal systems, dependency on the outside world, and adverse natural conditions.

This situation has several implications for establishing accounts.

- The stock of natural resources and its development take precedence over pollution problems in developing countries.
- An accounting system will be even more advantageous if it reflects the systems' effects and cyclical phenomena.
- Although the nomenclature of natural resources seems easily adaptable to the specific context of developing countries, the categorization of agents should be carefully reviewed and, if necessary, revised.

Available Information

The high cost of compiling new data and the chronic lack of qualified personnel in the combined fields of statistics and the environment make it difficult in the short term to prepare resource accounts in developing countries. Gathering information on the environment is generally not yet a priority concern for statisticians in these countries. In these circumstances, it is therefore likely that environmental accounting will in the short term either be based on existing data alone or depend on statistical programs already envisaged in other fields. This restriction makes it strategic to establish a precise inventory of all currently available data (mapping, scientific, and statistical).

In 1977 the United Nations Office of Statistics addressed itself to this task by undertaking a general survey of 122 countries and case studies on Kenya, the Dominican Republic, and the Fiji Islands (United Nations 1982). The main problems found were dispersed and compartmentalized data, insufficient specific information, extremely uneven quality of nonspecific data, and overgeneral statistics prepared by international agencies. These are discussed below in turn.

Dispersed and compartmentalized data. Some data on the environment already exist in the developing world. These data, however, have been compiled by a wide variety of different agencies, ministries, scientific institutes, business firms, and international organizations and are scattered and diversified. Usually appearing as by-products of research studies, sectorial surveys, and project evaluations, they are presented in diverse forms, such as individual observations on specific situations, statistical series, files, and maps. Most often used directly by the institutions producing them, these data are neither standardized, centralized, nor even widely disseminated or published. Thus in Thailand, more than eighty different bodies produce environmental data, which use frequently incompatible nomenclatures and formats. Forty-five such institutions exist in Kenya and thirty-eight in Fiji.

Although considerable potential does exist, it remains largely undeveloped. In this connection, the creation of an environmental or resource account could represent a decisive step forward, even if it were limited to creating a minimum of harmonization—and thus economies of scale—between competing data systems and to serving as a meeting ground where data producers and users—who otherwise have little contact—could meet.

Insufficient specific data. Some progress in collecting data has been made during the past years. Several countries now publish reports on the state of the environment. Monitoring networks have been established to analyze air and water pollution from a few standpoints. Remote sensing is now being used systematically to observe changes in soil use. At the instigation of the Economic and Social Commission for Asia and the Pacific, pertinent data have been collected in most Asian countries on deforestation and water resources (ESCAP 1982). These efforts, however, remain the exception. In Kenya, for example, which is one of the more advanced African countries, statistical data are still inadequate on such important phenomena as deforestation, air and water pollution, soil erosion, and marginal settlements in rural or urban areas. Generally speaking, existing data are often not sufficiently localized and are discontinuous or isolated. Once again, they are gathered by a host of independent agencies, which fail to circulate their findings among themselves.

In general, there is little data available on stocks and even less on their growth or depletion. Assessments of natural resource potential are generally dealt with in ad hoc studies or research, such as those carried out before a major project is implemented. Purely economic estimates most often remain confined to the university (at least at a global level), and studies summing up environmental expenditure at the national level are extremely rare. Finally—and most significant—qualitative data are virtually nonexistent.

Uneven quality of nonspecific data: abundant but not directly usable. The observation above leads to a simple conclusion: the feasibility of environmental accounting in developing countries will depend primarily on the ability to adapt data originally compiled for other purposes or to use existing statistical infrastructures to gather information from other sources. In most countries periodical statistics are available on population; employment and output, by major sector of activity; land area under agriculture, agricultural yields, and production; livestock, fertilizer and pesticides; quantity of timber and forest products for export; catches of fish; and construction of permanent dwellings.

Through a few relatively simple operations, such as geographic coding of data or the use of other data (for example, pollution coefficients or resource-use coefficients per unit of output), statistics directly usable for environmental accounts might be obtained, and an environmental section could gradually be added to some surveys.

Naturally, the success of patrimony accounts depends on the quality of their connection with the SNA, which has the tremendous advantage of having a homogeneous and consistent framework and of being appraised annually in most countries. National accounting is a necessary transition point, particularly if environmental accounts are to be used in national economic planning. There are two limitations to this approach, however.

First, it is clear that considerable gaps exist in the statistical material compiled—even at the purely economic level. For example, very little aggregated data exist on household spending and consumption or on income distribution, and information relating to volume (deflated according to a price index) is often contestable (IARIW–ECA 1982).

Second, it is obvious that the significance of accounts and the use of aggregates as overall indexes of activity are considerably reduced by the fact that they do not include nonmarket goods and services. Gunnar Myrdal

(1970) pointed out long ago the limitations of applying the notion of GNP to developing countries whose economies include sizable nonmonetary agricultural sectors.

These two limitations explain why the quality of aggregate data collected can vary considerably. In Africa, for example, estimates of GNP growth during 1960 to 1970 ranged, according to the sources and countries concerned, from 1 to 11 percent for Chad, from 1 to 13 percent for Mali, from 1 to 6 percent for Burkina Faso, and from 1 to 2 percent for Senegal (World Bank 1981). These gaps, which may at first seem to represent insurmountable obstacles to creating environmental accounts, can also, paradoxically, be viewed as significant opportunities. As pointed out on numerous occasions, improving the quality of conventional economic data systems (national accounting, in particular) will obviously benefit environmental accounts by emphasizing the nonmonetary sector.

Two examples—among many others—exist of this convergence. First, by excluding wood-based fuels, current statistics obscure the specific nature of the energy crisis in the developing countries and may lead to irrational investment decisions. In Zaire, for instance, if noncommercial energy sources were included, energy consumption would jump from 3 to 10 percent of gross domestic product (GDP). Second, because of the quality of data compiled on nonmarket food crops, Kenya was able to forecast harvest yields that proved to be invaluable during the drought in the late 1970s. A project specifically aimed at collecting data on natural resources not intended for export markets could thus easily become economically profitable.

Abundant but overgeneral data from international organizations. Beginning in the mid-1970s, many international organizations—including the Food and Agriculture Organization (FAO); Unesco Man and the Biosphere Program; the World Health Organization (WHO); and the U.N. Environment Programme (UNEP)--have involved themselves in far-reaching programs to compile data on the environment and natural resources.

For example, the FAO recently completed a soil map on a scale of 1:1.5 million, as well as a map of areas in the process of desertification. It has also launched a project to partition Africa and Asia into homogeneous ecological regions and has analyzed soil potential for twelve types of crops (UNEP 1981). It periodically disseminates data on soil use (in five categories), pesticide use, area of land under irrigation, and fishing yields. Two years ago, it completed an inventory of tropical forests and their growth, in conjunction with Unesco and UNEP.

For its part, UNEP has coordinated a monitoring network to oversee climate, long-range transport of pollutants, environmental health, oceans, and terrestrial natural resources (GEMS program). In many fields, these data are often the only available at the moment. The pollution monitoring network coordinated by the GEMS program comprises only 400 stations for the entire world, which represents an average of only 2 to 4 in each country. Last but not least, entire sections of environmental concerns have poor or inadequate data coverage; this is especially true of wildlife and flora and of environmental economics.

Environmental Accounting as a Tool for Policymaking

Natural resource accounting could act as a catalyst for framing environmental policy in developing countries. Many of these countries have complained that it is difficult to put the concept of integrated development into practice without a tool to facilitate the distribution of investment to various areas of the environment or to identify beforehand the payers and beneficiaries of the policies envisaged. To a large extent, environmental accounting answers this dual need. In this respect, it can fulfill, at the national level, the same role of initiator or driving force that impact studies have at the project level. It can supply environmental institutions with the means to open dialogue with economic administrators and members of the scientific community. It can also provide these same institutions with effective management tools in their particular field of competence, such as priority criteria and minimal data on anticipated expenditure and its impact. Environmental accounting cannot, of course, substitute for political will, but, for environmental administrations, which are often weak, it can constitute a powerful means of internal structuring and recognition with respect to other ministerial offices.

Proposals

The preceding survey shows that the development of environmental accounting in the developing world will inevitably encounter a set of serious obstacles. The problem of insufficient and poorly dispersed basic data is compounded by several factors.

- The shortage of financial and human resources that can be mobilized in the light of other, more urgent, priorities for statistical data that have not yet been filled.
- The lack of a coordinating structure capable of bringing together multidisciplinary teams.
- The unsuitability of a cost-benefit approach in sectors dominated by nonmarket activities.
- The present lack of political demand for this type of tool, particularly by economic planning bodies.

Although these obstacles may seem sizable, they are not insurmountable. There are a few factors that might help in establishing environmental accounts, and results from the few projects recently undertaken in developing countries have been encouraging.

Several factors can possibly facilitate the setting up of environmental accounts in the developing countries: their environmental problems may be more apparent than in the industrial countries, the convergence of requirements for economic and resource statistics may be more obvious, and the intermediate materials and results of the developed countries can be used.

In addition, remote sensing is an effective, well-developed tool. It is particularly well adapted to evaluating natural resources, and, having demonstrated its reliability, remote sensing can be an extremely useful tool in creating environmental accounts.

- It is relatively inexpensive compared with other methods of statistical and cartographical analysis.[3]
- Its global and composite nature allow it to analyze a large number of variables simultaneously, thus furnishing qualitative as well as quantitative results.
- It makes it possible to process rapidly large and inaccessible areas.[4]
- It is particularly suitable for repeated use, which is important in taking periodic measurements of differences in the state of the environment.

To date, there are no examples of natural resource accounting projects carried through to completion in developing countries. However, significant progress has been made with the launching of a few partial efforts under the auspices of the U.N. Statistical Office (UNSO), UNEP, and ESCAP, and on the initiative of individual countries.[5]

Cote d'Ivoire is a good example, as it began research in 1983 with a view to setting up a quantitative and qualitative soil account (Dravie and others 1983). Within a few months, it established a methodological framework and applied it to a small region, which permitted full-scale activities to be carried out in three directions.

First, a dual soil classification system (functional and qualitative) was created. Second, a central account was set up, which described both the changes in land allocation and the evolution of its potential use by phenomena such as erosion, desertification, and certain agricultural practices. Third, an economic account was established, which covered both the investment cost involved in soil protection and improvement and the monetary effect of the growth of potentially exploitable assets (taking into account theories on production techniques). Full-scale compilation of statistics for these accounts must, of course, be started before any conclusions may be drawn from this project.

At the National Level

The preparation of accounts cannot be contemplated without strong motivation on the part of the interested countries.

- In the poorest countries, priority should be given to preparing reports on the state of the environment (adding, where appropriate, a survey of investment expenditure).
- Patrimony accounts should be developed only in the economically most advanced countries and should emphasize accounting in physical terms before contemplating linkages with the SNA.
- Data collection and processing should initially focus on one or two resources regarded as economically and ecologically strategic by each country.
- The national (macro) and regional (major projects) approaches should be combined as far as possible within the framework of flexible and decentralized institutional machinery, which will draw maximum benefit from existing skills and information.

At the International Level

As was the case when the SNA was established, international cooperation will undoubtedly be necessary to help initiate the process of creating environmental accounts. The following six proposals fall within that context.

- A detailed survey should be made of the cost, logistics, human resource requirements, and performance of accounting systems being set up in the developed countries. At the same time, an audit on the reliability of remote sensing methods could be carried out.
- Full-scale experiments should be funded in a few countries (one per continent), which focus each time on a different aspect that is locally considered to have priority.
- Specific improvements in existing statistical systems should be promoted under the auspices of the U.N. Statistical Office, such as reorganizing data according to ecological zoning patterns, compiling economic data pertaining to environmental management in a single compendium, or adding a section on the environment or natural resources to industrial and agricultural surveys.
- An international network should be established to facilitate the dissemination of the results of successful experiments, the exchange of views and intermediate materials, access to data collected by international organizations, and the creation of a file of cost-benefit studies.
- Training programs should be developed for the statisticians, economists, and scientists involved in the accounting systems process, or training modules should be created to make national accountants and planning officials more aware of the importance of environmental accounting.

Conclusion: Toward a Program of Action

Actually, the greatest problem connected with environmental accounting is not to define once and for all a model transposable to all the developing countries, but to launch a process of implementation that takes into account the assets and constraints specific to each one of them. It is thus necessary to go beyond a list of desirable activities and to propose a program with very specific stages and time scales.

The following program proposes a series of steps in three stages (short-, medium-, and long-term), whose main aim is gradually to arouse in the developing countries concerned sufficient motivation to proceed to the final stage of creating accounts.

First Stage: Awareness and Experimentation

The aim of the first stage is to interest planning officials (and beyond them, political decisionmakers) in creating accounts as soon as possible. The stress is thus deliberately placed on producing results rapidly and on using accounts for economic forecasting.

For that purpose four or five pilot studies should be launched, with the participation of experts from these countries and from the developed countries who have experience with environmental accounting. Initially each study would prepare a central account (stock account) for one of the resources considered to be strategic by the volunteer countries (such as water, forest, soil, humid zones, fisheries, or genotype).

The first drafts of the accounts thus created are used in the second stage to analyze resource processing networks throughout the production system and to assess the modifications in the economic value of the stock at the beginning and the end of the period under consideration. It will be possible to test several methods of monetary evaluation concurrently.

The best way of turning the preceding information to account would be to construct in a third stage, together with planning officials, two contrasting resource management scenarios. One of these would prolong past trends, while the second would be a conservation scenario. This prospective analysis would illustrate by simple indicators the relevance—both from the economic and physical viewpoints—of a strategy of sustainable development. The case studies would also localize existing information and assess the cost and technical conditions involved in obtaining currently unavailable data. By the end of the first stage, the experts should thus be able to propose an initial program for organizing the existing environmental data in each country.

Finally, at the same time as this fieldwork is being done, it would appear to be essential to maintain or to set up an ad hoc assessment team. This team would be responsible for periodically following the progress of the case studies and for assessing the results of this first stage, together with the national leaders. The few rare experiments that have already been highlighted indicate that it will be possible to attain all these objectives within two years.

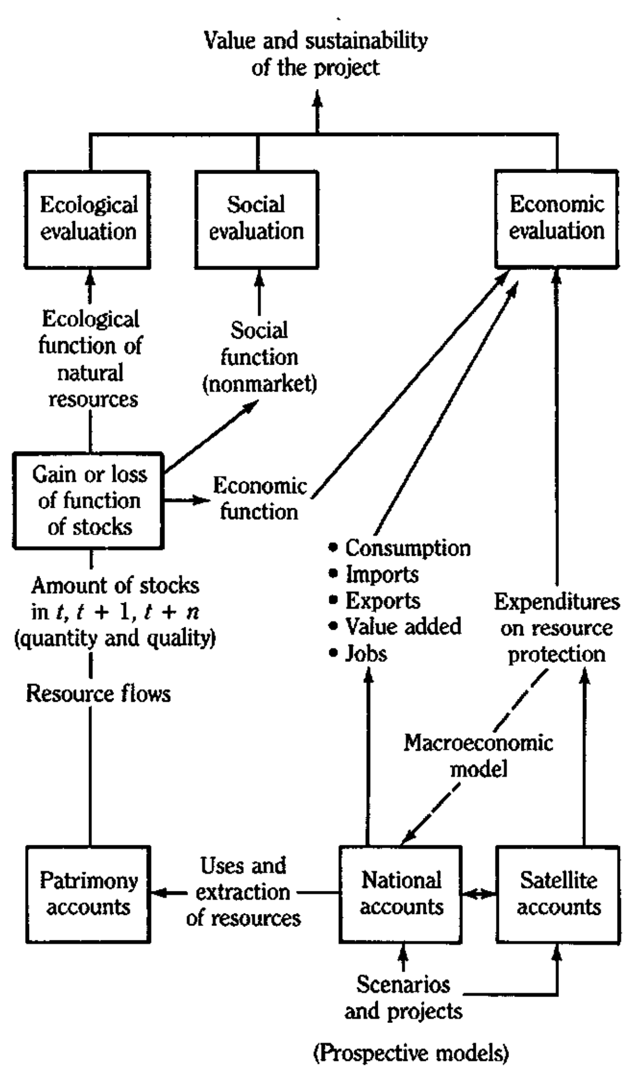
Second Stage: Development

The second stage should have two objectives: on the one hand, to extend the preceding steps so as to include fewer economic aspects and, on the other hand, to set up the essential institutional structures in each country concerned. The experts should thus be gradually replaced by national bodies.

The following activities could thus be carried out during this second stage.

- The setting up, in each of the countries in which a pilot study was done, of institutional structures responsible for the accounts (Figure 7-4).

Figure 7-4. *Using Accounts to Compare Projects or Alternative Development Scenarios*



• The preparation of a complete system of accounts on the resources studied during the first stage. This is equivalent to adding to the preceding analysis a satellite account summing up the expenditure on the management of this resource, a set of agent accounts, and, in particular, the bulk of the data on the ecological function of the resources (accounts and indicators of defects in ecosystems). This would be done by the institutional structures described above.

• The launching of international training and research activities.

At the end of this period four or five complete accounts, each dealing with a specific resource (such as water, soil, or forest), would thus be available. This should suffice to test the validity of the indicators, ratios, or units of economic and ecological measurement suggested in each case.

Concurrently with this detailed analysis of a resource, it would probably be desirable to use the available data to set up in four or five volunteer countries a provisional system of indicators of situation or of results for the other national resources. All this material should finally enable an increasing number of countries to become aware of the relevance of accounts before the third stage, which should consist of applying the pilot experiments on a large scale.

Third Stage: Dissemination

Until the program is about to enter its fifth year, it will not be possible to appreciate the relevance and feasibility of environmental accounting in the developing world and to arrive at serious conclusions regarding the accounting structure best adapted to the situation in these countries. The third stage should thus logically begin with an international conference to assess and adjust the program of action. The following long-term actions could eventually be launched, depending upon the results of this conference.

In countries that initiated pilot experiments during the first two stages

• Progressive extension of accounts established for a single resource to the totality of the natural resources (patrimony accounts) and of the expenditure on their management (satellite accounts)

• Simultaneous organization of existing information systems (such as data banks, monitoring networks, surveys, and inventories)

• Introduction in planning of a limited number of aggregate indicators of the state and development of resources, which are followed up periodically (and established on the basis of the accounts)

• Discriminating analysis of the possible linkups between resource accounts and national accounts

• Development, where possible, of prospective and macroeconomic models for assessing, on the one hand, the economic effects of environmental policies and, on the other hand, the consequences for the main ecological indicators of different growth scenarios

• Launching, on the basis of the preceding information, of a limited number of cost-benefit studies on policies for combating conditions such as desertification, deforestation, and water pollution (in accordance with national priorities).

In the other countries or on an international level

• Preparation of an international-level typical account structure adapted to the developing countries and of the corresponding methodological documents, such as guidelines and intermediate material

• Adoption of an international classification system for resources (such as water, air, soil, and ecosystems) and efforts to harmonize existing nomenclatures

• Improvement of the methods of storing and disseminating the data collected by the international agencies to make them more coherent and directly accessible to the developing countries

• Launching of a major international research program on indicators of defects in ecosystems (analysis of thresholds) and on resource economics (economic assessment of damage, calculation of shadow prices, and criteria for the interperiod management of renewable and nonrenewable resources). This research focuses on the problems of the developing world and will have to take explicitly into account the nature of the available information.

In conclusion, it is necessary to revert to another aspect, the institutional dimension. It seems obvious that an operation as demanding as the creation of accounts has no chance of succeeding unless it corresponds, at least to begin with, to specific political needs with respect to management, and unless it gives birth to a permanent framework for dialogue between the responsible government departments, scientists, economists, planners, and statisticians. Methodological problems are of secondary importance compared with these necessities.

Appendix. Nomenclatures of the French Natural Patrimony Accounts

A. Nomenclature of components
  1. Nonrenewable components
     - Fossil fuels
     - Uranium
     - Metalliferous ore
     - Nonmetallic ore
     - Quarry (including sand)
     - Other

2. Environmental media
   - Soils (exposed and immerged)
   - Continental waters (surface water, groundwater, snow, and glaciers)
   - Ocean waters (coastal waters and open sea)
   - Atmosphere (air, upper atmosphere, and climate)
3. Living organisms
   - Animal species (wild and domestic)—according to standard scientific nomenclature
   - Plant species (wild and domestic)—according to standard scientific nomenclature
   - Microorganisms

B. Nomenclature of ecosystems
1. Water ecosystems
   - Open sea
   - Coastal ecosystems
   - Inland ecosystems
2. Terrestrial ecosystems
   - Forest
   - Woodland and pasture land
   - Health
   - Meadow and land under cultivation
   - Turf
   - Pioneer ecosystems
3. Other ecosystems

C. Nomenclature of agents

According to the traditional distinction of the SNA among:
- Households
  - Business firms
  - Administrations
  - Other (such as foreign entities)

Other subcategories:
- Business: environmental firms or managing bodies (agricultural and nonagricultural)
- Administrations and environmental public bodies (associations, local administrations, and central administrations

Notes

1. The term "patrimony accounts" is a direct translation from the French language. The French system is very broad and includes, in addition to natural assets, those with a historical or cultural value.
2. Economic patrimony accounts have been prepared since 1986 within the framework of the expanded SNA. They assess in monetary terms all stock or capital goods held by economic agents (such as housing, capital equipment, land, subsoil resources, livestock, and forests) as well as financial assets (such as gold, currency, and stock).
3. For Landsat, the taking, processing, interpretation, and display of images on a scale of 1:100,000 costs roughly one tenth of photomapping using color infrared.
4. For example, only 40 Landsat images were needed to establish a 1982–83 inventory of terrestrial resources for half of Mali, whereas the same area would have required 5,000 aerial photos on a scale of 1:50,000 (excluding ground surveys).
5. ESCAP plans to supplement its report on the state of the environment with a section on resource accounting, based on one or two case studies.

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Linkages between Environmental and National Income Accounts

Richard B. Norgaard

Almost four decades ago K. William Kapp (1950) argued that both our conception of the development process and our national income accounts were inadequate for development planning. Neither our theories nor our primary indicators of economic development incorporate the services of the environment and of resources. This conceptual problem became a popular concern during the 1960s, as awareness of pollution and environmental management problems increased in the developed countries. By this time the shortcomings of the gross national product (GNP) became more and more apparent. GNP, as conventionally measured, could be increased by using up limited resources faster at the expense of future generations. It could also be increased both by degrading the environment and by correcting environmental degradation.

During the 1970s economists and others began to make serious suggestions for changes in the System of National Accounts (SNA) to correct the shortcomings. In spite of the logic behind many recommendations, however, the only suggestion that many countries have adopted in their national accounts is to keep separate track of environmental correction expenditures (named defensive expenditures elsewhere in this volume).

Since the early 1970s an increasing number of problems in developing countries also have been linked to inadequate consideration of environmental and resource factors. Both specific development projects and general strategies failed to reflect environmental opportunities and constraints. In the early 1970s the political leaders, government advisers, and academics in developing countries rejected the concept of an environmental crisis as perceived by their counterparts in developed countries. During the past decade, however, some of them have been active in reformulating development thinking to include the relationships between well-being, environment, and resources.

The international development organizations—as major users of information from the SNA, as advisers to developing countries, and as coordinators of systematic data collection and exchange—have initiated various efforts to improve the usefulness of environmental data. The Conference of European Statisticians of the Economic Commission for Europe began to investigate the organization and use of environmental data in 1973.

The U.N. Statistical Office (UNSO) began working on the problems of organizing environmental data in 1974. In 1983 the first of several Environmental Accounting Workshops was held. In late 1984 UNSO presented "A Framework for the Development of Environment Statistics."

The Environmental Accounting Workshops have struggled with the complex methodological issues of how various heterogeneous environmental data should be selected, organized, aggregated, and incorporated into or linked with the information provided by the SNA. Strong arguments, presented predominantly by economists, have been made that the SNA is already an effective tool. Its defenders believe that it simply needs to be improved by including both the value of environmental and resource services in the current account and the variation in the value of resource stocks and environmental systems in the capital account. Some economists believe that appropriate techniques exist to fully incorporate critical resource and environmental values in the SNA. Others believe that environmental accounting should be independent of economic accounting and that linkages should be made between the accounts as appropriate for different types of questions.

Economists have developed numerous techniques during the past three decades for estimating the monetary values of resource and environmental services. The values of the environments or environmental factors and of the resources from which these services derive are the present value of the services. Economists have tried to ground these techniques in economic theory, have obtained adequate data in some cases, and have established effective econometric procedures.[1] To most economists, environmental and resource valuation is a proven area, one where success appears consistently possible after sufficient effort. Thus most economists concerned with environmental accounting argue that the greatest problems of the SNA with resources and environmental systems can be corrected by developing a good system of accounts, with everything measured and aggregated in monetary terms. Furthermore, with everything in monetary terms, planners could readily compare options.

The skeptics are concerned with the limits of economic valuation or of any other single technique. They argue that the environmental accounts should be maintained in physical units to the extent possible and that multiple approaches to linking accounts with the SNA should be developed and used as appropriate, given the question under consideration. They have been unified by their skepticism of the economists' arguments, and they agree that questions related to appropriate development are too important, diverse, and complicated to be pursued through a single approach. But they have so far not reached a consensus on an alternative approach or combination of approaches.[2]

The methodological debate has circled around the economic approach versus the use of diverse, less formal, methods. Many of these other methods have been experimented with in the French system of environmental accounting.[3] A consensus, however, has hardly developed on which methods might be conceptually more suitable or practically more effective under different circumstances.

SNA Developed by Consensus, Not Theory

Most lay people and many planners assume that increasing the GNP means that the economic welfare of people has improved. But GNP only measures the level of economic activity that goes through the market mechanism. Welfare is best thought of as the sum of producers' and consumers' surpluses—the difference between the areas under demand curves and above supply curves. When these areas increase, other things held equal, welfare has improved. Expenditures are an awkward combination of the cost of supplying goods and services and the producers' surplus. And other things are rarely held equal. GNP increases when subsistence farmers join the labor force and stop producing their own food, when women join the labor force and hire domestic help and childcare, when the stock of housing and factories is destroyed by war and then replaced, and when the environment deteriorates and the government initiates corrective actions.

The SNA has these internal inconsistencies because of the difficulties of building accounts that are consistent with economic theory. The derivation of the SNA stems from heated debate as to what should be included and how. Thus, the SNA is based on conventions established through a process of acquiring consensus rather than based on procedures deduced from economic theory.

The Value Aggregation Issue

Much of the interest in environmental accounting stems from a concern with the sustainability of development. Economists argue that sustainability, to the extent that it is important to people, is incorporated in individuals' values and reflected in the decisions they make. For economists, one goal of environmental accounting is to provide appropriate indicators of people's willingness to maintain or improve the quality of the environment as development occurs. Valuation techniques for nonmarket goods and services, however, rely on individual preferences about the future as expressed for goods and services in those markets that are working.

Environmentalists argue, however, that they are ethically compelled to seek sustainable development. For these people, sustainability should be a constraint on, or separate social objective of, development strategies. Even if a society does not select sustainability as a constraint or objective, it should explicitly monitor the extent to which current preferences jeopardize future generations. Economic techniques, however, aggregate key environmental information of importance to social decisionmakers and consider social values by initially weighting them with respect to individual preferences as they are expressed in private markets.

Economists make tradeoffs between generations on the assumption that interest rates reflect optimal exchanges between present and future generations. The fact that future generations cannot possibly participate in capital markets provides a clear rationale for social intervention in capital markets and independent social decisions about conserving resources and environmental systems. Societies could, and to some extent do, protect future generations through interest rate policy. Societies frequently make decisions to directly reserve resources and environmental systems for future generations. The information for making these social decisions should not be presented solely in a form reflecting the current generation's values, as expressed individually by the rate of interest generated in capital markets.

Although the issue of sustainable development is relatively new, the philosophical division between thinking of social goals as the sum of the goals of a society's individuals and thinking of society as having its own goals above and beyond those of its individuals has deep historical roots. Economic theory is based on the former premise, but all societies operate on the second premise to some extent, most to a considerable extent. In the public policy arena, economists are repeatedly confronted by the contradictions between the premise upon which their indicators are based and the premise upon which they are used.

The ethical debate has theoretical analogs. The contradictions between economic indicators based on one premise about society that are used in public decisions involving another premise underlie, for example, the theoretical controversy over the use of benefit-cost analysis to efficiently design public projects. If one of the objectives of a project is to redistribute income, what is the significance of an efficiency analysis derived from valuations based on prices generated by the existing income distribution? The weighting of benefits and costs depending on their incidence by income groups is currently practiced, but it is quite controversial among economists because of the value judgments it involves.

With respect to sustainability, the parallels are clear. If one of the objectives of public decisionmaking is to enhance the likelihood of sustainable development, what is the significance of environmental valuations derived from information generated by an economy that is less sustainable than desired? Within environmental economics similar questions are now being theoretically considered by comparing total systems with and without a policy change. Using this approach, the values of environmental services are derived from the differences in utility gained with and without the policy change. This theoretical "solution" reverses the process advocated by economists for environmental accounting: environmental values change as a result of the policy input rather than environmental values providing input to the policy change.

The determination and use of interest rates reflects this theoretical quandary. Economists argue that the value of resources saved for the next generation, say twenty years hence, is equal to their value at that time discounted by dividing the value by one plus the rate of interest to the twentieth power. Given the economist's theory of how interest rates are determined in intergenerational capital markets, however, it would be just as appropriate to ask how future generations would interact differently in the capital market and affect the rate of interest if they were wealthier because this generation had redistributed resources in their favor.

The conventional economic answer to this issue has been to argue that market values with and without a policy change will be very close for small changes. This, however, would be incorrect if the ultimate objective were to significantly change the direction of development. In short, if the current economic development path was sufficiently inappropriate that significant corrections would be called for, current market signals would not provide appropriate indicators of how the path could best be corrected. Signals generated by economic methodology are best for fine-tuning on the margin. Quite consistently, supporters of, and detractors from, the economic approach tend to hold different opinions as to whether fine-tunings or significant changes are needed.

Economic techniques for valuing nonmarket goods and services are also based on the assumption that nonmarket goods are a marginal problem. If nonmarket goods and services comprise a small portion of the total economy, then the inclusion of these goods and services in the market would not significantly change the relative prices of goods and services or individual behavior. In this case, existing market prices and behavior can be used to estimate the value of nonmarket goods and services. If nonmarket goods and services comprise a large portion of the total economy, however, their inclusion would significantly change relative prices and the valuation of nonmarket goods and services. Again we are faced with the dilemma that economic techniques are more appropriate the less significant the problem. And again, advocates and opponents of the economic approach are divided as to whether our problems are small or large.

The economic approach suffers from several theoretical shortcomings. One might conclude therefore that another approach is needed. But all approaches contain similar methodological drawbacks. Any method of aggregating environmental and resource data, for example, implies value weightings which "should" be made by society. Yet society as a whole cannot be involved in every decision. Some method of weighting is necessary so that those to whom social decisionmaking has been delegated can assess current conditions, foresee the consequences of alternative courses of actions, and make decisions. Indeed, even if all decisions were made collectively, aggregation—with implicit valuations—would be necessary to convey information in a usable form to the public. This issue is being referred to as the value aggregation problem.

The value aggregation issue can be used to reduce the methodological debate to an ethical debate, with each side leaving the proponents of the other methodology with little more than their values supporting their argument. But one can look at the issue also in the following constructive way. Each methodology gives different weights to the values around which interest groups organize. With multiple methodologies giving alternative weights to different interests, the interests of all could be protected and a Pareto optimal solution might be possible.[4] The value aggregation problem in this light becomes an argument for methodological pluralism—for the use of multiple methodologies to help insure that all values are respected to the extent possible.

The Bounded-Knowledge Synthesis Issue

All models of social and environmental systems suffer from another problem. Scientific knowledge stems from specific models that simplify reality, in part, by artificially bounding the field of study. Science has not provided a way to synthesize bounded knowledge into knowledge of the whole. Yet such a synthesis is exactly what environmental accounting needs in order to derive better indicators for planners. This problem will be referred to as the bounded-knowledge synthesis issue.

Each methodology for aggregating bounded knowledge works better for some types of knowledge, less well for others. Preference for one methodology over another frequently stems from an individual's special understanding of a particular aspect of a problem and relative naivete of other aspects. Depending on the question being asked, some linking methodologies will be able to address knowledge more closely related to the question than others. One procedure, for example, might effectively aggregate soil fertility with economic productivity, while another might aggregate the ability of the soil to hold moisture during droughts to the variations in the need for foreign exchange. Each methodology for aggregating has advantages depending on the question being asked.

The bounded-knowledge synthesis issue also supports a pluralistic approach to aggregating environmental and economic information. The rule of "safety first" would indicate the use of multiple methodologies to insure that decisionmakers have information alerting them to as many aspects of environmental and resource phenomena as possible. Decisionmakers should not be limited to knowledge bounded by the particular models best addressed by one linking methodology. Planners and policymakers do not always know which questions should be asked and which methodologies are most appropriate.

The valuation of environmental services and resources and of their respective systems and stocks is a methodology that facilitates nothing more sophisticated than addition. Market goods and services can be combined with nonmarket environmental factors after valuation to obtain better measures of the level of economic activity. Similarly, the value of natural resource stocks and of environmental systems can be added to that of man-made capital. If better measures of the levels of economic activity and the value of assets are needed, valuation is an appropriate approach.

Policymakers and planners want to know not only how well the economy is doing but how it might be improved. For this they need to be able to predict the outcomes of alternative decisions. And predictions require models of cause and effect—of how different mixes of economic activity affect, and are affected by, resources and the environment over time. GNP is like a speedometer, and improvements in a speedometer's accuracy could prove quite important. But a speedometer does not indicate whether the wheels are spinning on ice or even on the road. To address the questions of long-term economic and environmental planning, a map is needed. Valuation can still be helpful when combined with explanatory models, but for most questions valuation itself is inadequate.

In summary, the theoretical component of the debate over the appropriate methodology for combining environmental and economic information has been sustained by the belief that there is a correct method for understanding the complex interactions between economic development and the environment.[5] The value aggregation and bounded-knowledge synthesis problems indicate that this belief is naive. A consensus for one methodology can only be reached by "nonlogical" means. Logic, however, indicates that multiple methodologies—conceptual pluralism—provide the key to a safer and more pragmatic strategy for linking environmental and economic accounting. Sustainability is too important, too multidimensional, and too poorly understood for societies to rely on one methodology.

Conclusions

The approach to combining environmental information with the SNA faces certain difficulties because of the derivation of the SNA (by consensus rather than a deductive methodology) and its attendant shortcomings; the value-aggregation issue; and the bounded knowledge-synthesis issue.

The existence of these problems means that broad, aggregate indicators for planners will have to be derived by consensus rather than by a deductive methodology. Each specific approach advocated by one group can be shown to contain shortcomings or inconsistencies. There is therefore a need to pragmatically work toward a consensus. Although no one methodology can be logically correct, the use of multiple methodologies will reduce the likelihood of making a significant error.

In conclusion, less effort should be spent on debating and more on experimenting, learning through doing, and sharing experiences. It seems appropriate at this stage to try two or three different approaches to environmental accounting in each of four or five countries with different types of environmental problems. Future workshops should be directed toward discussing the practical issues encountered and sharing the results.

Notes

1. For a general review of and guide to the use of these techniques, see Hufschmidt and others (1983). Much of the theoretical development of these techniques has been published in the *Journal of Environmental Economics and Management*. Peskin (1981) provides the clearest description of the use of these techniques to modify the SNA.

2. This is well documented in the rapporteurs' summary of the meeting in Washington, D.C., November 1984.

3. The French system of environmental linking, for example, has many attractive features, but those opposed to the economists' view cannot agree on its strengths and weaknesses. See Chapter 7.

4. A Pareto optimal solution is one in which some or many individuals would be better off and, at the same time, nobody would be worse off.

5. "Critical rationality"—the belief that rational methods exist for applying scientific knowledge to social questions—is the

dominant belief among scientists, economists, and policymakers. The belief is supported, although not "logically," by the mainstream epistemology of Popper (1979). During the past decade the dominant belief system has been attacked by philosophers (Feyerabend 1974 and 1978), by systems theorists (Churchman 1979), and by planners (Ulrich 1983).

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Environmental and Nonmarket Accounting in Developing Countries

Henry M. Peskin

National accounting systems, in one form or another, exist in nearly every nation, regardless of the nation's stage of development. The United Nations encourages standardization both in accounting procedures and in the layout of final tables—presumably to make it easier to compare economic performance across nations. One could argue, however, that there is a special need to depart from the standard in developing nations. In particular, they may benefit more than developed nations from modifications that better account for the contribution of environmental and other nonmarket assets.

An important characteristic of these nations, and a key indicator of their stage of development, is the large amount of economic activity that occurs outside organized markets. This activity has not been ignored by national accountants in these countries. According to a survey conducted by the OECD Development Centre, most of the sixty-five responding nations account to some degree for nonmarket, subsistence activities (Blades 1975). There is no evidence, however, that any of these nations account for the services of the environment, the principal nonmarket asset that is the concern of ministries of the environment.

This chapter points out how a system of national accounts, possibly developed along the lines of the framework described in the next chapter, could better serve the needs of developing nations. Certain implementation problems specific to these nations are discussed and a course of action suggested.

Uses of Expanded Accounts in Developing Countries

In developing as well as developed countries, there are two principal uses of the accounts: to generate measures of economic performance and to organize data on economic activity. The OECD survey did not ask the respondents why they engaged in nonmarket accounting. However, since only a dozen of the 150 nations classified as developing display the nonmarket information separately, it can be inferred that more importance is being placed on providing better measures of economic performance than on building better data systems (Blades 1975, p. 406). The concern that neglecting subsistence economic activity causes total economic activity to be underestimated seems well justified. Of the forty-eight surveyed countries that were able to determine the share of gross domestic product (GDP) accounted for by subsistence activities, nineteen estimated that these activities accounted for more than 20 percent of total GDP. Moreover, this percentage must surely be an underestimate since, as Blades points out, many nonmarket production activities are not accounted for at all. For example, most countries surveyed did not make an estimate for food processing, handicraft, construction, water portage, and transportation activities in the household sector.

The OECD survey does not indicate whether any of the respondents attempted to account for any nonsubsistence, nonmarket activities—in particular, the consumption of the services of the environment. To my knowledge, no nation, developed or developing, has adopted formal accounting for the services of the environment, although in recent years the U.N. Environment Programme (UNEP) has been attempting to determine what recommendations should be made to member nations along these lines. UNEP and the World Bank are concerned, with some justification, that neglect of environmental deterioration, and especially deterioration of the stock of natural resources, will give a false picture of economic growth as measured conventionally by national account aggregates such as the net national product (NNP).[1] Thus, although the neglect of many subsistence nonmarket activities causes conventional national accounting procedures to generate deficient indicators of economic performance in developing nations, perhaps a more important reason is their neglect of the deterioration of the stock of natural resources and environmental capital. This neglect has received much recent attention because of the failure of development policies to generate sustained growth.

Historically, overlooking declines in the stock of natural resources in the conventional accounts was thought to be of little significance. This view was based on the fact that discoveries of new natural resources were also neglected, as were other resource-increasing factors such as recharge and the natural growth of renewable resources. Therefore, as long as discoveries, recharge, and growth equaled or exceeded depletions, this mutual neglect was thought not to have any adverse social consequences (Landefeld and Hines 1982).[2] The current perception, however, is that discoveries, recharge, and natural growth are not keeping up with depletion. Moreover, for stocks of such environmental capital as clean water, clear air, and natural forests, the potential for new discoveries and rapid increases in growth appear slim indeed. Therefore, as long as maintaining the stock of these resources is considered essential to sustained growth in developing nations (an assumption examined in the next section), the neglect of their deterioration in the accounts is especially serious.

With respect to the second traditional use of national accounts—a framework for the consistent assembly of economic data—conventional accounting practice that neglects nonmarket activity is also deficient for the needs of developing nations. Although this deficiency has not received much attention in the literature, it should be clear that if nonmarket activity is widespread in an economy and if such activity is ignored in national data systems, then these systems will not be able to support accurate analyses of economic behavior.

Although cynics may feel that such analytical deficiencies affect the community of analysts far more than the community of developing nations, the lack of a framework for assembling nonmarket data can have more than mere academic consequences. Development planners have become increasingly aware that a lack of data on nonmarket activities, especially those that lead to negative externalities such as pollution, may produce a distorted view of the likely benefits of actual and proposed development projects. I do not believe that they are as equally aware of the contribution that a complete accounting of market and nonmarket activities can make to the analysis of the opportunity costs of actual and proposed development projects. Indeed, for estimating true opportunity costs as well as benefits, it is the accounting framework, and not merely the assembly of nonmarket data, that can make a significant analytical contribution.

This assertion derives from the fact that, in the absence of perfectly competitive markets, observed monetary costs will not measure true opportunity costs, and observed output prices will not measure true social benefits. Given this well-known result from economic theory, development economists have attempted to construct shadow cost or price measures, which either supplement or replace the conventional monetary measures.[3] It seems, however, that much more attention has been directed toward the benefit side than the cost side, even though theory suggests that observed costs and prices fail to adequately measure values for reasons that are just as applicable to costs as they are to benefits. Based on the relative number of books and articles devoted to each subject, one would have to conclude that planners are far more satisfied with their measures of cost than with their measures of benefits.

Clearly, however, when there is a large degree of nonmarket activity in an economy, monetary measures can be just as deceiving for estimates of true opportunity costs as they are for estimates of social values or benefits. Moreover, rectifying the problem can be just as difficult. There is, in fact, no easy quick fix. Although the literature implies that correct cost estimates can be made by adjusting the observed values, determining the appropriate adjustment factors is no easy matter (Little and Mirrlees 1969). For many years, the planning profession has recognized that the analysis of complex economic interdependencies requires some type of interindustry or activity analysis. One of the most important contributions of conventional national economic accounting has been its ability to generate the data sets necessary to support such analyses. An expanded accounting system that includes nonmarket, environmental activities can serve this traditional role for those developing economies for which the nonmarketed economic activities are as important as the marketed ones.

Implementation Problems

Several problems, unique in the developing nations, can arise if the attempt is made to implement an expanded, nonmarket accounting framework. Two of these are discussed in this section. These problems are not critical in the sense that their solution is a necessary precondition for implementation. In particular, the valuation difficulties discussed below may not be fully solvable. However, the failure to find acceptable valuations for nonmarket goods and services will not diminish the usefulness of the accounting structure as a data system to support economic planning, particularly in its ability to shed light on the true opportunity costs of alternative development strategies.

Accounting for Environmental Asset Depreciation

The following chapter emphasizes the important distinction between physical deterioration and economic depreciation. Only the latter is properly accounted for in an economic accounting framework.[4] As noted in that chapter, it is quite possible for a nonmarket (or a market) asset to remain physically intact but to depreciate economically in the sense that the present value of the services generated by the asset declines over time. The opposite is also possible. An asset, such as the stock of standing Indonesian hardwoods, can suffer some degree of physical deterioration and still have its present value increase over time, which implies negative depreciation, or capital gain.

The effort to introduce the concept of true economic depreciation into nonmarket accounting in developing nations raises a number of issues, some of which are amenable to technical solutions. Other issues are fundamentally more serious, however, in that they address the whole purpose of the accounting exercise and the potential conflicts between economic and conservation objectives. Thus, these latter issues are addressed first.

Environmentalists and, increasingly, economic planners are concerned that development programs may deplete certain vital natural resources. As a result, short-term economic progress could be followed by long-term economic decline—that is, the growth may not be sustainable. A related concern is that even if growth may be able to continue unabated, its composition may not be suited to the tastes of future generations. Unless the full menu of assets now available is conserved, future generations will be deprived of the options available to the present generation. Can and should the economic accounts, expanded to include the services of the environment, reflect these concerns?

The resources in question need not be confined to nonmarket, environmental assets. In fact, often the examples cited as such are marketed assets, such as minerals and farmland. The argument is that the private market mechanism is not sufficient to ensure that the stock of these assets will be adequately preserved for future generations. (Presumably the problem is just as severe, if not worse, for assets that do not trade in the marketplace.) It is quite possible that a private economy acting optimally (to maximize the present social value of its assets) could bring itself to a point of extinction by exhausting even one of its vital natural resources (Page 1977; Lind and others 1982). There is no inherent mechanism in a free market economy to prevent possible self-destruction. Therefore, the value of vital assets as revealed by the market underestimates their true value to the very existence of the society. According to this line of thinking, the social value of such assets should not be determined by the present value of income generated in the future, but rather by an appeal to a conservation ethic, an ethic that rejects economic valuation as inadequate to reflect the needs of future generations.

Before examining this argument, it should be noted that if the depletion of some asset does eventually lead to the demise of an economy, there does not appear to be any convenient way to reflect this fact in a single set of economic accounts. One year's income accounts could reflect the shrinking of the asset with a depreciation entry, and a single set of wealth or asset accounts could display the remaining stock. Only by analyzing such accounts over several years could inferences be drawn concerning when the stock will be exhausted. Whether the exhaustion of the stock will mean the demise of economic activity cannot be revealed by the accounts, except, of course, in the year when the demise occurs. Thus, accounting for the depreciation of natural resources might make only a minor contribution to preventing the eventual collapse of the economy because of the exhaustion of a natural resource.

To speak of eventual economic collapse is certainly a dramatic characterization of the sustainability problem. The dismal result relies on one or more of the following assumptions: that there is no technical progress, that the exhaustible resource has no effective substitutes, and that there are, indeed, identifiable assets whose contribution to the economy is so crucial that their physical exhaustion indeed would mean economic collapse.[5] Page apparently feels that it is fairly simple to identify natural resources that meet these characteristics; he cites, for example, the establishment of a strategic stockpile of critical materials for national defense (Page 1977, p. 184). However, a strategic stockpile is intended only to fulfill demands during fairly short-term events such as drought or war. Deciding what assets are critical to the sustainability of economic growth certainly requires a longer time frame.

In the context of developing nations, one naturally thinks of such resources as agricultural land, forests, and water supply as potential candidates for long-run conservation regardless of any calculation of present value. Those countries highly dependent on the export of minerals would certainly add such minerals to the list. Yet, upon closer examination, it is not so clear which, if any, of these assets are crucial to long-run sustainability (in Page's sense), and, more important, it is not clear to what extent their calculated present values distort their true social values.

Of the assets mentioned above, water, and especially the supply of potable water, appears to be the most crucial. Because of the lack of substitutes, its demand is inelastic (assuming that desalinized salt water or imported fresh water are not practical alternatives). Therefore, it is quite possible that as a nation's supply of fresh water diminishes, its unit value increases at a greater rate, leading to an ever-increasing imputed or measured value of fresh water wealth. Clearly, in this case, the apparent increase in the nation's water wealth would give a distorted picture of social well-being. Can the same case be made for the criticality of other, so-called vital assets? To answer this question, it is useful to consider one potentially critical asset, agricultural land.

Whether agricultural land is as critical as potable water depends on what one means by "agricultural land." Clearly, the elasticity of demand for the aggregate of all agricultural land is quite different from the elasticity of demand for the individual parcels that make up the aggregate. If these components are highly substitutable for each other, taken individually none could be considered vital. Moreover, because the substitutability implies high elasticities of demand, physical reductions in individual parcels will imply reductions in their values. That is, the reductions in quantities are less likely to be offset by high increases in prices. Therefore, a present-value wealth accounting would not falsely indicate an increase in land wealth.

What if some of the parcels were highly specialized and the elasticity of demand were highly inelastic for the products produced on these parcels? In this case, it is possible (but by no means assured) that a present-value wealth accounting could indicate an increase in wealth even as the physical stock of such land declined. Although this could possibly be misleading, there would not be any serious social consequences unless the products generated by this land were so crucial that the entire economy depended on them.

Certainly it would be disastrous in a developing country if the wealth accounts indicated that the amount of land (in value terms) devoted to, say, a crucial export crop was increasing when, in fact, it was decreasing. However, the existence of such a possibility does not justify declaring all agricultural land as crucial and, therefore, not subject to present-value valuation. Moreover, what may appear to be crucial in the short run may be quite expandable in the long run. The stock of silk worms is hardly crucial to the present-day Japanese economy, but it may have seemed so in the sixteenth century. Indeed, it could be argued that, given human ingenuity, virtually all assets are substitutable in the long run. If so, rather than searching for sustainable levels of particular vital assets, the appropriate conservation principle might be to maximize the level of all assets in the aggregate. A natural measure of this aggregate level is its monetary value, that is, the present value of gross national product (GNP). In other words, according to this argument, the best legacy for future generations is a high level of (properly measured) income and capital formation in the present generation (Baumol 1969).

The accounting structure put forth in the following chapter implicitly adopts this view with two crucial provisos (also endorsed by Baumol): that GNP (and the underlying asset base) be defined to include nonmarket services, particularly the services of the environment, and that certain assets, such as air, potable water, plant and animal species, beautiful vistas, and the cultural heritage be recognized as vital and irreplaceable and therefore beyond economic evaluation and beyond the scope of the expanded accounts.

Valuation Criteria and Social Organization

If an attempt is made to implement the expanded accounting structure described in the following chapter, several difficulties must be overcome. Clearly, the lack of data is one of the more serious problems. There are, however, even more serious impediments. These are more serious in the sense that they involve conceptual issues that, unlike the paucity of data, are not easily corrected even if a developing nation had more resources to work with.

One issue concerns the possibility of determining imputed nonmarket values that are independent of a country's economic and social structure. If, for example, the valuation procedure relies on society's willingness to pay for the nonmarketed services of a natural resource or some other environmental asset, then clearly it would be impossible to devise an economic valuation without knowing the society's preferences.

If one accepts the principle that a society should evaluate its own assets, then the lack of a socially independent valuation may not prove too troubling. It does create two problems, however. First, it becomes difficult to make any comparisons of expanded national income and product among countries if the countries have very different economic and social structures. Second, tracking economic performance over time can also be difficult if there have been substantial social and economic changes. This second problem presents a special conundrum if one of the purposes of economic accounting is to determine the extent of economic changes.

These points could be used to argue against nonmarket accounting in general. However, market prices also depend on a country's economic and social structure. Thus, as is well known by national accountants, comparisons of national income aggregates can also contain limitations if the countries being compared are very different. Country A could have the higher GNP if its relative prices were used for the comparison, while Country B could have the higher GNP if its relative prices were used. Although there is no solution to this problem, the responsible course of action would be to use both sets of prices for making two-country comparisons if the different price relatives would materially affect the results. Along the same lines, for making comparisons of nonmarket GNP between countries, the prudent course of action would be to use valuations that would reflect different economic and social structures. Of course, in view of the difficulty of producing even one set of nonmarket valuations, this procedure is unlikely to be followed.

Valuation methods used to implement the expanded accounting structure can be based on methods commonly used for benefit-cost analyses. These methods frequently use the concept of willingness to pay—the idea being that the value of a nonmarketed good or service should be measured by what society would be willing to pay for the good or service were it marketed. In practice this usually means what individuals in society would be willing to pay. This focus on the individual is consistent with the central proposition of capitalistic, free market economies: that the consumer is sovereign.

Related to the problem of making comparisons among countries when economic and social structures differ is the problem of whether the willingness-to-pay concept is appropriate for economic systems that have a more limited role for consumer sovereignty.[6] And if it is deemed inappropriate, what principles should take its place, and what valuation methods are consistent with these principles? Answers to these questions are important components of the task of finding nonmarket valuations for expanded national accounting frameworks in developing countries.

In a developing country, it is important to develop valuations and valuation methods that reflect both the principles of the country's social philosophy and its social objectives. Sustainable economic growth—one of the more important social objectives—must be translated into concepts that lend themselves to measurement and valuation if this objective is to be reflected in the expanded accounting system. Indeed, it may not be possible to develop valuation schemes that fully measure the degree of sustainability. Yet, it is important to point out that the accounting framework, even without complete or perfect monetary valuations, can provide a data system that can be of tremendous use to those responsible for making sustainable development policy.

Suggested Course of Action

Although there is some experience in implementing the expanded national accounting structure described in the following chapter, the effort to develop this framework relied totally on data from, and conditions in, the United States (Peskin 1987). No case is known where this system or some other nonmarket accounting has been fully implemented in a developing country, although there have been some partial efforts (Repetto and others 1987). Thus, implementation or, more precisely, initial steps at implementation should be viewed as a pilot project.

Based on the experience in the United States, the starting point is to assemble a complete body of physical data covering the stock of environmental assets, the demands for the services of these assets (for example, the demands for waste disposal services by industry, the demand for recreation services by households and tourists, and the demand for potable water), and the negative physical consequences on final and intermediate demand from consumption of these services (for example, adverse health effects from water pollution, damage to crop production from soil loss, and damage to electricity production from sedimentation).

After or, better yet, while the physical data are collected, efforts should be made at monetary valuation. In the U.S. context benefit-cost techniques were used. Thus, for example, the value to firms of waste disposal services provided by receiving waters was estimated by the opportunity costs to the firms if they were deprived of these services. These costs, in turn, were estimated by various techniques that attempt to measure social willingness to pay to avoid pollution (for example, the travel cost method, the property valuation method, and the discounted productivity method).

As noted above, it cannot be assumed that any of these methods will work in a developing country. Thus, a dynamic research effort is called for—dynamic in that it will have more of the characteristics of developmental research than of applied research, although the vast literature on benefit-cost techniques may provide a useful point of departure. Because this initial effort will be exploratory, the quality of much of the assembled information and its valuation will not be very good. This does not mean that the information will not be useful, however. Indeed, the U.S. experience has indicated that much of the preliminary information, especially on the physical use of the environment for waste disposal, is of great use to policymakers. Nevertheless, because so much of the information necessarily has to rely on estimation rather than on direct observation, the pilot project is probably best done by a nongovernmental agency, such as a university, in cooperation with various ministries that could provide some of the supporting data.

It is difficult at this time to be too precise about the appropriate staffing of such a pilot effort in a developing country. Regardless of the level of effort, however, it is important, for two reasons, that the bulk of the work be done by nationals and not by foreign consultants. First, because a long-term, multiyear effort is necessary, heavy staffing by consultants is likely to make the costs prohibitively high. Second, unless the bulk of the work is done by nationals, there is a good chance that the accounting effort will die when the consultants depart. Thus, an important goal is not simply to construct a resource accounting system, but also—and perhaps more important—to develop resource accounting skills in the country. At a minimum, a viable program, which would achieve these goals, would require two full- time nationals and about three to six staff-months of outside consultants a year.

One other consideration in determining the level of effort concerns the scope of the accounting function. Should the expanded accounts be confined to environmental assets or should the effort attempt to cover a full spectrum of nonmarket assets? In principle, the latter approach is preferable, basically because a fully expanded accounting system will be able to show important relations between environmental asset use and other nonmarket activity. For example, the amount of labor devoted to household fuelwood production, a significant nonmarket activity in many rural societies, crucially depends on the location and availability of natural forests and, of course, on competing market and nonmarket sources of energy. Analysis of such projects as the development of plantation forests would be greatly facilitated if the accounting system reflected these interdependencies.

Realistically, limitations of available staff and money may preclude development of an accounting system that fully covers all nonmarket assets. It may be necessary to confine the effort to environmental assets. Indeed, it may be necessary at first to confine the effort to one or two particular assets, such as water and natural forests. Such initial, modest steps should be encouraged.

Notes

1. In the accounting scheme outlined in the following chapter, depreciation of natural resources will not affect the gross product aggregates, such as GNP.

2. Of course, such a view neglects the important distinction made in the following chapter between changes in physical stocks and changes in the value of those stocks. A country could be suffering a real loss in wealth even if physical stocks of certain natural resources increased, if the resources in question proved to have declining value. The shift from tropical hardwood forests to softwood plantations in Indonesia may provide an example.

3. Although the terms "shadow cost" and "shadow price" are widely used, they are often defined differently by different authors. Here the terms are used rather loosely to refer to the unit values, necessarily imputed, of nonmarketed goods and services. Depending on the imputation procedures, the term could be equivalent to several shadow concepts. Examples are the shadow prices generated by a linear programming problem or the shadow wages, as defined by Little and Mirrlees (1969), used to measure net consumption changes associated with the movement of labor from agriculture to industry as a result of development projects.

4. The following chapter shows, however, that the two concepts can be related. Value depreciation can be defined to equal physical deterioration minus capital gain or plus capital loss. Nevertheless, the two concepts are quite distinct.

5. In effect, the result postulates a very simple economywide production function, which is not separable with respect to any of its inputs. A simple Cobb-Douglas production function would have the desired characteristics, even though all the inputs in such a function are, by definition, substitutes.

6. Following the analysis of Marglin (1984), if an economic system were based on neo-Marxist principles, consumer sovereignty would be limited, in theory, to the short-run determination of output mix. In contrast, if an economy were structured according to neoclassical principles, consumer sovereignty would have a much larger role to play. Of particular importance for the justification of cost- benefit techniques is the role of consumer sovereignty in determining relative prices.

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A Proposed Environmental Accounts Framework

Henry M. Peskin

The objective of expanding the national income and product accounts to encompass the environment requires the development of a theory linking environmental data with the economic information already covered by conventional national accounts. Such a theory is presented in this chapter.

The cost of the proposed expansion is minimized by adhering as much as possible to the accounting structure of existing national income and product accounts, such as the U.N. System of National Accounts (SNA). Indeed, the suggested changes are introduced as separable additions to the existing accounts. In this way, the modified accounts preserve all existing information, and the suggested changes can be ignored by users of the conventional accounts who do not require the additional environmental information. Because of the close linkage to conventional accounting structure, this discussion provides an overview of the conventional income and product accounts, presents a modified accounting structure, and emphasizes how closely the proposed modifications fit the existing national accounting concepts.

Theory of Environmental Asset Services

The first issue that arises when one sets out to account for the environment is to decide what aspect of the environment will be measured or accounted for. One possibility, reflecting the popular concern with air and water pollution, is to account for the generation and disposition of polluting materials. Thus, following the lead of Ayres and Kneese (1969) and Leontief (1970), a system can be devised to trace all physical flows of materials throughout the economy, whether or not these materials are valued with a positive market price. Using techniques of interindustry or input-output analysis, these material balance approaches are easily linked to the economic data drawn from national accounting systems.

Both an advantage and disadvantage of this approach is its apparent neutrality: only materials are being accounted for; there is no indication whether these materials are good or bad. This is in contrast to other environmental accounting schemes that attempt to measure or otherwise account for the negative effect of pollution and human activities on the environment. These approaches are more difficult to implement, since a metric must be devised to value the damage done by pollution and environmental degradation. Implementing a scheme based only on the measurement of physical flows is far easier. However, even though a material balance accounting scheme may be useful to organize and display certain environmental information, by itself it is not sufficient to augment the coverage of the accounts.

The problem is that the elements included in the accounting scheme should reflect economic welfare. If, at the outset, an accounting scheme is set up that, as a matter of principle, precludes placing a value on the elements being measured, then such a scheme by definition says nothing about economic welfare. Materials accounting, with its neutral valuation is similarly neutral with respect to economic welfare. Of course, inferences can be drawn about economic welfare from material accounts just as from indexes of production. But to do so requires the aggregation of dissimilar entities measured in different units (for example, tons of cement, barrels of oil, and gallons of water). The material accounts, themselves, offer no guidance on how to do this aggregation.

For its full implementation, the accounting scheme outlined below requires the measurement of all entries in

Note: Some of the material in this chapter, including a graphical analysis, is given in Peskin (1989).

value terms to allow for aggregation and the direct comparison of environmental with nonenvironmental entries. Often it is necessary to measure such physical information as the quantity of air and water pollutants emitted by industrial category. Efforts to build material balance accounts and efforts to build the expanded accounts can be very complementary activities. The objectives of the two exercises are, in principle, however, very different.

Rather than material flows, this expanded scheme attempts to cover flows of services generated by environmental capital. It is based on two concepts: all income originates from capital, and the physical environment is a form of capital fundamentally similar to the other forms of tangible and human capital that generate the income flows already accounted for in the conventional accounts. The first concept, which expresses the fundamental relation between income and capital, has been well accepted in modern economic thought ever since it was originally stated (Fisher 1906). The second concept, while hardly in the same central position in economic thought, would not be found to be objectionable by most economists. The environment "is a form of social capital which society must somehow manage if it is to maximize its welfare" (Johnson 1975, p. 321). Why this type of capital needs social management while other types of capital, such as factories and machines, can rely on private management is central to the theory of environmental management. This theory underlies both the proposed accounts framework and the proposed methods of valuation.[1]

Although, as argued above, material flow accounting by itself does not provide sufficient information to add to the accounting of the elements comprising economic welfare, the material flow and the proposed asset service flow approach are highly complementary. This is because the production of any material, whether it is a product to be sold or a waste material to be disposed of, can be linked to the services provided by some specific asset. Just as the production of goods sold in the marketplace reflects the capital services of the plant and machines used in the manufacture of the goods, likewise the production of waste products, such as smoke and spent process and cooling water, reflects a demand for the capital services provided by the environment—services of waste disposal, cooling, and the provision of important inputs, such as oxygen for burning or nutrients for crops.

To understand the relation between the demand for the services of environmental assets and the generation of pollutants, however, an important principle must be established: the polluter always has some choice about how much pollutant will be generated. Thus, while some pollution may be an inevitable consequence of most production processes, the amount generated for each unit of product can vary substantially, depending on a multitude of decisions affecting production levels, production technique, and product mix.[2] The model underlying this accounting framework assumes that these decisions are made wisely. More specifically, the chosen amount of pollution generated is assumed to be that which maximizes profits for polluting producers or which maximizes utility for polluting consumers.

Generally, the less pollution is generated or (what amounts to the same thing in this simple example) the less use is made of the disposal services of the environment, the more costly it is for the producer. Therefore, it is assumed that there are positive benefits to the polluter associated with higher pollution levels, which, however, at some point begin to become less positive. Indeed, if these levels get too high, the pollution may begin to impede the production process (say, by affecting the workers' health), and thus the benefits of polluting may even decline. (Since the producer is assumed to be rational, however, such a situation would not exist for very long.)

Up to now, the focus has been on the benefits of using environmental assets and on the associated pollution by the polluter. The other side of the coin is now considered, namely, the "disbenefits" or damages that may be associated with the use of environmental assets. There are two sorts of disbenefits. One is the familiar direct damage that pollution by one party can inflict on another. Air pollution's effect on a person's health is a clear example of this sort of direct effect. By measuring these direct disbenefits as negative benefits, one can imagine a relation between pollution and disbenefits that, in general, indicates virtually no disbenefit at very low levels of pollution, a rapid increase in disbenefit at moderate levels of pollution, and a satiation of disbenefit at very high levels of pollution. Although this pattern is realistic for many pollutants that cause adverse direct health effects, other patterns are possible. This pattern, however, along with the assumed form of the relation between pollution and benefits, illustrates the frequent situation where the net social benefits of pollution (the sum of the benefits and disbenefits) reaches a maximum at some positive pollution level, (where the marginal benefits and disbenefits of pollution are equal) but where pollution is at a lower level than the polluter finds optimal. Assuming a known relation between environmental asset use and pollution, optimal units of environmental service rather than pollution could also be determined.

The second type of disbenefit occurs when the pollution or environmental asset use denies someone else use of the environmental asset. For example, using a lake for waste disposal may deny the use of the lake to someone else for getting potable water or fishing. This second type of disbenefit is referred to as an indirect disbenefit to distinguish it from the direct disbenefits discussed above.[3] The key feature of this type of disbenefit is that it will exist only if there is a finite amount of available environmental asset service.

For the proposed accounting framework, three key elements are relevant. First, and most important, both positive and negative benefits are associated with any amount of polluting activity. Thus a single accounting entry will, in general, not be adequate to capture the effects of environmental asset use. Second, with a finite availability of environmental asset services, the identification of one party (for example, industry) as the polluter and another party (for example, households) as the injured party is not always appropriate. The accounting system should recognize that any actor in the economy may be using environmental asset services to the detriment of another actor. A third element concerns the effect of the total availability of environmental asset services. If the availability of such services is very great in relation to the demands placed on the environment, and depending on the method chosen to place values on these demands (see below), it may be appropriate to ignore certain environmental asset uses in the accounting system. Of course treating all environmental services as free goods and not assigning any value to them has in part contributed to the current environmental problems. The point being made here, however, is that a judgment must be made on a case-by-case basis on whether assigning a zero value for accounting purposes is justified.

Valuation Concepts

For valuation methods, a distinction should be made between the cost of pollution control already incurred by polluters and the potential cost to polluters equal to the forgone benefit if they were denied access to the environment (which equals the value to the polluters of being allowed to pollute). The former cost is, in principle, already accounted for in the conventional economic accounts (although it may not be clearly identified as a pollution control cost). The latter cost is not currently accounted for. Yet its estimation is important for the expanded accounting system, since it provides an estimate of the value to polluters of disposal services provided by the environment. This cost, that is, the prospective cost to the polluter of being denied any use of the environmental asset, measures the value of a nonmarketed factor input (the environmental asset service) just as, say, the wage bill measures the value of a marketed factor input (labor).

As environmental assets are used and pollution produced, disbenefits are also produced; this is also neglected in conventional accounting systems. Most available measures of these disbenefits rely on *total valuations*: the total value society would be willing to pay to avoid such disbenefits. But these total values are not entirely consistent with the valuation concept used for marketed goods in the conventional national accounts. The usual valuation for marketed goods is a price-times-quantity valuation, the price in question being that for the last or marginal unit sold. All other so-called infra-marginal units are valued at this same price (assuming that the seller cannot practice price discrimination). To measure the disbenefits associated with the use of environmental assets, *marginal valuations* should be used.[4] One important advantage of marginal valuations (besides consistency) is that they provide a way to estimate whether observed environmental asset use is greater or less than the optimal use, which maximizes net benefits. At the optimal level, the marginal benefit and disbenefit valuations are exactly equal; at levels greater than that, the marginal valuation of disbenefit exceeds the marginal valuation of benefit; and, at levels less than that, the marginal valuation of benefit exceeds the marginal valuation of disbenefit. These latter situations can be interpreted as conditions for too much and too little pollution, respectively. Although marginal valuations allow for this interpretation, total valuations are usually easier to estimate.

Up to now, cost and valuation principles have been used for the situation where a polluter creates a direct disbenefit. For indirect disbenefits, in addition to the total benefit to party 1 (formerly the polluter), the fact that party 2 (formerly the party suffering direct pollution damage) enjoys a benefit from the remaining units of environmental assets must be accounted for. Similarly, the indirect damage party 1 causes party 2 needs to be considered. To this value must be added the indirect damage party 2 causes party 1 by denying party 1 various units of asset service. Again at the optimal level, marginal valuations of benefits and disbenefits are equal. As opposed to the analysis of direct pollution damage, however, the difference between benefit and disbenefit estimates cannot be interpreted as conditions for too much or too little pollution or asset use. It can be said only that one party's use at the expense of the other party's use is too excessive to be socially optimal.

Investment and Depreciation

Conventional economic accounting distinguishes between the purchase of goods for consumption and for investment. A further distinction is made between gross and net investment, the latter being equal to gross investment less capital depreciation. In expanding the conventional accounts to include environmental asset services, these distinctions should be preserved. In particular, investments that increase the environmental asset stock should be accounted for if this is not already done in the conventional accounts. Similarly, there will be an entry measuring any depreciation in environmental assets. The definitions of investment and depreciation may not exactly be the same as those used in conventional accounting, however, although the definitions used are consistent with economic theory.

Specifically, following Alfred Marshall (1920), income (regardless of whether it originates from marketed or nonmarketed capital) is defined as the sum of current and potential future additions to well-being. The formation of capital that allows for both additions to future income and the maintenance of current income is gross investment. If current additions to well-being are identified as consumption, gross income can be defined as consumption plus gross investment. Net income is simply consumption plus net investment, where net investment is gross investment less that portion of capital investment just necessary to maintain current levels of consumption. Although depreciation is defined conventionally as the difference between gross and net investment, one should also distinguish between value depreciation and physical depreciation.

One reason that depreciation exists is that the physical ability of capital to generate consumable services declines over time. This loss in physical ability—physical depreciation—may also lead to a loss in the value of the capital stock—value depreciation; that is, value depreciation may reflect physical depreciation. However, value depreciation can also arise for other reasons. The value of capital can fall because of a change in tastes for consumption items produced by the capital or simply because of a change in interest rates.

The relation between income and the change in value depreciation can be shown as follows. A society's capital has value presumably because it generates a stream of goods and services, that is, income. Let V_0 represent this value at the beginning of the year and Q_1, Q_2, and so forth represent the services at the beginning of the next and subsequent years. Also Q_1 is defined as gross income in year 1.

V_0 can be related to the Q's as follows:

$$(1) \qquad V_0 = \frac{Q_1}{(1+i)} + \frac{Q_2}{(1+i)^2} + \ldots + \frac{Q_n}{(1+i)^n} + \ldots$$

where i is the rate of interest. Since V_1, the value of V_0 at the end of year 1, is simply

$$\frac{Q_2}{(1+i)} + \frac{Q_3}{(1+i)^2} + \ldots \frac{Q_{n+1}}{(1+i)^{n+1}} + \ldots$$

equation 1 can also be written:

$$(2) \qquad V_0 = \frac{Q_1}{(1+i)} + \frac{V_1}{(1+i)} = \frac{Q_1 + V_1}{(1+i)}$$

from which it follows that

$$(3) \qquad Q_i = iV_0 + (V_0 - V_1).$$

The term $(V_0 - V_1)$, representing the loss in value of the initial capital stock, can be identified as value depreciation occurring in year 1, or D_1. As before, gross income, Q_1 (using the Marshall definition), is defined as consumption plus gross investment. Since net income equals consumption plus net investment and net investment equals gross investment less depreciation, however, net income thus equals gross income less depreciation. It follows from equation 3 that net income equals iV_0. Thus equation 3 can be rewritten as:

$$(4) \qquad Q_1 = C_1 + I_1 + D_1$$

where C and I_1 are consumption and net investment in year 1. In other words,

Gross income = net income + (value) depreciation
= consumption + net investment
+ (value) depreciation
= consumption + gross investment.

This relation between income and depreciation was developed without any reference to the physical destruction of capital. It is true that as capital wears out physically, future Q's may fall, which explains why V_0 may exceed V_1. However, future Q's may fall for other reasons, such as a fall in the demand for the capital's services. The Q's may also decline because of an inability to employ the capital fully. That is, if capital complements labor, a decline in labor services would also bring about a decline in future Q's.

Moreover, in contrast to physical depreciation, value depreciation, $V_0 - V_1$, need not necessarily be positive; that is, V_1 could in principle exceed V_0. Conventional practice, however, is to define depreciation as nonnegative and to refer to the case where V_1 exceeds V_0 as a capital gain. This chapter does not follow this practice since it implicitly assumes that the term "depreciation" can only mean physical depreciation. Rather, value depreciation is decomposed into two components: the portion of the difference between V_0 and V_1 that is due to actual physical depreciation and the portion that is due to other causes. The latter, if positive, will be termed "capital gain" and, if negative, will be termed "capital loss." Thus by definition:

(5) Value depreciation = physical depreciation minus capital gain or plus capital loss.[5]

Of course, the physical depreciation must be valued to make this computation possible. How the units of physical loss should be valued—using the original price of the capital, its current price, or some other price—is a matter of some controversy. Since the choice affects the measure of physical depreciation, it has important implications for both corporate accounting (which is not of concern here) and for national accounting (which is of concern). If the focus is on value depreciation, however, the implications of choosing among alternative capital prices can be avoided by estimating value depreciation by successive application of equation 1 one year apart rather than by application of equation 5.

Sources of Environmental Asset Depreciation

Like any other capital asset, the depreciation of the value of an environmental asset is due both to physical depreciation and capital loss (or gain). To illustrate these two sources of value depreciation, two assets are considered: one experiences only physical reduction while the value of the other depreciates solely because each user perceives a reduction in the quality of services provided. The former asset might be a lake whose only service is to provide drinking water. It is assumed that as drinking water is withdrawn, neither manmade nor natural replenishment takes place, so that the availability of drinking water is steadily reduced.[6] The second example might be a stretch of seashore of a given length. It is assumed that the only service provided by this asset is recreation and, further, that as the demand for this service increases, the quality of service perceived by each demander diminishes.

In the first example—the demand for the services of the first asset, drinking water, over time by two users—in order to clearly distinguish the two sources of value depreciation, each user's demand is assumed to be constant over time. Also, to keep matters very simple, the demands are assumed to be identical, and the capital gain component in equation 5 is neglected. Each demander is assumed to have a maximum demand of, say, X. When capacity is reduced below $2X$, the remaining asset is assumed to be equally shared. Under the assumption that the demand functions are identical, such an even allocation is Pareto optimal: no other allocation can make one user better off without making the other worse off.

The implication for the lake's value over time is quite simple. Since the availability of drinking water is more than adequate for both users, for a time there is no value reduction and hence no value depreciation, even though in real terms there is physical depreciation. However, the value of this physical depreciation is initially zero. Yet, as soon as the lake's capacity is reduced to $2X$ drinking water units, the value of the lake begins to decline, and value depreciation increases. That is, the *value* of the physical depreciation becomes positive.

The second polar example is represented by the seashore. It is assumed that there is an increasing number of identical individuals, each demanding the same fixed length of seashore. To show the effect of this increasing demand in a two-dimensional diagram, the individuals are divided into two groups of equal size. Three basic situations arise: (1) when the number of individuals is small enough that their maximum demand is less than the seashore capacity, (2) when the number of individuals is moderate so that their maximum demands just exceed seashore capacity, and (3) when the number of individuals is so large that their summed maximum demands greatly exceed seashore capacity. For the latter two cases a Pareto optimal distribution is assumed: if capacity is z and the number of individuals is n, each of the identical individuals is allotted z/n of seashore.

The implications for the asset's value depreciation described in the second example are more complicated than those illustrated in the first example. Even though the amount of external damage each user inflicts on the other increases as the number of individuals increases, the total utility for all individuals as a group increases. Algebraically, at the time the number of individuals n is moderate, the assumed utility of each individual (for a Pareto optimal distribution) is $u = u(z/n)$. This utility decreases as n increases. However, the total utility for all individuals is $nu(z/n)$; this utility increases with increases in n, although at a decreasing rate. In effect, previous seashore users are worse off as n increases, but, because there are new users, total utility may increase even though average utility falls. Total utility may also decrease, however, depending on the relative size of an individual's total and marginal utility with respect to n. The theoretical change in total utility as n increases is $u(z/n) - u'(z/n)/n$, and this can be either positive or negative.

In sum, it is not self-evident that the value of an asset that does not deteriorate physically declines as it becomes more heavily used. A recreational asset may experience a capital gain even though it becomes heavily congested and even though each user becomes less satisfied with the services provided. Whether the value depreciation of such an asset is positive or negative depends on a comparison between the declining utility of each user and the increasing number of users. One important but perhaps disquieting implication is that if marginal valuations are used, a pristine lake has no value until a point of congestion is reached, that is, the point where demand curves start crossing. Actual physical congestion is not required; a demand can exist without actual use if the demand is in the form of a reservation for future use. The existence of such an *option* demand may suffice to give value to the pristine lake.

Nevertheless, many would feel that the pristine lake has value even in the absence of option demand or any other source of demand. Even if everyone accepted this view, it would not vitiate the theoretical structure just presented. The key point is that the accounting system discussed in this chapter is intended to cover only elements that affect economic welfare. Consistent with this objective, valuations are confined only to economic valuations—not to valuations that may have religious, ethical, or philosophical foundations. Unlike other sources of value, the basis for economic valuation is the interaction of demand and supply.

Overview of the National Accounting Structure

To analyze the implications of this theory of environmental assets for the proposed modification to the conventional national economic accounts, it is useful to discuss briefly national accounting concepts.[7] For illustration, this discussion focuses on the U.S. national accounts and concentrates primarily on the method of accounting for the inputs and outputs of marketed entities in production processes. The expanded accounting framework plans to treat the inputs and outputs of environmental and other nonmarket entities in an analogous manner.

Since 1958 the U.S. national accounts have consisted of five sub accounts: national income and product, personal income and outlay, government receipts and expenditures, foreign transactions, and gross saving and investment. The national income and product account includes gross national product (GNP), net national product (NNP), and national income (NI)—the indexes that receive the most public attention as indicators of well-being. Therefore, the other accounts will be ignored in the ensuing discussion. Although these accounts are not insulated from proposed changes in the treatment of environmental asset services, any effects on these accounts will be reflected by changes in the income and product account. Thus, few essentials are lost by focusing on just one account, and the discussion is greatly simplified.

The income and product account is a consolidation of many individual accountings of productive activities, the bulk of which are those of business enterprises and federal, state, and local governments. The consolidation process can be illustrated by considering a hypothetical economy where production is assumed to take place in only two business enterprises, A and B, and one government. This economy does not engage in foreign trade nor are there any interest charges for borrowing money. Also, it will be useful for later discussion if firm B is assumed to be a producer of pollution control equipment.

The dollar value of the output of each firm in the period covered by the account (usually one year) will be represented by X, with subscripts indicating the destination and the type of output. Actually, a firm is likely to produce and purchase two types of output: goods that will be used up or consumed within the current accounting period and goods that are used up over many accounting periods. The former are termed current goods, and the latter are termed capital or investment goods.

Firm A's output of current goods is designated by X_{AB}, X_{AC}, and X_{AG}, representing goods that will be used up in the accounting period by firm B, by consumers, and by the government, respectively. Expenditures for such goods are called current account outlays. Firm A's output of investment goods is designated by X_{AI}. Expenditures for these goods are called capital account outlays. Since these goods are not used up in the accounting period, the inputs of such goods to sectors A and B are not shown. Firm B's output—X_{BA}, X_{BC}, X_{BI}, and X_{BG}—are defined analogously.

Table 10-1. *Input and Output Accounts for a Hypothetical Economy*

Industry A		*Industry B (Pollution control industry)*		*Government*	
Input	*Output*	*Input*	*Output*	*Input*	*Output*
X_{BA}	X_{AB}	X_{AB}	X_{BA}	L_G	X_{GG}
L_A	X_{AG}	L_B	X_{BG}	X_{AG}	
D_A	X_{AI}	D_B	X_{BI}	X_{BC}	
T_A	X_{AG}	T_B	X_{BG}		
$-S_A$		$-S_B$			
P_A		P_B			

Note: X is the output of goods and services, L is labor, D is depreciation, T is taxes, S is subsidies, and P is profit or loss. The first subscript refers to the generating industrial sector (or government) and the second, if any, refers to the receiving industrial sector.

The right-hand side of the account for firm A in Table 10-1 shows the sales of A's output in the accounting period. The proceeds from these sales are divided among several inputs shown on the left-hand side of the account. These include X_{BA}, the amount of firm B's output purchased for use in the accounting period; L_A, the amount spent on labor; T_A, the amount spent for indirect taxes (that is, all taxes except taxes on income); S_A, any subsidies received by firm A (which, as shown, are valued as negative inputs); and P_A, profit or loss. Since P_A is determined as a residual, the left-hand and right-hand sides of A's account always balance. The input side of the account does not show any capital account outlays. It accounts only for the inputs used up in the accounting periods, whereas capital goods by definition are used up over several accounting periods. The portion of capital that is used up in the accounting period or depreciation (including other capital consumption allowances such as accidental damage to capital) is designated as D_A. Again the items that make up firm B's input, shown on the left-hand side of B's account in Table 10-1, are defined analogously.

The government production of goods and services in the accounting period is X_{GG}. The notation indicates that the government is viewed as producing goods and services for its own use and not for other sectors. In conventional national accounting, because of the difficulty of valuing government output, X_{GG} is set equal to the wages and salaries paid to government employees, L_G, plus its purchases from businesses, X_{AG} and X_{BG}. The governmental production account is thus very simple. Government transfer payments are not shown, since such transfers do not reflect any new production in the economy. Similarly, taxes are not shown, since these are not considered as inputs to government production. Such financial items as taxes and transfers show up only in the government receipts and expenditures account. The consolidation or merging of the three sector accounts where, by

Table 10-2. *Consolidated Production Account for a Hypothetical Economy*

Input	*Output*
$L_A + L_B + L_G$	$X_{AG} + X_{BG}$ (consumption)
$P_A + P_B$	
National income	$X_{AI} + X_{BI}$ (investment)
$T_A + T_B$	
$-(S_A + S_B)$	
Net national product	X_{GG} (government)
$D_A + D_B$	
Charges against gross national product	**Gross national product**

Note: See the note to Table 10-1 for definitions of the notation. Entries in bold refer to the sum of all entries above them.

assumption, all conventional(that is, marketed) production takes place yields the national income and product account for this simple economy. This account, in effect, pictures all the economy's production as taking place in one huge sector. The consolidation is performed by adding A's inputs to B's and the government's inputs, adding A's output to B's and the government's outputs, and eliminating items that appear in both the input and output totals. In this simple economy, the items so eliminated are X_{AB}, X_{BA}, X_{AG}, and X_{BG}. Items that represent the production of one industry for use by another in the accounting period are termed intermediate goods. In the United States and in the accounting systems of most western nations, such intermediate goods are not shown in the consolidated income and product account, since their value is already reflected in the value of the consumption, investment, and the governmental production items included.

Table 10-2 shows the results of the consolidation. The principal national income and product aggregates are defined by the groupings indicated by the entries shown in bold. These entries are the sum of the items listed above them. Thus, GNP is defined as total production of goods and services for consumption, investment, and the government.[8] Since the consolidated account must balance, GNP may also be defined as the sum of labor payments, profits, indirect taxes less subsidies, and depreciation. The sum of labor payments and profits alone is called national income (NI). It represents the sum of payments to factors of production. The fact that there may be other factors of production—such as the services of the environment—for which payments are not made is, of course, the subject of this chapter.

NI plus indirect taxes equals NNP. NNP also equals GNP less depreciation. It thus provides a measure of output that accounts for the fact that a certain portion of gross output must be set aside to replace deterioration of the nation's stock of capital. The fact that there may also be deterioration in environmental capital for which there is no capital consumption accounting is also a theme of this chapter.

Unfortunately, this simplified exposition fails to address several controversial issues concerning the ability of the accounts to measure well-being. For example, the classification of many items as investment, consumption, or intermediate goods is not always self-evident. Many items such as consumer durables are classified as consumption items when they could just as easily be classified as investment items. Another issue concerns the failure to consider any portion of governmental production as intermediate, even though such government services as policing and inspection are often essential inputs to business operations. A third issue concerns the fact that the accounting structure and its aggregates do not reveal how any of the components are distributed among members of the population. A society in which 10 percent of the population enjoys 90 percent of the consumption goods produced could have the same total GNP as another society where consumption goods are much more evenly distributed. Few would believe that both societies shared the same level of well-being.

One feature of the national accounts that is reflected in the above simplified exposition is the limited role households play as a producing sector. This limited role, in turn, reflects the preoccupation of the accounts with activities that take place in well-defined markets and where production is always reflected in monetary transactions. This preoccupation neglects, for example, the high portion of productive activity that occurs within the household.[9] The fact that GNP falls when "a man marries his housekeeper" is a curiosity that is highly relevant to the treatment of all nonmarket production, including, as shall be shown, the prospective treatment of the services of the environment.

Response of Conventional Accounts to Nonmarket and Environmental Activity

In recent years the ability of conventional accounts to reflect social well-being has been scrutinized more and more. One can identify much of the problem as a failure of the accounts to reflect adequately economic yet nonmarketed entities.

Using the simple accounting framework just presented, it is possible to be far more specific about these inadequacies. Since the focus of these efforts to modify the accounts has been toward improving their response to changes in the natural environment, the following discussion of the inadequacies ignores such failures as the conventional account's inabilities to measure fully the effect of changes in household productive activity or in the services of government capital. However, the analysis could easily be modified to cover these other nonmarketed entities.

As many have noted, a decline in environmental quality may be accompanied by an increase in GNP. In this simple economy, increases in, say, X_{AC} could require industry to increase its loadings of air and water pollutants. What many find even more bothersome is that the pollution itself could lead to an increase in both the level and cost of certain services, such as medical services, which also lead to a further increase in conventionally measured GNP. Of course, if the pollution were bad enough, work ability might decline, leading to a fall in L_A, L_B, and L_C and a concomitant fall in GNP. The fact that under such dire circumstances GNP will move in the "right" direction will, of course, do little to satisfy the critics.

Although declines in environmental quality are often accompanied by increases in GNP, it does not necessarily follow that improvements in environmental quality must be accompanied by reductions in GNP. The direction of the movement of GNP or other account aggregates depends on how the environmental improvement is brought about. In the simple economy depicted in Table 10-1, firm B, which was assumed to be in the business of manufacturing pollution control equipment, provides X_{BA} units of antipollution equipment to firm A, X_{BG} units of equipment to government, and X_{BC} units to consumers.

Suppose, in response to further environmental degradation, consumers or the government decide to increase purchases of antipollution equipment. In a fully employed economy the postulated increase in X_{BC} by consumers must come at the expense of a reduction in X_{AC} (that is, a fall in consumption of goods other than for pollution abatement), a reduction in X_{AI} or X_{BI} (that is, a reduction in investment, which is equivalent to a reduction in savings), or a reduction in X_{GG} (that is, a reduction in government activity). Similarly, a postulated increase in X_{BG} by government must, in a fully employed economy, be either at the expense of X_{AC}, X_{BC}, X_{AI}, X_{BI}, or at the expense of other components of X_{GG}, such as X_{AG} or L_G.

Although such reductions may change the composition of GNP and NI, it will not change the level of GNP or NI.[10] To the extent that investment is reduced, NNP may rise slightly, since depreciation may fall. (The remaining capital may be used more intensively, however, causing capital consumption allowances to rise.) Of course, if there were unemployed labor and capital resources, the increase in X_{BC} need not engender any reduction in other outputs, thus allowing all the accounting aggregates to rise. Indeed, an expansion in employment and output has been associated with pollution control expenditures in the United States (Data Resources 1979).

The situation is much more complicated when, as is often the case, businesses, rather than consumers, purchase antipollution equipment (Denison 1979b). The effect on the accounts depends on whether the pollution abatement expenditures are current or capital account outlays. Also, if the outlays are for investment goods, it will be necessary to distinguish the effect on the accounts in the year the investment is made from the cumulative effect over time.

An increase in current account outlays for pollution abatement by business and government, that is, X_{BA} or X_{BG}, does not show up on the consolidated account. (They are canceled out, since they are on both sides of the consolidated ledger.) However, the fact that such transactions between businesses are not shown does not mean that there will be no effect on the account aggregates. The more labor that firm B devotes to produce pollution control equipment to be sold to A, that is, X_{BA}, the less labor will be available to produce other goods, such as X_{BI} and X_{BC}. Therefore, barring a sudden change in technology, the increase in X_{BA} must be at the expense of one or more of the elements of GNP.

The same result must occur if firm A uses its own labor for pollution cleanup. If A attempted to maintain its production of goods that show up in the GNP (X_{AC}, X_{AI}, and X_{AG}) by reducing its production of intermediate goods, X_{AB}, firm B would have to reduce its output, since X_{AB} is B's raw material. The pollution control firm B might try to maintain its production of goods counted in GNP (X_{BC}, X_{BI}, and X_{BG}) by reducing its intermediate production, X_{BA}. This possibility can be ruled out, since such a response would mean an increase in pollution by A rather than the postulated decrease. Thus, diverting labor either for the production of current account, intermediate pollution control equipment or for in-house cleanup must reduce the GNP.[11] If, as is usually the case, however, most of the pollution control depends on the purchases of capital equipment, X_{BI}, the short-term effect on the accounts is the same as it was above when the increased pollution control outlays of consumers were analyzed. The only short-term effect will be on the composition of GNP, not on its level.

Yet, over the long term the situation might be different, since changes in investment are likely to cause changes in other types of output. Thus, investment that is diverted for environmental purposes will result in fewer machines and less equipment to support ordinary production. Some economists have estimated that for each 1 percent of investment so diverted, output, as measured by NI, falls by approximately 0.3 percent (Denison 1979a, 1979b). Although investigators have disagreed about the exact amount of the decline caused by diverted investment, there is general agreement that increases in pollution control investment will have some dampening effect on the account aggregates, again making these aggregates poor indicators of environmental improvement and overall well-being.[12]

A Modified Accounting Structure

The above theoretical structure suggests both a framework for introducing the services of environmental assets into the conventional accounts and the principles for evaluating these services. Basically, the framework assumes that these services can be treated as unpaid factor inputs to either production or consumption activities. The adverse effects of pollution or of the denial of environmental services to others caused by the use of the services as inputs can be treated as negative output or damages.[13] A balancing term is required to assure that the conventional equality between total inputs and outputs is maintained.

The following set of accounts, modified to reflect these ideas, is rather similar to the conventional accounting structure outlined in Tables 10-1 and 10-2.[14] Although Table 10-2 shows the consolidated account as a combination of industrial and governmental production accounts, here the consolidated account is a combination of production accounts in four sectors: industry, government, household, and the environment (nature). To make them more understandable to those familiar with the conventional accounts, additional entries are shown, which, to simplify the exposition, were neglected in the accounts in Tables 10-1 and 10-2. There are no new entries for current pollution control outlays, since these are already included in the conventional accounting of costs. As noted above, however, it probably would be useful to identify these costs separately, as has been done by the Bureau of Economic Analysis (U.S. Department of Commerce) since 1972.

Industrial Sector

The typical industrial account shown in Table 10-3 contains three new entries that would ordinarily be absent from a conventional account of the industry's inputs and outputs. In addition, capital consumption allowances include natural resource and environmental depreciation as well as ordinary depreciation. Item 10 is an accounting of the environmental services, and item 15 is an accounting of damages—not just to consumers, but to any agents in the economy that are damaged, including other businesses. Because they are "free," environmental services are like a subsidy to the industry. Therefore, they are entered as a negative input. Item 11 is the arithmetic difference between items 15 and 10. It ensures that the modified accounts balance. Since it is defined as the difference between the service benefit of the environment and the disbenefit of environmental damage, it has been named net environmental benefit.[15] The modified industrial account input and output totals equal the conventional input and output totals less the absolute value of environmental damage.

Government

As is suggested by the above discussion of the standard national accounts, the conventional governmental product account is rather simple. Likewise, the modified account shown in Table 10-4 is very simple. It contains those additional entries that account for the government's use of the environment, the resulting damage, and the necessary balancing entry. However, it also differs from the industrial account in that it displays an entry accounting for environmental depreciation. The implicit assumption is that all environmental assets are "owned" by the government.

Households

The conventional national accounts assume that very little production takes place in households (primarily accounted for by nonprofit institutions and the services of domestics) (Table 10-5). The focus of the conventional accounts on activities that reflect market transactions precludes consideration of the outputs related to keeping up a house, preparing meals, raising children, and do-it-yourself projects.[16] Households are far more important in the modified accounts. Especially in developing countries, households account for a substantial portion of environmental damage to water because of direct discharges of sanitary wastes.[17]

Households are unique among the producing sectors in that most of the environmental damage caused by households (as a result of their consumption of environmental services) are inflicted within the household sector itself. In contrast, industries and governments tend to inflict damage outside their own sectors.

Nature

The modified accounting system differs most markedly from the conventional system in its inclusion of nature as a separate sector (Table 10-6). Nature is shown as the primary source of all environmental asset services and as the final consumer of environmental damages. Nature also must be included because it generates a substantial portion of environmental damage. For example, a large portion of dissolved solids in water have a natural origin, and, on average, naturally generated particulates and nitrogen oxides (other than NO_2) greatly exceed the man-made production of these air pollutants.

Although some may have a philosophical objection to the idea of nature as a polluter, the concept is required for practical reasons. Available estimates of damages caused by air and water pollutants cannot distinguish between damages from offensive residuals that have a human origin and those with a natural origin. Rather than attribute all the damage to nonnatural causes, it is more accurate to prorate the damages between the two sources.

Table 10-3. *Industrial Product Account for a Typical Sector (I)*

Input	*Output*
1. Purchases from other industrial sectors	12. Sales to private sector (current account)
2. Compensation of employees and proprietors (incl. rental income)	a. To other industries
	b. To households
3. Profits after inventory valuation and capital consumption adjustment	c. Exports
	13. Sales to government
4. Net interest	14. Sales for gross investment
5. Imports	
6. Transfer payments	
7. Indirect taxes	
8. Subsidies received (−)	
9. Capital consumption allowances	
Gross industrial sector input	**Gross industrial sector output**
10. Environmental services (−)	15. Environmental damages (−)
a. Air	a. Air
b. Water	b. Water
c. Land	c. Land
11. Net environmental benefit (I.15−I.10)[a]	
Modified gross industrial sector input	**Modified gross industrial sector output**

a. I.15, I.10, and so forth, means item 15, item 10, and so forth, account I.

Table 10-4. *Governmental Product Account (II)*

Input	*Output*
1. Purchases from industry (I.13)	7. Governmental goods and services
2. Compensation of employees	
3. Imports	
Governmental input	**Governmental output**
4. Environmental depreciation	8. Environmental damages (−)
5. Environmental services (−)	a. Air
a. Air	b. Water
b. Water	c. Land
c. Land	
6. Net environmental benefit (II.8–II.5)	
Modified governmental input	**Modified governmental output**

Table 10-5. *Household Product Account (III)*

Input	*Output*
1. Purchases of intermediate goods from industry (I.12.b)	8. Services to households
	a. Nonprofit institutions
2. Compensation of employees and proprietors	b. Domestics
3. Imports	
4. Surplus of nonprofit institutions	
5. Capital consumption allowances	
Gross household input	**Gross household output**
6. Environmental services (−)	9. Environmental damages (−)
a. Air	a. Air
b. Water	b. Water
c. Land	c. Land
7. Net environmental benefit (III.9–III.6)	
Modified gross household input	**Modified gross household output**

Table 10-6. *Natural Account (IV)*

Input	*Output*
1. Environmental damages (including those naturally generated)	2. Environmental services
a. Air	3. Net environmental benefit (IV.1–IV.2)
b. Water	
c. Land	
Natural sector input	**Natural sector output**

Consolidated Income and Product Account

The modified accounts shown above can be consolidated into a modified income and product account, as in Table 10-7. The procedure is the same as that used to consolidate the accounts shown in Table 10-2. As before, all flows within sectors have been eliminated. That is, all items appearing on both sides of the consolidated account are eliminated. Also as before, households are not included in the consolidation; nor is the nature account (except for natural sources of environmental damage). Although nature is viewed as the source of environmental services and the consumer of environmental damages, the proposed accounting framework does not view nature as undertaking production activities. It is thus excluded from the gross production account.

The new entries have been arranged to preserve the conventional account entries, which will enable those who may not be interested in the modifications to simply ignore them. Thus, for example, while the modified accounts show environmental depreciation as a negative adjustment (item 9) to NNP, it is added back (item 11) to leave the conventional measure of GNP unchanged. Arranging the entries in this way should alleviate the fears of those who object to modifying the conventional accounts on the grounds that such modifications destroy the integrity of the accounts.

The Modified Account Aggregates

Inspection of the modified consolidated account indicates that modified GNP equals conventional GNP less environmental damage. Actually this relation is an identity: it is necessarily true because of the way the entries are arranged in the accounting structure. Several other arrangements are possible, however, each leading to its own formula relating the conventional GNP to a modified GNP.

Table 10-7. *Consolidated National Income and Product Account (V)*

Input	*Output*
1. Compensation of employees and proprietors (incl. rental income) (I.2 + II.2 + III.2)	14. Personal consumption (I.12.b + III.8)
2. Profits after inventory valuation and capital consumption adjustment (I.3)	15. Gross private domestic investment (I.14)
3. Net interest (I.4)	16. Exports (I.12.c)
National income	17. Imports (−) (I.5 + II.3 + III.3)
5. Transfer payments (I.6)	18. Governmental goods and services (II.7)
6. Indirect taxes (I.7)	
7. Subsidies (−) (I.8)	
8. Statistical discrepancy	
Net national product	
9. Environmental depreciation (−)	
Modified net national product	
10. Capital consumption (I.9 + III.5)	
11. Environmental depreciation (+)	
Charges against gross national product	**Gross national product**
12. Environmental services (−) (I.10 + II.5 + III.6)	19. Environmental damages (−) (I.15 + II.8 + III.9 + IV.1)
a. Air	a. Air
b. Water	b. Water
c. Land	c. Land
13. Net environmental benefit (V.19–V.12)	
Charges against modified gross national product	**Modified gross national product**

To show this, the following notation is first defined:

VA = charges against conventional GNP or value added
GNP = conventional GNP
GNP^i = modified GNP, definition i (i = 1, 2, 3, or 4)
ES = environmental services
NEB = net environmental benefit
ED = environmental damage.

Since the left- and right-hand sides of the consolidated accounts must balance, the following identity holds:

(6) $$VA - ES + NEB = GNP - ED.$$

As noted, this identity implies the following definition of modified GNP:

(7) $$GNP^1 = GNP - ED. \qquad \text{(Definition 1)}$$

Accounting arrangements are somewhat arbitrary, however, and other arrangements are possible as long as the accounts balance. For example, by adding ES and ED to both sides of equation 6 and noting that NEB = ES − ED, a new identity can be formed:

(8) $$VA + ES = GNP + ES$$

which leads to a new definition:

(9) $$GNP^2 = GNP + ES. \qquad \text{(Definition 2)}$$

Similarly, adding ES and ED to both sides of equation 6 and again noting that NEB = ES − ED produces a third definition of modified GNP:

(10) $$GNP^3 = GNP + NEB. \qquad \text{(Definition 3)}$$

Finally, first adding ES to both sides of equation 6 and then subtracting NEB from both sides produces a fourth definition:

(11) $$GNP^4 = GNP. \qquad \text{(Definition 4)}$$

Thus, modified GNP can be defined alternatively as conventional GNP less environmental damage, as conventional GNP plus environmental services, as conventional GNP plus net environmental benefit, or simply as equal to conventional GNP. These definitions are by no means equivalent, but they are all consistent with the modified accounting structure discussed above. The pros and cons of these alternatives are discussed in the next section.

The Environment and the Modified Accounts: Options for Modifying GNP

The relation between the modified accounts and the environment can be discussed in terms of the modified GNP concepts defined in the previous section. Since the fourth definition of modified GNP is exactly the same as conventional GNP, however, the discussion need only cover the first three, since the relation between the environment and conventional GNP has already been discussed.

Option 1: GNP^1 = GNP − ED

It was demonstrated above that the conventional account aggregates do not always respond to changes in environmental quality in a manner that would make these aggregates acceptable indicators of well-being. GNP tended to increase with environmental deterioration, and efforts to improve the environment are often reflected by reductions in GNP, particularly if these efforts were undertaken by reallocating business current account inputs or shifting investment. Clearly, the above definition of modified GNP seems to perform much better as an indicator of well-being. GNP^1 appears to move correctly with respect to changes in ordinary GNP and to changes in environmental quality. Perhaps this is why this modification to conventional GNP was recommended by Olson (1977). Yet, this first definition covers only part of the environmental relation. The second definition covers another part.

Option 2: GNP^2 = GNP + ES

The theoretical analysis behind the suggested modified accounting framework demonstrated that there was a beneficial environmental service associated with any observed environmental damage. This service, being unpriced and apparently "free," does not show up directly in conventional GNP. The second definition directly accounts for this unpriced input. Its use as an index of well-being would have interesting and perhaps controversial implications. For example, the difference in income between an unindustrial, developing society in a tropical climate that generates environmental services in the form of warmth and abundant, freely available food and an industrial society in a cold climate that requires a highly sophisticated agricultural system may be far less if income is measured by GNP^2, rather than ordinary GNP. (The difference might also be less under the first definition if the industrial society were also the more polluted.)

However, GNP^2 is prone to possible double counting of environmental services consumed by business. While these services may not be accounted for directly, they may be reflected in profits, which are captured by ordinary GNP. For example, a business that can dispose of its wastes in the ocean has a distinct advantage over a competing business that must treat its wastes. The opportunity to use the ocean's disposal service may show up as an increased profit rate for the business. For the national accountant to add in an amount equaling the value of the ocean service would, in this example, be superfluous.

One interesting aspect of GNP^2 concerns its behavior with respect to pollution control expenditures by business. As noted, conventional GNP either is unaltered or declines depending on whether the expenditure by business is on capital or current account and on whether capital outlays for pollution control divert capital from more productive uses. Assuming full employment, however, GNP^2 will always decline as pollution control expenditures increase. According to the theory behind the modified framework, pollution control expenditures mean that marketed goods and services are being substituted for environmental services. Thus, since ES will decline, GNP^2 will also decline. Some may feel that this result, along with the potential for double counting, makes GNP^2 a less desirable indicator of well-being than GNP^1. However, its focus on the benefits of ES is a strong point in its favor.

Option 3: $GNP^3 = GNP + NEB = GNP + ES - ED$

This definition of modified GNP appears to be a compromise between GNP^1 and GNP^2 and shares the strengths and weaknesses of both measures. As an indicator of well-being it appears to move in the correct direction: increases in ES and decreases in ED imply increases in GNP^3. Yet there are some circumstances under which GNP^3 has difficulty in moving in any direction. In the absence of technological change, decreases in environmental damage by business, ED, must invariably be accompanied by decreases in environmental services to business, ES. Thus, under policies of pollution control, NEB may remain essentially unchanged. For this reason, it may not be very effective as an indicator of well-being after all. If D and ES are valued using marginal valuations (as described under "Valuation Concepts," above,) however, GNP^3 can convey important information beyond that of the other two measures of modified GNP. For considerations of whether any of the modified GNP concepts are good indicators of social well-being, total valuations of environmental services and damages are of more interest that marginal valuations. However, marginal valuations provide a piece of valuable policy information. As described above, if the marginal valuations of ES and ED are the same (neglecting the minus signs), the allocation of the services of environmental capital is optimal in the sense that any other allocation lowers social well-being. Thus, if marginal valuations are used (and if environmental depreciation is neglected), an optimum allocation occurs when $ES = ED$ or, equivalently, when NEB equals zero or when $GNP^3 = GNP$. If NEB were negative or $GNP^3 < GNP$, well-being would improve if ED were decreased. Such a policy recommendation to reduce environmental damage would not be very controversial. However, the analysis also indicates that if NEB were positive, or $GNP^3 > GNP$, there may be too little environmental damage for social optimality. The concept of too little environmental damage is a natural consequence of the fact that environmental asset services contribute to well-being just as does the reduction in environmental damages. GNP^3 explicitly recognizes this duality and the fact that the benefits of pollution reduction are rarely gained without cost: some portion of the benefits of environmental services usually have to be forgone.

As noted from Table 10-7, in this framework environmental depreciation modifies only NNP, but not GNP. For this reason environmental depreciation was neglected in the foregoing discussion of modified GNP concepts. Since many prefer NNP to GNP as an aggregate measure of economic performance, however, it is possible to recast all the previous discussion in terms of NNP. By simply subtracting capital consumption allowances and environmental depreciation (items 10 and 11 in Table 10-7) from both sides of equations 6 through 11, all the conclusions can be restated for NNP. Thus, for example, $NNP^1 = NNP - ED$, $NNP^2 = NNP + ES$, and so forth. The above inequalities hold as well.

Notes

1. Environmental management theory has found its way into several texts, but one of the best expositions is the seminal book by Kneese and Bower (1968).

2. Simple input-output models, which view pollution as a by-product produced in fixed proportion to salable product, neglect this important principle. The earliest example of such a model is Leontief (1970).

3. Both direct and indirect disbenefits can occur simultaneously.

4. Marginal valuations equal total valuations less consumer's surplus.

5. That is, if physical depreciation is *Dp* and capital gain is *G*, the decomposition of value depreciation requires that $V_1 = V_0 - Dp + G$ or $V_0 - V_1 = Dp - G$.

6. Of course, in practice the availability of drinking water may be reduced for other reasons, notably by poisoning from waste products. To keep the analysis simple, however, it is assumed that the lake provides only one service—drinking water—and not a waste disposal service.

7. For a more detailed discussion of accounting concepts, see Ruggles and Ruggles (1956; 1970) and U.S. Department of Commerce (1954).

8. This simple economy does not include a foreign sector, nor are there any interest payments. If these were included, net exports (exports less imports) would also appear on the right-hand side of the consolidated account and net interest on the left-hand side.

9. One implication of this household production is that many consumer goods are really intermediate in nature and thus contribute only indirectly to well-being. See Hirsch (1976) for a good discussion of this issue.

10. This statement assumes that the economy will remain fully employed in spite of these shifts in output. If factors of production do not shift easily—as may be the case in the real world—GNP may fall.

11. The reduction in the right-hand side of the consolidated account in Table 10-2 must be offset by an equal reduction in some components on the left-hand side. Since the total amount

of labor is fixed, either profits, indirect taxes, or depreciation must be reduced.

12. See Christiansen and others (1980) for a summary of estimates of the effect of pollution regulation on the economy.

13. To avoid double counting, these damages should be measured net of damages already reflected in any reduced production caused by pollution-related productivity losses (for example, effects of air pollution on worker health). (Robert Repetto called attention to this point.)

14. This section is based on Peskin (1976) and Peskin and Peskin (1978).

15. Net environmental benefit is shown as the difference between the environmental damages entry and the services entry. Since damages and services are entered negatively, however, it actually is equal to the absolute value of the services less the absolute value of the damages.

16. The one major nonmarket activity associated with households that is included in the accounts—the imputation for the implicit rents from owner-occupied housing—is included in the business sector.

17. In the modified system, sewered households are not considered to pollute the environment. Sewered wastes are considered inputs to municipal treatment works, an industrial sector, which is credited with any resulting environmental damage.

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Environmental Accounting and the System of National Accounts

Peter Bartelmus

An important outcome of the 1972 U.N. Conference on the Human Environment in Stockholm was to affirm that environmental problems are caused by highly accelerated economic growth as well as by activities induced by an actual lack of development. A broader view of environmental damage was also advanced, which included, besides the discharge of toxic substances, the degradation and depletion of natural resources. An integrated and coordinated approach to development planning, which included safeguarding the natural resources of the earth for the benefit of present and future generations, was proclaimed in the "principles" of the conference report (United Nations 1973).

Eight years later the World Conservation Strategy advocated the "achievement of sustainable development through the conservation of living resources" as its basic aim (IUCN 1980). The International Development Strategy for the Third U.N. Development Decade also referred to the "need to ensure an economic development process which is environmentally sustainable over the long run" among its goals and objectives (United Nations 1981, para. 41). During its 38th session the U.N. General Assembly called upon the World Commission on Environment and Development to propose long-term environmental strategies for achieving sustainable development by the year 2000 (United Nations 1984b). Accordingly, sustainable development is the all-pervading theme of the Commission's report (World Commission 1987).

Although there is general agreement on the desirability of sustainable economic growth and development, it is less clear how "sustainability" can be defined operationally so that indicators can be developed that signal significant deviations from the sustainable path of development.[1] It appears that politicians in most countries continue to base their decisions on the assumption that overall economic and social welfare rises and falls with the popular macroindicators of gross domestic or national product, GDP or GNP. In fact, these indicators are usually taken to move parallel with aggregate income, which is obtained by making an allowance for the wear and tear of capital assets used to produce output and corresponding income. As far as the produced capital is concerned, an element of sustainability is thus introduced in the definition of national income. This approach reflects the Hicksian view of income as a practical guide for prudent conduct toward consumption, which should not exceed a certain limit beyond which a person or a population would be impoverished (Hicks 1946, p. 172).

The concept of capital maintenance has not been extended to natural and human capital assets in national accounting. As a result, in the case of natural assets, the degradation and depletion of the natural environment and its resources contribute to illusionary income flows that cannot be maintained in the long run. Moreover, expenditures by government or households for "regrettable" measures to counteract deteriorating environmental conditions actually increase national product and income. Measures of economic welfare were therefore advanced that purported to correct the misclassification of regrettable expenditures as final and that made allowances for important nonmarket activities, environmental degradation, and the depletion of natural resources. Best known are perhaps the pioneering efforts by Nordhaus and Tobin (1972), made popular by Samuelson's textbook as "net economic welfare" or NEW (Samuelson 1980, p. 183).

Note: The author is a staff member of the United Nations. The views expressed here are his own and not necessarily those of the United Nations.

At the request of the U.N. Committee for Development Planning, the U.N. Statistical Office (UNSO) critically reviewed the concepts, methodologies, and empirical applications of these measures. The review concluded that considerable conceptual and measurement problems make estimates of the value of environmental damage "essentially exercises for multidisciplinary research and experiments, not for routine collection of statistics," and that difficulties of agreeing on the scope, concept, and measurement of welfare would render such approaches "inappropriate for official and especially international use" (United Nations 1977b, pp. 54 and 66). The environment statistics program of the UNSO focused, therefore, on developing physical statistics and related indicators (*see* "Environment Statistics," below). A significant limitation of such data is that they lack a common *numéraire*, which would permit aggregation across broad sectors of the environment. Despite its limitations, GDP thus continues to be the main indicator of economic success or failure.

The joint UNEP/World Bank workshops set out, therefore, to reexamine the feasibility of physical and monetary accounting and concentrated on the field of environment and natural resources. This field appeared to be better researched and easier to assess than the whole gamut of welfare effects originally addressed by economic welfare measures. A consensus emerged in the workshops that enough progress had been achieved to link environmental accounting to the standard System of National Accounts (SNA) (United Nations 1968) and to include certain aspects of environmental accounting in the ongoing revision of the SNA. This chapter examines the treatment of environmental issues in the SNA and reviews the main approaches to resource and environmental accounting for possible linkage or integration with the SNA.

Environment Statistics and Physical Accounting

The close interactions among environment, population, natural resources, and development require an integrated approach to planning and policy formulation, which in turn need to be supported by comparable social, economic, and environmental data. On the one hand, environment statistics systems attempt to compile raw data from a multitude of sources and to present them in a coordinated manner in statistical compendia such as yearbooks or bulletins. Further aggregation and more rigid presentation of the stocks and flows of natural resources in physical terms are, on the other hand, the objective of natural resource accounts and balances.

Environment Statistics

At the international level, the Conference for European Statisticians (CES 1973) of the Economic Commission for Europe took the initiative to develop a system of environment statistics that would complement the already existing systems of economic statistics (the SNA) and social and demographic statistics (the System of Social and Demographic Statistics, SSDS) (United Nations 1975). It soon became apparent, however, that the current state of knowledge about the environment and its statistical measurement, as well as widely differing environmental concerns and priorities, did not permit an internationally applicable statistical system to be established. Therefore, under the guidance of the U.N. Statistical Commission and with the financial support of the U.N. Environment Programme (UNEP), the UNSO developed a flexible Framework for the Development of Environment Statistics (FDES) (United Nations 1984a). Since the FDES itself does not recommend statistical definitions and classifications, no direct linkage through common concepts and classifications was established with the SNA or other statistical systems.[2]

The FDES is currently being expanded into a series of technical reports on "Concepts and Methods of Environment Statistics," which will propose definitions and classifications for statistical variables and indicators of high priority. Because these statistics include indicators of resource depletion and environmental degradation, their use for establishing resource and environmental accounts in physical terms will be addressed specifically in a report on "Statistics of the Natural Environment." These methodologies will be applied at the regional and national levels in a Global Program of Environment Statistics (U.N. Statistical Commission 1987, p. 29).

Materials/Energy Balances

Close linkage to the SNA has been attempted in more selective approaches to accounting for flows of materials and natural resources. The UNSO developed draft guidelines for statistics on materials/energy balances (MEB), which were seen as a module of a larger system of environment statistics (United Nations 1976). The primary purpose of the MEB is to trace the extraction and transformation of materials and energy from natural resources, through various successive stages of processing, to final use, and thence back to the environment as waste or, alternatively, to secondary use. Compatibility with the SNA is achieved by using its standard categories, such as domestic output and consumption, imports, and exports, and its classification of economic activity. Contrary to the concepts of market transactions and monetary valuation used in national accounting, physical stocks and flows and materials/energy transformation processes are presented in such balances.

The U.N. Statistical Commission considered the MEB to be an interesting long-term approach, but too ambitious for short-term implementation because countries still lack the necessary statistical capabilities. As a consequence, only the energy part of this approach was further developed in balances that show energy flows from the production of primary energy, through conversion processes, to the stage of final consumption (United Nations 1988).

A work program to standardize definitions and terminology for mineral resources was initiated by the U.N. Committee on Natural Resources and later transferred to the Statistical Commission. The commission requested the UNSO to further develop mineral consumption statistics and raw material balances (including the secondary recovery of metals), provided the necessary resources could be made available. Such resources could not be found, however, and work on this program has been suspended.

Environmental Aspects of Input-Output Systems

In focusing on processes of resource flows through the economic system, the MEB can also be considered as a physical extension of the input-output tables of national accounting. These models can incorporate resource requirements and waste residual outputs, which reflects the fact that the materials/energy inputs and outputs for the economy must always balance. However, detailed classifications of production processes that provide for a further breakdown of the relatively heterogeneous classification by industries would be needed to obtain more stable technical coefficients of resource use, production, and residuals.

Although the SNA provides for the full integration of input-output tables, country tables were often compiled separately from national accounts because they focused on specific analytical uses. A future handbook on input-output statistics and the current review of the SNA as a whole will address problems of better integration of input-output practices into the SNA framework. For the time being, however, there are no plans to deal specifically with natural resource and energy flows or pollution processes in the input-output system.

Resource Accounting

A few countries with well-developed monitoring and data collection capabilities have turned to a somewhat simplified physical accounting approach. The basic objective of resource accounting systems is to provide a coherent picture of resource use and depletion or increase, which can be linked to, or integrated with, the national accounts. Norway's resource accounts concentrate on selected natural resources and extend the SNA balance sheets to cover the total stock (including nonmarketed stocks) of the respective natural resources in physical units (Statistisk Sentralbyra 1987). The French "patrimony" approach is more ambitious in its attempt to include ecological processes that are not directly affected by human intervention, that is, interactions among the physical components of the environment and its biota (INSEE 1986a; see also Theys, Chapter 7).

Environment and Natural Resources in the SNA

Common to all the above approaches is the use of physical units, which permits aggregation only in very limited areas as, for example, in the energy sector by means of conversion factors. Physical accounts and the indicators presented in their framework assess resource availability, use, and overuse, and they are thus important tools for managing natural resources. However, they are only an intermediate step in the overall assessment of the national resource base, which is required to formulate and evaluate resource policies that are compatible with general development policies (Repetto 1986). To calculate overall measures of economic performance, a common *numéraire*, such as the monetary unit of national accounting, is needed. Therefore, aspects of the environment that are already covered by the SNA are examined below before any further methodologies of monetary environmental accounting are described.

Flow Accounts

The basic objective of the SNA is to provide "a comprehensive and detailed framework for the systematic and integrated recording of the flows and stocks of an economy" (United Nations 1968, p. iii). No explicit reference to the environment or natural resources is made in any of the core flow accounts described in the "blue book" of the SNA. Various activities listed in the international standard industrial classification (ISIC) refer, however, to the use of natural resources such as agriculture, hunting, forestry, logging, fishing, mining, water supply, and transportation as well as to the environmentally related services of housing and sanitation. Similar services are also reflected in the classification of government expenditures by purpose. Since the cost of land improvement is included in gross capital formation, this concept also covers transactions dealing with selected natural resources. In none of these concepts and classifications, however, are environmental transactions clearly identified. They are typically lumped together with other nonenvironmental transactions. Moreover, certain environmental expenditures are treated as final where they actually represent a cost to society (*see* "Environmental Costs and Expenditures," below).

Balance Sheets and Reconciliation Accounts

To date national efforts have largely focused on the accounting of flows or transactions to the neglect of the stocks presented in balance sheets. This occurs despite the fact that balance sheets form an integral part of the SNA, linked to its flow accounts through capital transaction and reconciliation accounts. There has been growing interest, however, in measuring national wealth and, in particular, its tangible aspects, a significant part of which is made up of assets of the manmade and natural environment.

Following a recommendation of the "blue book," the UNSO issued detailed guidelines on balance sheet and reconciliation accounts within the framework of the SNA (United Nations 1977a). The guidelines distinguish between reproducible tangible assets, including the fixed assets and stocks of enterprises, financial institutions, government, and private nonprofit institutions, and the nonreproducible tangible assets of natural resources and historical monuments. The classification of stocks and fixed assets presents important aspects of the manmade environment and lists buildings and infrastructural works as part of fixed assets. The measurement of the availability and use of natural resources and the assessment of related environmental problems are considered to be some of the main uses of the classification of nonreproducible tangible assets. Land, timber tracts and forests, subsoil assets and extraction sites, and fisheries are the principal categories of this classification.

In line with the basic principle of the SNA to limit its scope mainly to market activities (except for imputations for directly competitive nonmarket activities), natural resources in the public domain are excluded. This category includes rivers, lakes, parklands, unused wilderness, and the atmosphere, which are not subject to ownership rights and are thus generally not sold or purchased. Outlays on the permanent improvement and extension of these items are covered in capital formation and thus increase the reproducible tangible assets (as "other construction works" or "land improvement") of the balance sheets. But no capital consumption is charged against these outlays. However, the total initial expenditure for naturally growing but commercially traded assets, such as the stock of animals, timber tracts, plantations, and fisheries, is counted as capital formation. Further growth and depletion are not recorded as capital formation but are included in "reconciliation accounts" (see below).

Balance sheet accounts are linked to the SNA flow accounts by capital finance accounts, which portray a significant part of the changes between opening and closing assets and liabilities. There are, however, several other changes in assets and liabilities, such as revaluations, unforeseen events, and, in particular, increases or decreases in nonreproducible assets, which are not included in the flow accounts of the SNA. To cover all differences between the balance sheet accounts at opening and closing dates, these changes are formally introduced in so-called reconciliation accounts.

The following items of the reconciliation accounts are particularly relevant for environmental analysis: natural growth less depletion of timber tracts, forests, and fisheries; new finds less depletion of subsoil assets; and losses in land and timber tracts in catastrophes and natural events. Changes in land quality due to erosion, waterlogging, desertification, or upgrading and increased availability of mineral resources due to technological advances are not shown separately. They are recorded as changes in the market value of land and subsoil assets as part of the revaluation item of the reconciliation accounts. All these items are excluded from the capital transaction accounts and thus do not affect the level of national income or product.

Monetary Environmental Accounting

As already discussed, physical indicators and accounts cannot be aggregated into overall measures of resource depletion and environmental degradation. Consequently, they cannot be compared directly with the standard measures of economic performance to assess the sustainability of economic growth or development. For this reason, physical measures have not become standards in national planning and policymaking, but have been largely restricted to use in environmental and resource management. Because of the prominent role of national accounting and its main aggregates in formulating and evaluating national plans and policies, various environmental accounting approaches attempted to tackle the issue of sustainability and environmental degradation within, or as close as possible to, the established systems of national accounting.

Most of these approaches favor the direct adjustment of SNA concepts, classifications, and tabulations. It is hoped that this would cause politicians and administrators to base their plans and decisions on a concept of sustainable income, which accounts for the total cost of destructive and wasteful uses of the environment and natural resources. During the current revision of the SNA, however, it was generally agreed that no significant conceptual changes should be introduced in the central framework of the SNA. Rather, the emphasis should be on clarifying, simplifying, and updating the SNA for both producers and users of the system and on improving its consistency with other international standards of statistics. A possible compromise (suggested below in "Future Work") is to elaborate the different methods of environmental accounting in satellite accounts and tabulations of the SNA.[3]

The following review of the main approaches discussed in the UNEP/World Bank workshops illustrates the possible contents of satellite accounts. Three basic categories of environmental accounts are distinguished according to the main environmental concerns addressed in the workshops, namely accounts of environmental costs and expenditures, natural resource capital, and environmental services.

Environmental Costs and Expenditures

The measurement of environmental outlays and, as far as possible, of resources or "incomings" of the principal agents of the national accounting system has been pioneered by France in "environmental satellite accounts" (INSEE 1986b). Operating (running) costs or current outlays are distinguished from investment and other capital formation expenditures. One of the main problems in this approach is to identify the environmental activities for which outlays have been incurred. This problem exists because the standard classifications of the SNA were not designed to generate statistics on environmental expenditure.

For government expenditures, the classification of the functions of government (COFOG) does not yet contain a category relating to the protection of the environment, but it indicates that such a grouping may be feasible in the future (United Nations 1980). A list of functional classes that include information on research and other aspects of environmental protection is advanced for "further examination." A draft classification of outlays of industries by purpose (COIP) was developed by the UNSO in 1975 but was not further discussed or promoted. It lists nine categories, one of which specifies outlays on pollution abatement and control. For this category, outlays for "end-of-line" measures are said to be relatively easily allocated. However, the incremental costs of measures that are incorporated in the production process can be only estimated. For private nonprofit bodies serving households, the SNA contains a classification of purposes consisting of eight categories that do not specify environmental purposes. For households, the SNA's classification of household goods and services might eventually be linked to a general and more detailed central product classification (CPC), which has been prepared by the UNSO. One division of this classification reflects environmental functions in categories such as "sewage and refuse disposal" and "sanitation and similar services."

The development of functional classifications in the SNA that cut across sectoral boundaries and identify expenditures for environmental purposes would permit these expenditures to be aggregated for the whole field of the environment and broken down by environmental protection category. The aggregate of the total (final and intermediate) environmental expenditure describes how much a nation has been willing to spend on environmental protection during the accounting period. This aggregate also facilitates international comparisons, since it is not affected by different institutional arrangements for environmental policymaking and budgeting.

Functional classifications of environmental expenditures can also be used to measure so-called defensive expenditures incurred by the government, households, or industry to counteract environmental degradation. When such expenditures are counted as final consumption or investment, they increase directly national product or income. Governmental expenditures typically include outlays for environmental protection and remedy, while households might bear the cost of medical treatment for pollution-related diseases or the avoidance of environmental disamenities, for example, by resettlement. If environmental expenditures are incurred by industry, however, their current cost component is counted as intermediate consumption, which potentially decreases (in the case of full employment of the factors of production) industrial value added, that is, industry's contribution to national product. Capital expenditure for environmental protection by industry is treated, however, as final expenditure and is thus fully counted as an increase of GNP.

All these expenditures serve only to maintain a certain level of environmental quality or, in other words, to "defend" society against the unwanted side effects of production and consumption. They could, therefore, be considered as a cost to society, to be deducted from gross production and final consumption (*see* "Indicators of Sustainable Product and Expenditure," below). Apart from expenditures for environmental protection and compensation for environmental damage, defensive expenditures may also include other social costs of urbanization and industrialization, such as commuting costs and provisions for environmental hazards in industries and the working environment (Leipert 1985). As already mentioned, it may be difficult to identify separately defensive costs in the case of combined measures that restore environmental conditions and raise productivity or utility at the same time.

The social restoration cost of meeting or maintaining environmental standards for safeguarding sustainable economic development has been advanced as an indicator that might usefully supplement national product (Hueting, Chapter 6). The indicator describes how far a nation has drifted from its desired level of environmental quality and can thus be compared with the extent the nation has progressed in raising its level of production. Standards for sustainable development could be set by decisionmakers or by science, and appropriate measures to meet these standards could then be formulated and costed. For irreversible losses of renewable resources (extinction) or for nonrenewable resources, the cost of developing alternative resources or facilities could be estimated. The method of using standards has been proposed because of the difficulties of devising shadow prices for environmental functions (and their losses) that are directly comparable with market prices of produced goods and services.

Natural Resource Capital

Most changes in the resource assets of a country have been excluded from the standard flow accounts of the SNA because of the lack of reliable data and uncertainties in estimation and valuation procedures, particularly for assets whose returns are typically spread over many accounting periods. As described above, some of the more commercial changes are recorded separately in reconciliation accounts, but these accounts have rarely been prepared and thus are largely neglected in policymaking. Now, however, awareness of the unsustainability of income resulting from the consumption of finite natural assets has created new interest in accounting for selected resources in physical accounts and has also revitalized attempts to assign monetary values to the stocks and flows of these accounts.

In principle, such accounts can be developed in harmony with national accounting concepts by extending the SNA's balance sheets to cover fully natural resources such as water, forest, or wildlife, even if they have not been the object of commercial transactions. Contrary to the practice of reconciliation accounts, the separate listing of additions (discoveries, net revisions, extensions, growth, or reproductions), reductions (extraction, deforestation, or degradation), and revaluations in "national income accounts for natural resources" has been proposed to record changes in the values of the stocks of natural resources during the accounting period (Repetto 1986). Net changes in the value of the resource position can be estimated from these accounts for the calculation of sustainable income or product indicators. Other procedures to estimate the depletion factor in the calculation of sustainable income include applying depreciation principles to the stock of natural resources or calculating user cost allowances for their intermediate consumption (see "Indicators of Sustainable Product and Expenditure," below).

Environmental Services

The amount of environmental expenditures or costs described above does not reflect the correct value of actual environmental damage. On the one hand, the value of damage may be higher or lower than the cost of repairing it. On the other hand, accounting for environmental expenditures neglects the fact that pollution is connected with both the benefits of using nature's disposal and absorption services and the "disbenefits" resulting from losses of these and other services that benefit consumers directly. Contrary to defensive expenditures, these services are not priced by the market system and are thus excluded from standard national accounts (see Peskin, Chapter 10).

The introduction of a natural production account into the national accounting system was therefore suggested. Such an account would record environmental services (for example, waste disposal, cooling, and provision of oxygen and nutrients) as output from, and environmental damage (in particular pollution effects) as input into, the environment, with the balance representing a net environmental loss or benefit. Industry, government, and household production accounts receive nature's output as "free" services (counted as a subsidy or negative input) and deliver environmental "bads" (as negative outputs) to nature's production account (Peskin 1981).

The model claims to be fully consistent with the principles of neoclassical economics in measuring the environmental aspects of social welfare. There are, however, considerable problems in measuring and valuing nonmarket contributions from and to nature and in double counting the external economies and diseconomies of these contributions that are already reflected as productivity changes in the production accounts.

Indicators of Sustainable Product and Expenditure

The environmental accounts described above produce aggregates that can be used to modify the value added or the value of gross production created, and the amount of expenditures allocated for consumption and investment by those transactors of the economy that use or protect natural resources and environmental services. Accordingly, the following new concepts of gross and net domestic product, income and expenditure have been proposed to supplement traditional GDP or NDP calculations.[4]

Sustainable Net Product and Expenditure

Correcting national income for changes in the net resource position, which is obtained from accounting for depletion and the increase in the stock of natural resources, has been proposed for calculating indicators of sustainable income or product (see "Natural Resource Capital," above). It has been argued, however, that geological discoveries of natural resources can be neglected, since they do not reverse the process of depletion but extend only the period over which depletion can continue. Consequently, if the depreciation concept were extended to the consumption of natural capital by resource-exploiting industries, it would account sufficiently for sustainability in a measure of sustainable product (Daly, Chapter 2).

The valuation of natural resource stocks could be based on the principle of replacement costs or willingness to pay. However, changes in the value of environmental assets can result from both physical depreciation and capital loss or gain, as, for example, with increasingly heavy use of a natural resource, such as the use of a water body for fishing and recreation. In theory, valuation of capital loss or gain should be based therefore on the marginal benefits of uses (Peskin, Chapter 10).

The extension of the depreciation principle to the consumption of natural capital affects the net value added of industries that exploit natural resources and thus the NDP. In addition, defensive expenditures have been considered as intermediate rather than final consumption, and the further deduction of such expenditures from net national product has been proposed. This procedure would yield a new indicator, which has been termed "sustainable social net national product" (Daly, Chapter 2).

Such sweeping treatment, however, loses track of the accounting identity between national income (the sum of value added created in production) and national product (the value of final demand) because defensive expenditures contain elements of both intermediate and final consumption and capital formation. A new, more systematic approach to dealing with (deducting) defensive expenditures has therefore been proposed in a draft SNA Framework for Environmental Satellite Accounting (Bartelmus and van Tongeren 1988). The idea is to reduce the production boundary of the SNA by covering only nonenvironmental activities and thus excluding all production of environmental goods (filters, chemicals, or waste disposal plants) and services (protecting or restoring the quality of the environment) that are used in intermediate and final demand. In this manner, value added and final demand are adjusted to obtain identical total values. Further allowance for the depreciation of natural resource assets then obtains a measure that could be termed "sustainable net national expenditure" (SNNE).[5]

As an alternative, the joint UNEP/World Bank Expert Group Meeting in Paris (November 1988) suggested applying a wider concept of depreciation to calculate "environmentally adjusted net domestic product." This concept would include both the depletion of the environmental "stock" assets of natural resources and the degradation in the quality of "permanent" environmental assets. The depreciation of environmental quality could be estimated as the difference between actual defensive expenditure and the cost of restoring environmental quality to the level at the beginning of the accounting period (in other words, "potential" defensive expenditures). However, such a procedure neither accounts for the "inflation" of NDP by defensive expenditures nor reflects actual environmental degradation or damage. Clearly, more research is needed to clarify the relations between damage costs (expenditures) and actual damage as well as their implications for environmental accounting.

Sustainable Gross Product and Expenditure

Unfortunately, net product is infrequently calculated and rarely used in quantitative economic analysis because of the well-known difficulties of estimating depreciation. Therefore, GDP has usually received more attention in economic planning and policy, under the assumption that the gross and net indicators move similarly over time. The adjustment of gross rather than net product or income has therefore been suggested to obtain a measure of "sustainable gross domestic product" (SGDP) or "sustainable gross domestic expenditure" (SGDE).

The draft SNA Framework for Environmental Satellite Accounting proposes to calculate SGDP by accounting for the exploitation of natural resources as intermediate consumption of different production activities and deducting a corresponding amount from final demand as a change in "environmental assets."[6] For estimating the amount of intermediate consumption to be deducted from the gross output of resource-exploiting industries, the calculation of a so-called user cost allowance has been advocated (El Serafy, Chapter 3). User costs calculations avoid the difficulties of estimating physical or value depreciation by allocating a certain amount of the receipts from extractive industries to an actual (Ward 1982) or hypothetical fund, which, if invested, would "create a perpetual stream of income that would provide the same level of true income, both during the life of the resource as well as after the resource has been exhausted" (El Serafy, Chapter 3). Discoveries are simply dealt with by changing the parameters of the life expectancy of the resource, that is, the resource-extraction ratio.[7] SGDE is derived from SGDP by deducting additionally defensive expenditures of environmental protection. An approach for deducting defensive expenditures without violating accounting identities was described above (see "Sustainable Net Product and Expenditure").

Modified Gross or Net Product

The accounting for environmental services and damages (or their difference, that is, the net environmental loss or benefit) has been described as the result of introducing a natural production account that modifies gross output in the production accounts. This procedure would yield a "modified gross national product" (Peskin, Chapter 10). Deducting environmental and other economic depreciation from this aggregate produces a "modified net domestic product," which would account for environmental degradation as well as resource depletion. Considerable problems of measuring and valuing environmental services and damages will probably make the estimation of these indicators the object of research studies rather than of routine compilation in environmental accounts.

Future Work

As indicated at the beginning of this chapter, worldwide concern with the sustainability of current patterns of production and consumption has raised doubts about the suitability of standard accounting and its main aggregates for integrated socioeconomic and environmentally sound planning and policies. In this context, the World Commission on Environment and Development drew attention to the need to shift emphasis from the standard environmental policy of dealing with environmental effects after they occurred to "an approach concentrating on the policies that are the sources of those effects" (World Commission

1987, p. 310). Such policies should be assessed by indicators that present socioeconomic progress net of all environmental costs. Up to now these costs have generally been neglected or wrongly accounted for in the standard macroeconomic aggregates.

The obvious place to develop and standardize concepts and procedures of environmental accounting is the existing standard System of National Accounts, the SNA. The ongoing revision of the SNA provides a unique opportunity to examine how the concepts, definitions, classifications, and tabulations recently developed in the fields of environmental and resource accounting can be related to, or integrated in, the SNA. At the current stage of development it might be premature, however, to radically change a well-established system of data collection and accounting that serves many different short-, medium-, and long-term socioeconomic analyses.[8] Therefore, standards for environmental and resource accounting should be further elaborated in a satellite system of environmental accounts of the SNA. Efficient linkage will require some amendments to the existing classifications as well as explanations of, or cross-references to, alternative concepts and tabulations in the core recommendations of the SNA.

A first draft of the SNA Framework for Environmental Satellite Accounting was discussed by the joint UNEP/World Bank Expert Group Meeting on Environmental Accounting and the SNA, and several recommendations were made.

- The revised SNA should provide a place for environmental accounts within the overall system and should discuss the fact that conventional income and product measures do not reflect environmental degradation and depletion of natural resources.
- Environmental accounting should be presented as satellite accounts and not in the SNA itself.
- Functional classifications should be developed that identify separately environmental goods and services, in particular in COFOG, CPC, COIP, and ISIC.
- Environmental resources that cannot be valued as stocks should be listed in the form of an inventory that may include indicators of physical quantity and quality.
- A first step toward measuring sustainable income and product should be to deduct the depletion and degradation of environmental assets; further research on deducting defensive expenditures is required.

The meeting also suggested that further work be undertaken toward a draft manual through pilot-type case studies and the evaluation of existing resource accounting systems in industrial countries. The UNSO has included the preparation of a handbook on environmental satellite accounting in its work program and will collaborate closely with the World Bank, UNEP, and other organizations in this effort.

Notes

1. For a further discussion of the concept of sustainable development, see Bartelmus (1987a).
2. See, however, Bartelmus (1987b), who proposed to apply the generic principles of the FDES to the SNA and the SSDS to develop an "overall framework for statistical integration."
3. The term "satellite accounts" is used here in a broad sense to include, besides outlays and financial resources for environmental protection (as presented in environmental satellite accounts in the narrow sense; see, for example, INSEE 1986b), costs and benefits of environmental impacts and resource depletion or discovery.
4. Of course, these modifications apply also to national product and income (adding net factor income from abroad); these indicators are less frequently used, however, and, unless otherwise indicated, reference is made to domestic product only.
5. Even though accounting identities are maintained by this procedure of deducting defensive expenditures, several assumptions make the meaning of SNNE somewhat ambiguous, especially for ex-ante analysis. The first assumption is that environmental production is not replaced by nonenvironmental production. This is realistic only if SNNE is to reflect the aggregate value of nonenvironmental income ex post. If it is to approximate potential income, however, and refer to a situation free of environmental distortions, one could assume that factor inputs released from environmental production would have been used to generate additional income. In addition, the above definition of defensive expenditures does not account for indirect effects, that is, the employment of nonenvironmental goods and services in the supply of goods and services related to defensive expenditures.
6. Changes in environmental assets introduce a new element into final demand, which replaces the concept of capital accumulation with a new concept of "changes in tangible wealth."
7. Another possibility is to consider discoveries of new resources as the creation of an asset and to record this activity as own-account capital formation of the mining industry (OECD 1985).
8. At least, this appears to be the view of the experts working on the current revision of the SNA, who concluded that "no major conceptual changes in the SNA should be introduced" (United Nations 1986, p. 6).

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Recent Developments and Future Work

Ernst Lutz and Salah El Serafy

The System of National Accounts (SNA) that is currently in use is based on a document published more than twenty years ago (United Nations 1968). A revision of this system was started in the early 1980s, with a number of expert groups looking at various issues and considering how improvements could be made with as little disturbance to the SNA core system as possible. The revisions are scheduled to be completed by 1991, at which time a new version would be issued.

Given the shortcomings of the current system with respect to the environment and natural resources, the question is how to reach the long-term goal of making the necessary changes so that national income accounting more accurately represents true, sustainable income. Some, at least in the past, have argued for radical changes, while others have supported more gradual changes that would improve income estimates by moving them in the right direction. Although it is clearly desirable to make improvements as soon as possible, some outstanding conceptual issues are yet to be resolved, and much empirical work must still be done before specific recommendations for changes in the core of the SNA can be made. In the meantime, the creation of satellite accounts appears to be the only realistic option for progress in this area.

SNA Expert Group Meeting (Vienna, March 1988)

In the context of deliberations over whether and in what way the SNA should be revised, the World Bank presented a discussion note to the SNA expert group meeting held in March 1988 in Vienna under the agenda item "Links between SNA and Environment Statistics." The note focused on the two main concerns elaborated in Chapter 1: defensive expenditures and the depletion and degradation of natural resources.

For defensive expenditures, the Bank recommended that the experts:

- Discuss and, as soon as feasible, decide which expenditures are to be included under "defensive expenditures"
- Agree that these are to be shown as a separate line item
- Decide where the adjustments are to be made and where the adjusted aggregates are to be shown (in satellite accounts or in the main system of production, consumption, and accumulation accounts).

On the issue of resource depletion and degradation, the Bank recommended that the expert group:

- Adopt the principle of SNA-linked satellite accounts, where adjustments for resource depletion and degradation can be made
- Advise countries where a significant portion of gross national product (GNP) is based on the depletion or degradation of natural resources that current income, as calculated at present, overestimates sustainable income and that policymakers should explicitly be alerted to this fact
- Encourage work on estimating the costs and benefits of resource depletion and degradation.

The members of the group agreed that these two issues are of great importance and indicated that they shared the Bank's concern about the environment and supported the construction of satellite accounts linked with the SNA, as well as the development within the central SNA framework of the functional classification of government expenditures (COFOG) and enterprise expenditures (COIP) in order to identify expenditures relevant to environmental analysis. However, they did not agree to changing the core accounts of the SNA in any fundamental way. Three reasons were given for this.

Note: The annex was written by Jan W. van Tongeren.

- Since there are various conceptual approaches that could be taken for revising the SNA, a consensus should be reached before the core SNA is revised.
- In the environmental field many valuation issues are difficult, and more work is required before standard valuation techniques can be applied.
- The group was pleased that a list of papers presented at the joint UNEP/World Bank workshops was attached to the Bank's position paper. But since they had not seen them before because of the limited communication so far between environmentalists and national accountants, they did not know what the issues and options were (and this supported the urgent need for producing this volume).

As a concession to the environmental community, the chairman stated that if and when adequate experience has been gained with satellite accounts and when various conceptual and valuation issues have been resolved, the national accountants should be open to an SNA revision, even if that was much sooner than the twenty-year period between the last and the current revision.

During the discussion some other points were made by various participants.

- Users should be cautioned about the gross domestic product (GDP) as calculated at present; the revised SNA manual ("blue book") should include a discussion of the shortcomings of the GDP and state necessary warnings against its indiscriminate use.
- Communication between national accountants and environmental economists should be encouraged so that problems can be discussed jointly.
- Approximations that may be needed in environmental accounting may not be worse than some current arbitrary estimations already sanctioned by the SNA.
- The SNA should be linked not only with environmental statistics but with social statistics as well.

At the end of the meeting the group agreed that these issues would have to be discussed again and that preferably national accountants and resource economists should address them together. A meeting combining the two groups was held in November 1988, as described below.

Joint UNEP–World Bank Expert Meeting on Environmental Accounting and the SNA (Paris, November 1988)

National accounts experts and environmental economists met in Paris to discuss a draft framework for a proposed set of environmental satellite accounts (Bartelmus and van Tongeren 1988). Both groups were willing to learn, the meeting was very productive, and a consensus was reached on several points.

- Natural resources and the environment are important and are likely to become more so in the future, so they should be properly accounted for.
- As presently calculated, GDP is not a comprehensive indicator that can satisfy adequately a diversity of needs, and its shortcomings should be kept firmly in mind.
- Replacing GDP with a more sustainable measure of income is not yet feasible. For the time being, therefore, satellite accounts linked to the SNA should be created in which adjustments and alternative computations can be made.
- The revised version of the "blue book" (the volume describing the core accounts of the SNA), to be issued in 1991, should have a section in which satellite accounts for the environment are outlined.
- For the environment, net measures, such as net domestic product (NDP), may be more meaningful and should be emphasized more than gross measurements, such as GDP.
- Further developments of the draft framework might deal with various assets such as air, water, and land separately, since a uniform treatment may not be possible.
- A classification of intermediate consumption by function (COIP) and government expenditure by function (COFOG) should be developed where "environmental goods and services" are identified.
- Accounting for stocks of natural resources should be done in physical terms, not in monetary terms; monetary estimations, however, should be attempted for changes in the stock of resources within the period under consideration.
- For exploitable, commercially salable resources such as minerals, a user cost approach, such as the one proposed by El Serafy, should be followed (Chapter 3).
- For "permanent" resources, such as air, water, and soil, two options should continue to be pursued simultaneously: treating restoration costs as intermediate expenditures rather than as final ones, as is generally done in the SNA, and treating damages to "permanent" resources as consumption of natural capital.
- Two (or possibly three) NDPs should be computed:

GDP − consumption/depreciation of man-made capital = NDP^1

NDP^1 − consumption/depreciation of natural capital = NDP^2.

- Further research is necessary to decide what deductions for defensive expenditure would be appropriate to produce NDP^3.

These points of agreement were communicated to the SNA expert meeting later held in Luxemburg, which is described below.

SNA Expert Group Meeting (Luxemburg, January 1989)

This was the last expert meeting of many held during the past few years on the revision of the SNA before an actual complete draft of the new "blue book" is considered. Many outstanding issues had to be decided. On the issue of the environment, the meeting endorsed the creation of environmental satellite accounts linked with the SNA. It was decided that the new "blue book" will describe these, and further research in this important area was encouraged. In another context, as far as the concept of income is concerned, the meeting adopted the Hicksian definition (See Daly, Chapter 2 and El Serafy, Chapter 3), with a minor addition, as a basis for defining the coverage and treatment of capital flows. Accordingly, income is the maximum an individual (or nation) can consume during a period while keeping intact the stock of capital at the beginning of the period as well as any net additions to capital during the period. The explicit adoption of this concept does not imply, however, that the central SNA framework has fully adopted the concept of sustainable income.

As a matter of fact:

- GDP will continue to be defined under the revised SNA without adjustment for the degradation of natural capital from the process of production and consumption.
- The use of nonrenewable subsoil assets will not be taken into account in defining value added.

An alternative sustainable income concept to GDP therefore will have to be elaborated in a separate handbook on environmental accounting.

A description of the current treatment of nonreproducible assets, stocks, and flows in the SNA and a proposal for its modification was circulated as a background document; it is reproduced as the annex to this chapter. The proposal is very important from an environmental point of view, but there was no time to discuss it at the meeting.

Future Work

Inducing production and consumption practices with less negative effects on the environment worldwide is a formidable task. Changes are needed in policies, programs, projects, institutions, the distribution of income and wealth, and human behavior. But necessary changes are often slow in coming. Improvements in any one area can make only a partial contribution to an approach where many parallel activities are needed to achieve development that is both equitable and environmentally sound. Environmental accounting is only one of many tools that are needed, and, given the lack of past effort, it will take time to develop it into an effective tool to improve policymaking. Nevertheless, serious work in this area should now be pursued actively and vigorously.

After several years with little visible progress, some steps forward have been made recently in the field of environmental and resource accounting. But much more remains to be done both at the conceptual as well as the practical levels.

- Draft manual/handbook. The Bartelmus-van Tongeren "Draft Framework for Environmental Satellite Accounting" needs to be developed into a draft manual and eventually into a handbook in the handbook series of the SNA.
- Evaluation of existing schemes. Currently, several industrial countries (Canada, France, Federal Republic of Germany, Japan, Netherlands, Norway, and the United States) have developed or are developing resource accounting systems. Each of those approaches should be evaluated and any general lessons identified.
- Pilot case studies in developing countries. These pilot projects would: try out the Bartelmus-van Tongeren framework in several countries with different natural and environmental resource problems and perhaps in one or two industrial countries with the most available data, provide lessons for integration into the draft manual, and determine the policy implications of the improved income accounting.
- Working group and expert meetings. The authors of the draft manual and the persons involved in the pilot studies should meet to review the draft manual. The resulting revision would subsequently be presented to an expert meeting and afterward be developed into a handbook.
- In-depth case studies on developing countries. Contrary to the pilot studies, the in-depth case studies would involve new data generation and longer-term institution building.
- Physical resource accounting. UNEP has already done considerable work in this area, but further effort is needed to assess the environment and natural resource base, its changes in quantity and quality, and its linkage to monetary accounting.

It is foreseen that these tasks, as well as other possible ones, would be undertaken cooperatively by the World Bank, the U.N. Statistical Office (UNSO), the U.N. Development Programme (UNDP), and UNEP, along with interested foundations (including the Ford Foundation and the Noyes Foundation), bilateral donors, nongovernmental organizations, and developing-country governments.

Annex. The Treatment of Nonreproducible Assets, Stocks, and Flows under Present SNA and "M.60 Standards" for Reconciliation Accounts

M.60 is an important document from the point of view of environmental analysis because it includes a framework and supplementary guidelines for developing resource balances (stocks and flows) that are compatible with the SNA. Since M.60 was developed much later than the SNA, however, it reflects some advances in the field that were not available when the 1968 SNA was drafted. Therefore there are several incompatibilities between the SNA and M.60 that should be addressed during the present SNA revision.

The general rule in the SNA and M.60 is that changes in nonreproducible assets are recorded in the capital (flow) accounts when a transaction (a purchase or sale) occurs and in the present M.60 reconciliation accounts when other changes occur in the asset balances. In addition to price changes, the latter include changes from new finds, growth, destruction, and depletion of assets (see Chapter 11). The value of nonreproducible assets in the balance sheet and reconciliation accounts when there is no sale is based on actual values of similar assets that are sold (such as for land) or on the sum of discounted future values (such as for timber tracts and mineral deposits).

The general rules are not applied uniformly to all assets and are unclear for some. The actual treatment distinguishes among land; historical monuments; timber tracts and forests; plantations and orchards; cultivated agricultural products; livestock for dairy, breeding, and draft; and livestock for meat production.

Specific Applications of the General Rule

- Natural resources in the public domain are entirely excluded.
- Land and historical monuments are included in the balance sheets only after an actual sale. This implies that only entries for changes in these assets are recorded in the M.60 reconciliation accounts if sales take place.
- For mineral resources, new finds as well as depletion are recorded in the present M.60 reconciliation accounts. It is not clear, however, what the exact coverage of the new finds is; does it include all new finds, does it include only those mineral deposits that are actually mined, or is there some intermediate type of coverage for new finds?
- Natural growth minus depletion of timber, plantations, orchards, and so forth is recorded in the reconciliation accounts. There is no link between this treatment in the balance sheets and production, which is recorded only when timber is logged and when orchard and plantation production is harvested.
- The growth of livestock is included, on the one hand, as an item in the M.60 reconciliation accounts (together with the other natural growth items mention above) and, on the other hand, as either gross fixed capital formation (for animals for dairy, breeding, draft, and so forth) or changes in stocks (for animals for meat production). These two treatments seem contradictory.
- Agricultural production is not reflected in the balance sheets or reconciliation accounts and is not registered as changes in stocks during the growth process. It is recorded as man-made production after it is harvested.

Proposed Modifications

The following modifications would make the above treatments more consistent.

- Nonreproducible assets should be included in the balance sheets when they are marketed and their use in human production activities generates product and income. This implies that land should be included when it is used for agriculture, human settlement, and so forth and that income should be reflected in GDP, GNP, or national income, either as a result of marketed or imputed production, including own-account agricultural output and imputed dwellings services to owners. For the same reason, historical monuments should be included in the balance sheets as soon as the assets generate identifiable income. In other words, assets should not be included when they are marketed but when they are actually used for production and other activities that produce flows registered elsewhere in the SNA. It is important to establish this link between income and production, on the one hand, and the assets used in production, on the other, to arrive at correct capital-output ratios and other measures of productivity.
- The natural growth of agricultural products, products of plantations and orchards, timber, and livestock for dairy, breeding, and meat production should be recorded as gross output at the moment of growth and not at the moment of harvest (for products of agriculture, plantations, and orchards), logging (for timber), or birth (for livestock). During growth, the production should be reflected in changes in stocks, and, once allocated to uses, the stocks should be reduced again. This treatment would eliminate from the present M.60 reconciliation accounts the entries for natural growth minus depletion and would channel these entries through all changes in stocks, except for livestock growth used for dairy, breeding, and similar purposes, which would be allocated to gross fixed capital formation. This proposed treatment is an extension of the treatment for agricultural products suggested by the November 1988 meeting in Buenos Aires organized jointly by the Economic Commission for Latin America (ECLAC/CEPAL) and the Monetary Center for Latin America (MCLA/CEMLA). That suggestion was made to better link gross output and cost in agricultural production, particularly under high inflation. Similar arguments would hold for all the other products of natural growth mentioned above.

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Appendix
Participants at the UNEP–World Bank Workshops

The affiliations given were those at the time the workshops were held.

First Workshop, Geneva, February 23–25, 1983

Chairman: Yusuf J. Ahmad, UNEP, Nairobi, Kenya

Contributors

Anthony Friend, Statistics Canada, Ottawa, Canada. "Natural Resource Accounting: International Experience."

Per Garnasjordet, Central Bureau of Statistics, Oslo, Norway. "Resource Accounts: The Norwegian Experience."

Roefie Hueting, Central Bureau of Statistics, Voorburg, Netherlands. "Use of Environmental Data in Economic Decisions: Netherlands."

Henry M. Peskin, Resources for the Future, Washington, D.C., U.S.A. "National Income Accounts and the Environment."

Michel Poitier, Environment Directorate, OECD, Paris, France. "National Resource Accounts: OECD."

Walter Spofford, Resources for the Future, Washington, D.C., U.S.A. "Environment and Development."

Jacques Theys, Ministry of Environment, Paris, France. "Natural Resource Accounts: France."

Atsushi Yoshikawa, Environment Agency, Tokyo, Japan. "Macroeconomic Accounting for the Environment and the Quality of Life."

Other Participants

Partha Dasgupta, London School of Economics, United Kingdom

Robert Goodland, World Bank, Washington D.C., U.S.A.

Second Workshop, Washington, D.C., November 5–7, 1984

Chairman: Yusuf J. Ahmad, UNEP, Nairobi, Kenya

Rapporteurs: John Dixon, East-West Center, University of Hawaii, Honolulu, U.S.A.; and Richard B. Norgaard, University of California, Berkeley, U.S.A.

Contributors

Robert Goodland and George Ledec, World Bank, Washington, D.C., U.S.A. "Neoclassical Economics and Principles of Sustainable Development."

Roefie Hueting, Central Bureau of Statistics, Voorburg, Netherlands. "Economic Aspects of Environmental Accounting."

Richard B. Norgaard and John Dixon, University of California, Berkeley, and University of Hawaii, Honolulu (respectively), U.S.A. "Project Design and Evaluation Using Economic and Coevolutionary Criteria."

Jacques Theys, Ministry of the Environment, Paris, France. "Environmental Accounting and Its Use in Development Policy."

Other Participants

Ali Al-Damkhi, Environment Protection Council, Safat, Kuwait

Ali Al-Juwaiser, Saudi Fund for Development, Riyadh, Saudi Arabia

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Jeremy Warford, World Bank, Washington, D.C., U.S.A.

Ted Wolf, Worldwatch Institute, Washington, D.C., U.S.A.

Third Workshop, Paris, September 30–October 2, 1985

Co-chairmen: Yusuf J. Ahmad, UNEP, Nairobi, Kenya, and Robert Goodland, World Bank, Washington, D.C., U.S.A.

Rapporteur: Salah El Serafy, World Bank, Washington, D.C., U.S.A.

Contributors

Herman E. Daly, Louisiana State University, Baton Rouge, U.S.A. "A Modest Proposal for a Modest Start in Modestly Relating Environmental and Economic Accounts."

John Dixon (with Richard Carpenter, Louise Fallon, Paul Sherman, and Supachit Manopimoke), East-West Center, University of Hawaii, U.S.A.. "Economic Measurement of Environmental Effects."

Huib Jansen and J. B. Vos, Free University, Amsterdam, Netherlands. "Indicators for Environmental Problems in Developing Countries."

Richard B. Norgaard, University of California, Berkeley, U.S.A. "Linking Environmental and National Income Accounts."

Jacques Theys, Ministry of the Environment, Paris France. "Environmental Accounts and Development Planning: Proposals for a Programme of Action."

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Fourth Workshop, Washington, D.C., November 17–18, 1986

Chairman: Salah El Serafy, World Bank, Washington, D.C., U.S.A.

Rapporteur: Derek W. Blades, OECD, Paris, France

Contributors

Peter Bartelmus, UNSO, New York, U.S.A.. "Environmental Accounting and the SNA."

Derek W. Blades, OECD, Paris, France. "Environmental Statistics and the National Accounts."

Herman E. Daly, Louisiana State University, Baton Rouge, La., U.S.A. "Toward a Measure of Sustainable Social Net National Product."

Salah El Serafy, World Bank, Washington, D.C., U.S.A. "The Proper Calculation of Income from Depletable Natural Resources."

Anthony Friend, Statistics Canada, Ottawa, Canada. "Natural Resource Accounting: A Canadian Perspective."

Roefie Hueting, Central Bureau of Statistics, Voorburg, Netherlands. "Possibilities for Incorporating Changes in the Environment, Including Natural Resources, in the National Income."

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Robert Repetto, World Resources Institute, Washington, D.C., U.S.A.

Sophie Schlingemann, UNEP, Nairobi, Kenya

Fifth Workshop, Paris, November 20–21, 1986

Chairmen: Jacques Theys, Ministry of Environment, Paris; and Yusuf J. Ahmad, UNEP, Nairobi, Kenya

Rapporteur: Per Garnasjordet, Central Bureau of Statistics, Oslo, Norway

Contributors

A. Gilbert and W. Hufkamp, Free University, Amsterdam, Netherlands. "Natural Resource Accounting in a Multi-Objective Context."

Roefie Hueting, Central Bureau of Statistics, Voorburg, Netherlands, in cooperation with N. Yunus, University of Indonesia, Jakarta. "A Note on the Construction of an Environmental Indicator in Monetary Terms as a Supplement to National Income with the Aid of Basic Environmental Statistics."

H. Jansen and B. Vos, Free University, Amsterdam, Netherlands. "Indicators for Assessments of Sustainable Development."

T. Loikkanen, Ministry of the Environment, Helsinki, Finland. "Environmental Accounting Developments in Finland."

I. M. Naredo, Madrid, Spain. "Caracteristiques des Approches Economiques Necessaire pour Tenir Compte des Resources Naturelles (Comparison avec le Systeme Standard)."

J. L. Weber, Ministry of Research, Neuilly, France. "Les Comptes du Patrimoine Naturel (Presentation Succinte d'Experience Francaise."

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Expert Meeting, Paris, November 21–22, 1988

Chairman: Salah El Serafy, World Bank, Washington, D.C., U.S.A.

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THE WORLD BANK

That the pressures for development may cause long-term damage to the environment and the natural resource base has become of increasing concern to environmentalists and economists alike. A great deal of work is now being done to clarify the linkages between development and the environment. Such work should make it possible to integrate concerns about environmental and natural resource management more effectively into the process of economic analysis and decisionmaking.

An important problem has been that current calculations of gross domestic product (GDP), the most commonly used indicator of national economic performance, ignore the degradation of the natural resource base and view the sale of nonrenewable resources entirely as income. The papers in this volume were selected from a series of international conferences jointly organized by the United Nations Environment Programme (UNEP) and the World Bank during the past six years. The authors are either economists, who argue that present methods for calculating national income fail to reflect the consumption of natural capital and that present practices inflate income from defensive environmental expenditures, or they are income statisticians, who offer ways to adjust for shortcomings in systems of national accounting.

The combination of economic and statistical perspectives on environmental and resource accounting provided in this volume is rare. Throughout, the environment is treated as natural capital that needs to be accounted for and maintained. The authors both deal with the conceptual side of accounting and propose a variety of methods to help produce better measurements of income, which, in turn, could better guide economic policies in general and also encourage a more sustainable use of natural resources.

Yusuf J. Ahmad is senior adviser to the executive director of the United Nations Environment Programme, Salah El Serafy is economic adviser on the Economic Advisory Staff in the Office of the Senior Vice President–Operations at the World Bank, and Ernst Lutz is a senior economist in the Environment Department, also at the World Bank.

ISBN 0-8213-1224-3