THE WORLD BANK

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Environment Department

A Survey of Resource and Environmental Accounting in Industrialized Countries

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August 1990

Environment Working Paper No. 37

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Acknowledgements and Disclaimer

Henry M. Peskin is a Consultant to the Environmental Policy and Research Division. This survey represents a part of a World Bank research project which is exploring improved methods of accounting for natural resources and the environment. The project is under the supervision of Ernst Lutz, who commented in detail on earlier drafts, collected and provided survey materials, and made many useful suggestions for which the author is extremely appreciative.

The author benefited greatly from assistance provided by those directly involved in resource and environmental accounting projects in various countries. He appreciates their timely response to requests for information as well as comments on an earlier draft. He wishes particularly to thank Tony Friend, Kirk Hamilton, Roefie Hueting, David James, Lorents Lorentsen, Thorvald Moe, Michel Potier, Gary Rutledge, Per Schreiner, Udo E. Simonis, Carsten Stahmer, Jean-Louis Weber, Jan Wright, and Mike Young. Comments are also acknowledged from Salah El Serafy, John English, and Michael Ward of the World Bank. Of course, the characterizations of the various country efforts are those of the author and any conclusions or recommendations are solely his responsibility. The paper reports on findings that are particularly significant in the context of the overall work program of the Environmental Policy and Research Division.

A SURVEY OF RESOURCE AND ENVIRONMENTAL ACCOUNTING IN INDUSTRIALIZED COUNTRIES

Abstract

Several industrialized countries have explored or are in the process of developing alternative methods to account for the economic implications of environmental degradation and resource depletion. There is a general perception that the conventional national accounts reflect environmental and resource changes poorly and thus may generate estimates of income levels and growth that are not sustainable. Because of their often severe resource and environmental problems, similar concerns are being expressed in the developing world. Should these countries decide to undertake their own programs in resource and environmental accounting, they may benefit from the experience being gained in the industrialized countries.

The purpose of this report is to survey accounting efforts in several industrialized countries and to evaluate them to the extent possible, with the understanding that many of the programs are in their initial stages and are, thus, undergoing continual revision. All the approaches surveyed can be classified into four groups. The first approach involves the identification of pollution-abatement and other environmental expenditures. This approach characterizes official efforts in the United States, although similar statistics have been prepared in France, Germany, and the Netherlands. A second approach is to account for flows of and changes in the stocks of resources using physical units of measure. Most of the Norwegian resource accounting activities are along these lines. Similar physical accounts also exist in France. A third approach is to adjust GNP and NNP by subtracting out the value of natural resource depletion. This technique has been applied in Indonesia by Robert Repetto and his associates at the World Resources Institute. Similar activities are underway in China and Costa Rica. Finally, there are approaches that attempt a comprehensive resource and environmental accounting in both physical and value terms. Early Dutch efforts and the approaches of Peskin and of staff members of the U.N. Statistical Office fall into this category.

These various accounting approaches are described in terms of how they respond to perceived deficiencies in the standard economic accounts. Problems of implementation are also identified. The report then focuses more directly on the various country efforts and, in particular, their objectives and their data needs.

The principal findings of the survey are as follows:

1. Most approaches attempt to address one or both of the two major functions of conventional national accounting (performance measurement and data framework).

2. Regardless of the intent of the various approaches, they may better succeed in addressing one function more than the other. Thus, each approach should be judged on its actual as much as its intended outcome.

3. The approaches differ significantly in their complexity and coverage.

4. The differences in complexity and coverage reflect not only the relative emphasis on the two major functions of national accounting but also different policy objectives.

5. While the approaches may have different structures, reflecting their different emphases and policy objectives, they may be similar in their data requirements. Thus, extensive debate over the relative merits of each approach, as a prerequisite to implementation, may be unnecessary or even counterproductive.

6. Because of missing information--especially regarding data development costs--it was not possible to determine the cost-effectiveness of the various country efforts and the implications of these efforts for policy-making.

Because many resource and environmental accounting programs are still in their initial stages in the industrialized countries, there is, at present, little applicable experience that can be immediately transferred to developing countries. However, the findings suggest that, should a developing country wish pursue its own program of resource and environmental accounting, it need not make a firm commitment to any particular accounting approach before data development begins. Data collected to support an initial approach most likely will support alternative choices in the future and may be valuable for other purposes as well. A final decision regarding framework or system design and the depth to which the approach is implemented should reflect a comparison of the individual country's policy needs with the resources it can devote to data development.

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A SURVEY OF RESOURCE AND ENVIRONMENTAL ACCOUNTING IN INDUSTRIALIZED COUNTRIES

Introduction

In response to concerns about the ability of conventional national accounting systems to reflect adequately resource depletion and environmental degradation, several industrialized nations have embarked on programs of research with the objective of developing improved resource and environmental accounting approaches. The overall goal of these programs is to supplement the conventional economic accounts, which generally follow the accounting patterns recommended by the United Nations System of National Accounts (SNA), with supplementary or satellite accounts that will address the environmental and natural resource concerns.

Since many developing nations have both heavily resource-based economies and severe environmental quality problems, their need for improved resource and environmental accounting may even be greater than is the need in the industrialized world. While there is good reason to believe that there is no single resource and environmental accounting approach that is immediately transferable and is applicable to all developing nations, it is likely that the eventual choice will contain elements from one or more of the approaches being adopted in industrialized countries. Therefore, as developing countries formulate their own solutions, they should find the experience of the industrialized nations helpful.

Accordingly, the purpose of this report is to describe current and planned efforts to make national economic accounting systems more responsive to changes in the environment and natural resources, and to point out those aspects of alternative approaches that may or may not have relevance for the developing world. It should be emphasized that any comparisons made between approaches are for the purpose of exposition. The intent is not to "rank" the approaches. Nor is it the intent of this report to recommend any particular framework, system, or approach.

Scope of the Survey

There are no standard definitions of resource and environmental accounting approaches. The term "environmental accounting" could be used, for example, in the general sense of "taking account of the environment" or in the much more specific sense of setting up some sort of double-entry bookkeeping of environmental activity. This survey covers approaches that are less general than the former but not quite as specific as the latter. Specifically, it only covers those approaches that attempt to correct deficiencies in the conventional economic accounts. In principle, the approaches could range from those that require a major restructuring of the conventional economic accounts to those that only call for separate ("satellite") physical natural resource accounts with indirect links to the conventional economic accounts. In practice, most the surveyed approaches are closer to the latter than the former.

It should be noted that the perceived deficiencies in the standard economic accounts could refer to account aggregates that, because of their neglect of resources and the environment, appear misleading either as measures of economic activity or of economic well-being. On the other hand, the deficiencies could refer to possible weakness in the standard accounts in their role as an information system. Some of the surveyed approaches address the former, some the latter, and some both.

Indeed, before one makes any judgments about these approaches, the dual role of the national accounts should not be forgotten. Because these approaches can both generate alternative measures of economic performance and serve as an information system, it is possible to take exception to the way the approach is used to create new indexes of economic performance, but still rate the approach highly valuable in terms of its coverage of environmental and resource degradation.

In general, the focus of the survey is on those resource and environmental accounting efforts taking place, that have taken place, or will soon to take place within (or with support of) official governmental agencies of the following countries: Australia, Canada, France, Japan, The Netherlands, Norway, West Germany, and the United States.[1] However, because they provide useful points for comparison and because some of their features have been applied to developing countries or are under consideration for adoption, three other accounting approaches, which are not country-specific, will also be covered: the approaches of Peskin, Repetto, and the United Nations Statistical Office.

The survey depended primarily on written materials such as reports, letters, and official publications, and mainly those available in English. It is confined to more or less "official" accounting efforts. University-sponsored and private research by country nationals is not covered. To be considered "official", the work must be conducted under the auspices of as governmental agency--usually a statistical bureau--and be part of a governmental program. It is recognized, however, that the degree of commitment by countries may differ as evidenced by different staffing levels, financial support, and by different project longevity. By these criteria, one might conclude that the Norwegian effort is more "official" than, say, the Dutch or French effort, with the Japanese effort the least "official" of the group.

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[1] The selection of countries was partly based on our knowledge of existing approaches and on studies readily available to the World Bank and the author. Reviewers have pointed out that there are similar efforts underway in New Zealand, Sweden, Czechoslovakia, Hungary, Finland, Portugal, and Spain. Some of these efforts are briefly described in (ECE, 1990). Work is also underway in China using an approach similar to that of Robert Repetto (see Appendix II), but with far more reliance on labor-cost as opposed to market valuations.

Brief Overview of Country Approaches

This section provides a brief overview of the accounting approaches in place or under consideration in the countries surveyed. Also briefly described are other approaches suggested by Peskin, Repetto, and researchers in the United Nations Statistical Office. More detailed and critical assessments may be found in Appendices I and II.

Australia

Presently, there are no official resource and environmental accounting initiatives underway at the Federal or state level. However, there is extensive interest in several official agencies and commissions including the Department of the Environment, the Bureau of Rural Resources, and the Resource Assessment Commission. The Australian Bureau of Statistics supports the concept of satellite accounts to the SNA but is awaiting specific guidance from the United Nations.

Canada

Statistics Canada is initiating a program on resource and environmental accounting including the development of satellite accounts. The principal objectives are to assess resource quality and quantity, to provide a framework for the development of environmental data, and to improve measures of economic sustainability. There may be parallel efforts under consideration at Environment Canada.

Initial emphasis appears to be on the assembly of data on pollution-abatement expenditures and on the tracking of physical resource flows. There are also plans for the monetary valuation of physical resources. The exact form of the accounting framework has yet to be determined but could draw on earlier Canadian approaches including the STress Response Environmental Statistical System (STRESS) and the Population-Economy Process model (PEP).

France

Development of the French system of Natural Patrimony Accounts has been underway for several years, albeit with fairly modest levels of funding. In concept, this system is, by far, the most ambitious of the systems surveyed in this report in that its intent is to cover economic, ecological, and social environments. These accounts are intended to be part of a multi-level data system, with raw statistics and data summaries at the lowest levels and with aggregate indices of general welfare at the highest level. The Patrimony accounts are envisioned to occupy a level between these two extremes.

The Patrimony accounts are further subdivided into physical accounts, which describe physical resource stocks and flows; geographical accounts, which describe physical resources by region or by ecologic or land classes; and agent accounts, which describe utilization of resource stocks and flows by economic groups. The agent accounts are defined in both monetary and physical units.

While examples of all these different sub-accounts exist for a select group of "priority" sectors, the final form of the Patrimony system remains under development. The intent is to b. flexible and pragmatic in order to reflect changing data availabilities and the needs of policy.

Japan

The last official Japanese effort to account for environmental degradation was completed in 1973 with the report of the Net National Welfare Development Committee. However, the estimates have recently been updated to 1985 by Prof. Kimio Uno of the University of Tsukuba.

The approach involves adjusting conventional GNP in a number of ways in order to make it better reflect changes in national welfare. Adjustments include an accounting for the services of governmental and human capital, the value of leisure time, household production, and the negative effects of urbanization and pollution. Environmental damages are measured by the costs necessary to meet governmental standards.

While there are no plans to continue this work at official levels, future resource and environmental accounting may be necessary to support environmental-economic models currently being developed by the Environment Agency.

Netherlands

While work on resource and environmental accounting, led by Roefie Hueting, has a long history in the Netherlands, official efforts to adjust the GNP for environmental losses and resource depletion have just been initiated. The intended approach is to subtract from GNP environmental damages, measured by the costs of technical procedures and reductions in economic activity necessary to attain a sustainable use of the environment. The concept of "sustainable use" refers to the ability of the environment to provide useful functions for the present and into the future. Hueting believes that objective standards to meet this goal can be established from the ecological literature.

To effect the intended adjustment to GNP, a 13-stage program of research is envisioned. This program covers such areas as problem identification, data collection, development of suitable technical measures, and costing.

Norway

The focus of the Norwegian approach has been on physical resource accounting: analyzing the flows of natural resources and pollutants and the relationships between these flows and economic activity. Physical accounts describing levels of stock, discoveries, depletion and deposition of the more important natural resources in Norway (e.g., fish, petroleum, forests) have been published since the early 1970s.

The intent of the Norwegian effort is not to adjust GNP. There is no attempt to convert physical measures into monetary units. The primary objective of the Norwegian effort, rather, is to provide data and information to support both the development of specific resource policy and the general needs of the Norwegian economic planning process. Therefore, the scope of the accounting effort and the specific content of individual accounts is determined by political and practical considerations.

United States

The principal emphasis of official environmental accounting efforts has been on the assembly of pollution-abatement expenditure data. For manufacturing establishments, the Bureau of the Census has been assembling expenditure data since 1972. Over the same time period, the Bureau of Economic Analysis (BEA) has been assembling similar data for more broadly defined national accounting sectors, relying primarily on a survey of companies. Due to budget reductions, the BEA survey was shifted to Census in 1989 and greatly reduced in scope.

So far, there are no plans to use these data to adjust conventional GNP. However, both the BEA and the U.S. Environmental Protection Agency are currently investigating the feasibility of developing more extensive resource and environmental accounts. These accounts may include GNP adjustments. They are likely to be viewed as supplements to, rather than substitutes for, the conventional accounts.

West Germany

The Federal Statistical Office is considering the development of satellite environmental accounts. The intent is to describe the physical state of the environment but to link changes in the physical state with economic activity.

The form of these accounts is yet to be determined. However, initial approaches are likely to reflect recent West German research on the effect on GNP of defensive expenditures and of pollution-abatement expenditures.

Peskin

The accounting framework developed by Henry M. Peskin is based on a neo-classical economic theory that treats environmental assets as if their contribution to economic activity were similar to that of conventional, marketed assets. The "environment" is thus viewed as a producer of inputs consumed by other productive economic sectors and as a generator of output services consumed by final demand. The accounting structure, consistent with this theory, has the input-output form of the conventional consolidated income and product account with several modifications.

On the input side are environmental services to producers (primarily waste disposal services) and on the output side are positive services to consumers (for example, recreation services) and negative damages (e.g., pollution), resulting from the use of environmental services by producers and from natural

causes. The various services and damages are valued according to the estimated willingness-to-pay for these services by their users. Since the estimated input and output values may not equal, a balancing entry is required. The accounts also include on the input side an entry accounting for the economic depreciation of environmental assets and natural resources. This entry affects net product but not gross product.

As an experiment, the U.S. Environmental Protection Agency is currently applying this framework to the Chesapeake Bay region of the United States.

Repetto

The approach of Robert Repetto is to adjust gross and net income measures by subtracting out the value of the net depletion of natural resources. The depletion value is measured by the change over the accounting period in sales minus production costs or, equivalently, net economic rent. No adjustments are made to GNP for pollution damage, current environmental services, or for the costs of pollution abatement.

The procedures have been successfully applied in Indonesia and further applications are underway or are under consideration in China, Costa Rica, and the Philippines.

United Nations Statistical Office

Staff of the United Nations Statistical Office (UNSO) (with collaboration of Carsten Stahmer) have recently designed a system of environmental and natural resource accounts that closely follows the structure of the conventional U.N. System of National Accounts. The preliminary version of this system attempts to maintain the SNA definitions of productive sectors. The primary purposes of the system are to explicitly identify financial flows that are environmentally-related, show linkages between physical resource accounting and monetary accounting, allow for the comparison of environmental benefits and costs, and provide better indicators of income sustainability.

The UNSO system is currently under revision. Plans are for the preparation of a "handbook" to guide potential pilot projects that will test the feasibility of implementing the system in developing countries.

Modifying the Accounts to Include Resources and the Environment: Alternative Approaches

The survey of accounting activities in industrialized nations revealed a number of possible approaches to address one or more deficiencies in the conventional accounts with respect to their treatment of natural resources and the environment. These deficiencies involve perceived inadequacies in the ability of the accounts to measure economic and social performance, to treat all sources of income and wealth consistently, and to reflect fully all determinants of economic activity. Appendix III discusses these issues more fully. The

proposed approaches will be discussed in turn, starting, more or less, with those measures that make modest or little demands on existing national accounting frameworks to those that would entail major changes in the existing structure.

1. Identification and reclassification of environmental expenditures

Expansion of the conventional accounts could mean something other than extending coverage to environmental and natural resource activities. It could also refer to changes in the definition and classification of accounting entries. In particular, one of the more frequently-made suggestions for making environmental modifications to the accounts (put forth, for example, by the French and Japanese) is to reclassify final demand (consumption and investment) expenditures for pollution abatement as "intermediate," thereby subtracting them from the GNP.[2] The Germans have suggested taking this approach one step further by subtracting out (using input-output techniques) currently intermediate business expenditures on environmental control that may be embodied in the value of final output. While there has been no effort to adjust GNP in the United States for environmental expenditures, identifying them constitutes the principal environmental accounting activity by official U.S. agencies. Similar statistics are also generated in France, Germany, and the Netherlands.[3]

Closely related to the suggestion of removing "final demand" pollution-abatement expenditures from conventionally-measured income is the suggestion to remove from consumption certain purchases of goods whose only purpose is to "defend" against environmental externalities. The purchase of face masks, like those frequently worn in the polluted streets of Tokyo and Taipei, are examples of such "defensive" outlays. However, as desirable as may appear to deduct defensive outlays from output, to do so raises troublesome problems regarding the classification of "final" as opposed to intermediate input goods.[4]

The problem is that nearly all "final" expenditures can be interpreted as "defending" against something and thus be reclassified as inputs. As Jaszi

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[2] This approach has reasonably long historic roots. In the many conferences and workshops on national accounting improvements held since World War II, much more discussion has been directed towards definitional and classification issues that towards extensions to nonmarket activities. Typical of these conferences are those of the International Association for Research in Income and Wealth held every two years.

[3] According to Michel Potier, the OECD will review these efforts in a forthcoming publication.

[4] These problems were raised by George Jaszi in his comments on Juster's article. (Juster, 1973).

wrote, "... food expenditures defend against cold and rain, ... medical expenditures defend against sickness, and religious outlays against the fires of hell." (Jaszi comments on Juster, 1973). Indeed, one could imagine a simple economy without investment or governmental activity and where labor could be viewed as the "output" of the household sector and consumption, the "input" to this sector. Under such a view, there would be no "final" expenditures and none of the usual, well-known account aggregates such as GNP. Thus, even in a more complex economy, if all "final" expenditures were interpreted as "defending" against something, as Jaszi suggests they could be, there would be no GNP.

While Jaszi's rhetoric serves to highlight the extent of the problem, it doesn't provide much guidance as to what should determine whether a consumption outlay is or is not "final." In view of the above arguments, it clearly is not useful to declare all consumption as "intermediate." But simply following current practice, with its often arbitrary distinctions (e.g. a refrigerator installed in a home is a consumption good; installed in a supermarket, an investment good), is equally unsatisfactory. For example, the Japanese and Peskin accounting approaches both require a negatively signed final good entry that represents environmental damage. The magnitude of this entry equals the value of (environmental) defensive outlays plus the value of any remaining environmental damage.[5] If conventional practice is followed with respect to the treatment of defensive outlays as positive consumption items, it could lead to the following unfortunate result. Increases in environmental damage that engendered defensive outlays of the same magnitude would leave the GNP equal to what it would have been were there no increase in environmental insult.[6]

Data on both environmental damage and defensive outlays permit a comparison of environmental damage with actions taken in defense of this damage. These data also can be used for analysis of defensive expenditures on prices and general economic activity. Thus, identification of both pollution-abatement expenditures and environmental defensive outlays seems a worthwhile pursuit even if, as is the case in the United States, the resulting estimates are not used to make any adjustments in the conventional account aggregates.

2. Physical resource accounting approaches

One of the more practical suggestions for rectifying the deficiencies with the conventional economic accounts is to develop separate or "satellite" accounts that describe the flows of resources, materials (including pollutants), and energy that underlie any economic activity. Each one of these accounts

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[5] The value of air and water pollution damage was about $47 billion in 1978. See the discussion of the Peskin framework in Appendix II.

[6] This result, however, is preferable to the current situation. Conventional, unmodified GNP will increase as successfully-defended environmental damage increases.

would display input-output balances that are necessary consequences of physical conservation laws. Thus, in principle, such accounts could not only show the depletion of natural resources and additions to the resource base through discovery and natural growth, but also their transformation into goods and materials, some of which may find their way back to the environment in the form of pollutants. The material or energy accounts can be linked to the conventional economic accounts through the use of ratios (or input-output coefficients) that express units of energy or material use per unit of production or sales.

On a more or less "official" governmental level, this general approach is being tried in France[7] and especially in Norway, where a number of resource accounting tables have been published.[8]

There appear to be two types of physical accounts, both of which are found in the Norwegian and French systems. The first is a stock account, which typically indicates an "opening stock", any additions to the stock either through discoveries or growth, any subtractions due to exploitation or natural destruction, and, finally, a "closing stock." This type of account is typically applied to depletable resources, such as minerals, or to renewable resources, such as forests. The second type of physical account applies to pollutants. This account typically describes air and water pollution generation by polluting source. While there also have been some research efforts to trace the flow to final deposition as well as generation, typically the tables only provide some measures of resulting ambient environmental quality (e.g., air pollution concentrations, etc.). Many countries engage in this second type of physical accounting as part of their efforts to generate environmental quality reports.[9]

Because purely physical accounting approaches do not attempt to value material and energy flows in monetary terms, they can not directly provide the

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[7] As is apparent from the discussion in Appendix I, beginning on page A-I-8, the French system conceptually comprises more than just physical resource accounting. On the other hand, the scope of the physical resource accounting--that is, the number of individual resources covered--is actually far less extensive than suggested in the previous paragraph.

[8] The OECD also has a pilot project to develop forest and water resource physical accounts for several industrialized nations.

[9] One could argue that this second type of data should be more properly referred to as "environmental statistics" rather than "accounts." However, the definition of what constitutes environmental statistics as opposed to environmental accounts must remain unclear until there is, in the words of the UN Statistical Office, a "...generally accepted model or classification of the environment." See (United Nations, 1984).

information to correct social and economic indicators generated by the conventional accounts. Nor can they address the inconsistent treatment of depreciation between natural resource and marketed capital discussed above. Moreover, if they are to be very comprehensive, physical accounts can get large and unwieldy since it is hard to find a common physical unit of measure that would permit aggregation. The alternative is to be selective. Thus, the Norwegian accounts are confined to a very few sectors deemed important for the Norwegian economy: forests, fishing, hydro-power. However, even with limited coverage, the Norwegian experience indicates that these accounts can provide valuable information relating economic and environmental activity and, thus, go a long way towards filling in the missing items in the economy's production function.

3. Depreciation of marketed natural resources

Another approach to modifying the standard economic accounts is to focus on their failure to depreciate natural resource and environmental assets. This particular strategy has received recent popular attention through the work of Robert Repetto and his colleagues at the World Resources Institute.[10]

It is important to note that Repetto's focus is primarily on what the Norwegians refer to as "material resources": those resources, such as timber and petroleum, that either generate marketed product directly through harvesting or mining or attain their economic value by closing contributing to the production of marketed product. Top soil falls into the second category. Resources, such as rivers and lakes, which generate nonmarketed environmental services, are not covered. Forests in their role as providers of habitat or recreation or other services that fall into the nonmarketed category are also not covered by the Repetto approach.

Concentrating on the depreciation of material resources makes sense especially in resource-based developing countries and where resource problems may be quantitatively more important than environmental problems. Thus, Repetto's adjustments have been implemented in Indonesia and similar efforts are underway in Costa Rica and China.

The depreciation calculations depend on estimates of changes in the physical stock of the natural resource times the difference between the average unit price and extraction cost of the marketed resource over the accounting period. This procedure, due to Landefeld and Hines (1985), is only an approximation to true economic depreciation (the change in asset value over the accounting period, where the asset value equals the present value of the future

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[10]See Repetto (1989).

stream of services).[11] Experts in forestry (e.g., Clarke and Dragun, 1989) have questioned this approximation for renewable resources. It is, for example, quite possible that physical reductions in the size of a forest could lead to larger long-run yields and, thus, increases in asset value (quite apart from any increases that may be due to asset revaluations).

In addition, the Repetto approach has also been questioned by those with strong interests in countries highly dependent on non-renewable resources such as petroleum (e.g., El Serafy, 1989). In this case, the criticism has to do not just with the method of calculating depreciation but, rather, with the entire procedure of defining net income as the difference between gross income and depreciation.[12] This criticism appears to stem from the observation that depletions of physical resources may not be welfare decreasing if some of the proceeds are re-invested such as to replace the eventually depleted physical resource with a new asset of equal value. Thus, if a country's wealth were totally dependent on, say, mineral reserves, its net income, calculated with the Repetto depreciation adjustment, could equal zero even though it might enjoy relatively high levels of consumption and end up with no diminution in wealth.[13]

A third criticism of the Repetto approach is related to this second criticism: namely, that the procedures thus far adopted have not captured all the creation of new wealth due to the destruction of natural resource wealth. Essentially, the analysis has been partial--focusing on one asset at a time. In developing countries especially, some of the new wealth will be in the public sector or it may be nonmarketed wealth. In either case, it may not be fully accounted as "investment" in the conventional income accounts.

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[11]Note also the implicit assumption that the difference between price and extraction cost is non-zero--that is, there is rent. With certain resources, such as open-access fisheries, free entry may reduce rent to zero or near zero.

[12]El Serafy would define the "true" income generated by natural resources as annual proceeds from its extraction less an amount that if invested would earn a return that would replace the resource when it is exhausted.

[13]This criticism, while valid, may be more a criticism of net income as an income or welfare measure than a criticism of depreciation accounting per se. Moreover, it is not clear that when a country totally depends on its mineral base, net income would necessarily equal zero. If, for example, the re-invested proceeds supported domestic production, net income would equal the value-added of this production less any depreciation of the stock of growing capital that supports this production. Thus, a more complete accounting framework--one that captured both the income generated by the depletable asset and any income deriving from investments of the proceeds from the depletion activity--should meet much of this criticism.

It does not appear that any of these criticisms are overly damaging. The first one could be met by using a more sophisticated depreciation calculation that better captured the long-run value of renewable resources. The third criticism and much of the second could be met by the use of a more general and more comprehensive accounting approach. Finally, information supporting the Repetto approach could also be used to define a new income aggregate if one wished to follow El Serafy's suggestion.

4. Full environmental and natural resource accounts with valuation

This final modification to the conventional accounts is the most ambitious since its intent is to accommodate all the elements of physical resource accounting and natural resource depreciation calculations but also to place monetary values on all physical entries. The Dutch (Hueting, 1980) system, the United Nations Statistical Office (Bartelmus, Stahmer, and van Tongeren, 1989) framework, and the Peskin (1989) framework provide three examples of this approach. However, while all three strive for monetary valuation, there are differences in coverage, presentation, and valuation methods.

The Dutch approach centers around the concept that there are various "functions" of the natural environment and that there is competition for these functions by various "agents" in the economic and environmental system. Each agent competes for a function (e.g., industry competing for water for waste disposal) against other agents competing for the same or different functions (e.g., households competing for drinking water). This competition may lead to a "loss of function" as perceived by competing agents. Hueting values this loss by the estimated cost of restoring the function to a "sustainable" level as determined by scientific standards. This cost plus any ex post environmental expenditures is deducted from conventionally measured gross product. It should be noted that Hueting does not value the functions themselves--only the losses in function due to competition. Thus, there is no positive adjustment to conventional product due to, for example, nonmarketed recreational services provided to households by the natural environment.

The proposed UNSO framework has a more conventional accounting appearance.[14] Indeed, it was designed to be a satellite account to the SNA and, therefore, attempts to follow SNA accounting conventions. In particular, the coverage is limited to those sectors (or "production boundary") defined by the SNA. Like Hueting, the UNSO framework also accounts for damages or losses in function. In addition, it covers the depletion of natural resources.

While it follows SNA sectoring, the UNSO framework treats the depreciation of natural resources quite differently from the standard SNA treatment of

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[14]The discussion of the proposed UNSO framework here and in Appendix II is based on currently available materials. It is the author's understanding that the proposal is undergoing substantial revision.

ordinary marketed capital. In particular, the depreciation of natural resources is treated as separate deduction from gross product, made before any deduction of ordinary depreciation. The gross income so adjusted is termed "sustainable gross income." Moreover, environmental damage estimates are entered into the accounts as if damage were another type of resource depletion. In effect, environmental damage is viewed as a destruction of environmental assets. Although one could take issue with both the accounting treatment of resource depreciation and with the accounting of environmental damage, it does not appear too difficult to rearrange these entries more conventionally.

As is the case with the Dutch approach, environmental damage values are estimated by the costs to eliminate the damage. Therefore, there is no way of comparing the value of damages with the opportunity cost of eliminating these damages. It is thus not possible for the accounts to generate data that could be used to investigate the economic efficiency of environmental policy.

A third version of a complete set of resource accounts with valuation is Peskin's neo-classical framework. This approach treats the services of environmental and resource capital as if these services were marketed. These services are entered into the accounts as inputs, if consumed by production sectors, or as output, if consumed by final demand sectors (such as households). Since the consumption of these services usually leads to dis-benefits (e.g., waste disposal services lead to pollution), the negative value of these dis-benefits (or "damages") is also entered into the output side of the accounts.

Input services and damages are valued as if the services and damages were traded in private markets. In particular, environmental input services to producers (for example, waste disposal services) are valued according to estimates of the producer's willingness-to-pay for the services. Similarly, resulting pollution damages are valued in terms of what damaged parties would be willing to pay to avoid the damages. In practice, these willingness-to-pay estimates rely on a number of approximation approaches drawn from the environmental benefit-cost literature.[15]

A major difference between the Peskin framework and that of the Dutch or the UNSO is that input services and any resulting damages are valued differently. Like the Dutch and the UNSO, data on the prospective costs of attaining standards are widely used--not, however, as estimates of damages but rather as proxy measures of the willingness-to-pay for the service by the consumer of the service (or "polluter"). Resulting damage valuations are also based on willingness-to-pay concepts. However, the estimates are based on results of cost-benefit studies that usually avoid the use of pollution control costs as willingness-to-pay proxies. Rather, these studies rely on such techniques as property-valuation, the travel cost method, contingent valuation, estimated productivity losses, etc. Thus, unlike the Dutch and UNSO framework,

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[15]See Freeman (1979) for an overview of these techniques.

data from Peskin's framework can be (and was) used to assess the relative efficiencies of environmental policies.

A very limited implementation of this framework was completed by Peskin and his colleagues at the National Bureau of Economic Research and Resources for the Future using U.S. data. This implementation excluded depreciation calculations and the only environmental services measured were those associated with the disposal of pollutants to air and water. However, the estimates did include both the positive and negative aspects of these pollution activities. In addition, data from this limited implementation was used by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture, and the U.S. National Oceanic and Atmospheric Administration in connection with a number of policy studies. (See Appendix II, page A-II-4 for references.) More recently, the U.S. Environmental Protection Agency, as a pilot study, is using the Peskin framework for the development of a set of resource and environmental accounts for the Chesapeake Bay.

As with the Dutch, Japanese, and UNSO frameworks, it is possible to use the Peskin accounting data to re-adjust conventionally-measured gross product. Adjusting U.S. GNP downward due to the negative value of pollution lowered GNP by about 2.5 percent in 1972 and by about 1.5 per cent in 1978, the lower figure being due to the effects of the pollution-control policies of the early 1970s.

Implementation Considerations

All these modifications to the standard accounts pose their own specific implementation challenges.

1. Difficulties in estimating pollution-control expenditures

The basic approach used in the United States to estimate pollution-control expenditures is to rely on surveys of firms and industrial establishments. Based on the written material available, it is not clear how the Germans and Japanese developed their own versions of such expenditure data. Besides the use of surveys, it is possible to estimate such expenditures by using engineering estimates of pollution-control costs along with assumptions concerning payment schedules and the amount of time needed to install control equipment. The Dutch use both approaches--that is, the Central Bureau of Statistics surveys enterprises and governments, but uses technical literature and statistical data to fill in gaps.

While surveys may be more accurate, their use presents difficulties. For example, the respondent may be unable to make a reliable cost estimate either because internal corporate accounts do not identify pollution-control outlays or because pollution control outlays cannot be separated from other expenditures. The latter problem often arises when the pollution control is brought about by process changes or by plant modernization. Also, it is not clear how "internal" transactions should be handled. A factory may use its own land for pollution control purposes while another might have to purchase the

requisite land. Even though the first factory incurs no expenditure for land, it might be argued that an imputed expenditure value should be assigned anyway in order to maintain comparability.

If U.S. experience is any guide, poor response rates can be a source of additional statistical problems including bias. In past surveys, usable responses were often less that fifty percent of the total.[16] It is quite possible that the responses tend to come from the firms experiencing the relatively larger pollution-control expenditures. If so, the resulting estimates may be biased in the upward direction.

2. Difficulties with physical accounting

There are both practical and conceptual difficulties associated with physical resource accounting. In addition to the obvious problem of having to assemble data on the stock of physical resources, any changes in this stock, and their transformation into products and waste materials, there is the practical problem of just what to collect and in what detail. Lacking a common unit of measure, it may be difficult to make comparisons and to determine what is or is not important. As a result, even though the physical accounts of, for example, Norway are quite detailed, some may justifiably feel that relatively too much detail has been provided on, say, material resources (such as forests) and relatively too little on industrial pollution.

The lack of a common monetary unit of measure creates conceptual problems as well. With different physical units, aggregation, of course, is impossible. And while one could find a non-monetary unit of measure that would be applicable to a large number of different resources (e.g., weight or volume), it is not obvious which single measure will convey the most useful information. Indeed, even ignoring the aggregation problem, it is not obvious which unit of measure is appropriate for any individual natural resource. For example, the reduction in the size of a forest could be measured in terms of the reduction in the number of trees, the number of trees of a particular type of species (e.g., hardwoods), the volume of available timber, or the acreage.

The obvious response to this problem is to use a variety of units of measure. However, the greater the variety of units, the more complex the framework and, as Hueting points out (Hueting, 1988, p. 5), the greater are the difficulties in making aggregations useful to policymakers. Moreover, as Alfsen and Lorentsen (1989) have emphasized, the more complex the framework, the greater the costs of data development, and the greater the possibility that resource accounting costs will exceed the benefits of the effort. Perhaps, with more experience in actually implementing such accounts will come a satisfactory compromise.

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[16]See Peskin (1978).

3. Difficulties in estimating natural resource and environmental depreciation

As with physical resource accounting, depreciating natural and environmental resources presents both conceptual and practical problems. The principal conceptual problem involves an important distinction that must be made between physical deterioration and the loss of economic value. Only the latter, the true economic depreciation, is properly deducted from gross income to produce net income.

While physical deterioration of, say, a natural forest may imply that the forest depreciates in value terms, it need not necessarily be the case. For both economic and biological reasons, the smaller physical forest may show a gain in economic value--that is, it may show negative depreciation or "capital gain." Such apparent anomalous behavior can arise because the value of a resource depends not just on its short-term ability to generate output, but also on its ability to generate something of value over its entire life. While, for example, the smaller physical forest may generate less product in the near-term, it might be biologically and economically more productive than a larger, perhaps more crowded forest, over the long-term. Also, it might happen that the demand for the output from a smaller capital stock rapidly increases over time. If so, again its economic value could grow as its physical size diminishes.

The conceptual problem of estimating true economic depreciation may not create major practical difficulties if the capital stock is traded in well-functioning markets. In this case, observed market values may suitably reflect the long-run, future economic productivity of the asset--or, at least, a market consensus of its long-run productivity. However, most natural resource and environmental assets are not traded in markets, even though certain products generated by these assets (e.g., hardwoods from a rain forest) may have market-determined values. Thus, both the current value of many natural resources and most environmental resources and the change in this value, or depreciation, must be "imputed" or inferred. While market-observed prices may provide valuable information for these inferential estimates, focusing only on the marketed outputs of an environmental or natural resource asset can lead to substantial underestimates of value and incorrect estimates of depreciation. Put simply, the value of a rain forest is greater than the value of all its salable hardwoods.

4. Difficulties in estimating environmental and natural resource accounts with valuation

As suggested above, the most challenging modification to the conventional national accounts would not only be to include the above elements of physical and cost accounting but, in addition, to place monetary values on the services generated by natural and environmental assets.

The principal problem, of course, is to place values on the services and on any societal damages that may arise due to the consumption of these services (e.g., pollution from waste disposal services). There are a number of methods

for doing this. For example, we have seen that both the Dutch and the Japanese approaches value damages by the costs of their elimination. However, many economists would prefer to rely on the "consumer-sovereignty" concept according to which the value of the environmental service is equal to what consumers of the service would be willing to pay for the service. Similarly, the value of any damages to society for, say, pollution, would be equal to what members of society would be willing to pay to avoid these damages.

While implementing this valuation principle presents many technical and data problems, estimation methods exist and are continually being refined. It is true that these techniques have been attacked as judgmental and subjective. But such criticism can be directed against any estimation method that is not commonly accepted. It is possible that as resource and environmental accounting becomes more widely adopted, techniques for estimating, say, the monetary value of health damage could become as accepted as the methods for estimating the depreciation of plant and equipment. (It should be noted that direct observation of true economic depreciation is not possible. Some estimation procedure is required.)

There is, however, a conceptual problem that has little to do with data and technique: namely, the appropriateness of the consumer-sovereignty principle for determining societal valuations. Many justifiably fear that many services of the environment are too socially important to be determined by willingness-to-pay techniques. In the first place, these techniques favor the rich over the poor, since the empirical evidence is often based on observed expenditures for environmentally-related goods. In addition, there may be services of the environment whose long-term value to society may be under-appreciated by present-day consumers. The long-term ecological value of certain species or the opportunities for future generations to have the option to enjoy the gifts of nature may be two examples. For these sorts of environmental and natural resource services, it may be necessary to find alternative valuation principles.

Why Accounting Approaches Differ

As has been discussed above, there has been a variety of responses to perceived inadequacies in conventional accounting systems in various countries. What has not been addressed is why particular approaches were chosen, as well as how successful, how cost-effective, and how policy-relevant the approaches were.

Undoubtedly the selection of approaches is affected by a number of capricious factors such as historical accident or simply the interests of the individuals responsible for developing the approaches. However, to the extent that the accounting approach is to serve policy needs, the selection probably also depends, to some extent, on an objective or subjective effort to balance policy goals against the costs of attaining these goals. Therefore, one would expect these approaches to differ to the extent that differences exist in the

functions these approaches are expected to serve and in the costs of generating data.

Certainly the expressed purposes of the various accounting efforts differ. In addition, one can identify actual purposes to which the approaches have been put to the extent that, as is the case with Norway, there is a history of implementation. Also, it is possible to identify potential purposes based on considerations of the structure of the proposed framework or system. These same structural considerations might also suggest instances where the fulfillment of expressed purposes is extremely unlikely. Thus, if one expressed objective was to support cost-benefit analysis of policy, attainment of this objective may not be possible to the extent that, as is the case with several approaches, cost estimates were used as a proxy for benefits.

The following chart (Figure 2) attempts to compare various approaches in terms of functional objectives.

FIGURE 2: PRIMARY FUNCTIONS BY ACCOUNTING APPROACH

	CANADA	FRANCE	JAPAN	NETHERLANDS	NORWAY	UNITED STATES	W. GERMANY	PESKIN	REPETTO	UNSO
IMPROVED ECONOMIC PERFORMANCE MEASURES		*	*	*			*	*	*	*
IMPROVED MEASURES OF SUSTAINABLE INCOME AND GROWTH	*			*					*	*
IDENTIFICATION OF POTENTIAL ENVIRONMENTAL /ECONOMIC INTERACTIONS		*		*	*		*	*		*
SUPPORT OF MACRO-ECONOMIC OR SECTOR PLANNING MODELS		*			*	*		*		
SUPPORT OF EFFICIENT ENERGY OR ENVIRONMENTAL POLICY DESIGN					*			*		
RESOURCES ASSESSMENT	*	*		*	*		*		*	
ENVIRONMENTAL DATA FRAMEWORK	*	*						*	•	

Note that in some cases (e.g., the UNSO), the approach is only in the planning stage. Therefore, it was only possible to determine expressed or potential objectives. In other cases (e.g., Norway), the chart can rely on actual experience. Thus, while the box labeled "IMPROVED ECONOMIC PERFORMANCE MEASURES" is checked for both the French and the Repetto approach, only in the case of the Repetto approach is there actual evidence that it is being put to

this purpose. For this reason, it is probably more illuminating to compare the approaches in terms of the indicated differences in function rather than the similarities. More specifically, it is apparent that certain approaches have very limited objectives (e.g., the United States), while others are far more ambitious (e.g., the French). Given these large differences, it is difficult to determine whether any one of these approaches is clearly superior as each one may outrank the others according to its own objectives.

The approaches differ also in terms of cost of data gathering and effort involved. Unfortunately, however, the available information does not permit any analysis of these costs.[17] As a result, analyzing these approaches, even informally, in terms of their cost-effectiveness will have to await the assembly of further information.

However, the written materials do give some indication of the types of data that are required to support the various approaches. Figure 3 describes the different data needs for actual and proposed country approaches. For comparison, the actual and prospective data needs of the Peskin, Repetto, and UNSO approaches are also shown.

The types of input data have been grouped into four categories. First, are those data that have to do with natural resources that generate marketable output or what the Norwegians refer to as "material resources." Second, there are those data that describe the state and use of environmental resources, resources such as air or water that generate nonmarketed environmental services. Third, there are data on environmental expenditures, divided into those ex post expenditures that already in the conventional national accounts (but usually not separately identified as such) and those ex ante costs of environmental control measures needed to reduce pollution or otherwise mitigate environmental damage. Finally, there are data on transnational pollution and on global damage.

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[17] In fact, one feature common to all the countries surveyed is the lack of detailed information on data was generally not possible to determine from the written materials how data were obtained or how such data will be obtained for those approaches still in the planning stage.

FIGURE 3: DATA COVERAGE BY ACCOUNTING APPROACH

	CANADA	FRANCE	JAPAN	NETHERLANDS	NORWAY	UNITED STATES	W. GERMANY	PESKIN	REPETTO	UNSO
MATERIAL RESOURCES										
STOCK LEVELS	✲	✲			✲		⊙	⊙	✲	
USE										
AS INPUT TO PRODUCTION	⊙	✲			✲					⊙
AS FINAL DEMAND	⊙	✲			✲					⊙
PHYSICAL CHANGE										
DEPLETION	⊙	✲			✲			⊙	✲	⊙
DISCOVERY	⊙	✲			✲			⊙	✲	⊙
NATURAL GROWTH	⊙	✲			✲			⊙	✲	⊙
LIFETIME					✲			⊙ (1)		
ASSET VALUE	⊙	✲			✲			⊙	✲	
DEPRECIATION	⊙							⊙	✲	⊙
ENVIRONMENTAL RESOURCES										
CONDITION OR LEVEL	✲	✲		✲	✲			✲		
USE										
AS INPUT TO PRODUCTION								✲		
AS FINAL DEMAND								✲		
PHYSICAL CHANGE										
DEGRADATION								⊙		
NATURAL RECOVERY/GROWTH								⊙		
ASSET VALUE								⊙		
DEPRECIATION								⊙		
POLLUTION DISCHARGES	✲	✲	✲	✲	✲			✲	✲ (2)	⊙
DAMAGES										
TO INDUSTRY	⊙			✲						⊙
TO FINAL DEMAND	⊙			✲						⊙
UNSPECIFIED	⊙			✲				✲		
ENVIRONMENTAL OUTLAYS										
EX POST EXPENDITURES	✲		✲	✲		✲	✲			
EX ANTE COSTS	⊙		✲	✲				✲		
EXTERNAL "TRADE"										
POLLUTION EXPORT				⊙						
POLLUTION IMPORT										
GLOBAL DAMAGE				⊙						

✲ SOME IMPLEMENTATION ⊙ FUTURE PLANS

(1) If required to estimate depreciation

(2) Sediment only

Consistent with the differences in objectives, there are differences in data coverage. Generally, the more ambitious the objectives, the wider the data coverage. However, wide coverage does not imply identical coverage. Both the French and the Dutch approaches have broad objectives and fairly wide coverage. However, the French appear to have relatively less interest in international environmental data and cost data, both of which are (or will be) priorities in the Dutch approach.

One important message that can be drawn from Figure 3 is that frameworks, which are structurally very different, can rely on similar data sets. Therefore, with respect to the "data framework" function of national accounting, some of the differences between these approaches may not be a great as they may first appear.

Principal Findings

Among the more important findings from this survey of resource and accounting in industrialized countries are the following:

1. **Most approaches attempt to address one or both of the two major functions of conventional national accounting (performance measurement and data system).**

   One major function of the national accounts is to provide measures of economic and social performance. The surveyed resource and environmental approaches address a deficiency in the conventional accounts as to their ability to fulfill this purpose. The conventional accounts misstate income and, perhaps, growth because of their neglect of environmental deterioration and the depletion of natural resources. A second major function of the national accounts is to provide for a coherent data base to support economic policy, research, and modeling. There is a perceived need for additional information that will better reflect environmental-economic interactions.

   The various approaches differ on their emphasis on each of these two broad functions. Thus, for example, the responsible governmental agencies in Norway and the United States have so far shown little interest in producing a "better GNP." Their emphasis, instead, is on producing a better data base for policy analysis and economic modeling. In contrast, Repetto's primary concern is to correct the tendency of conventional income indicators to overstate the rate of economic performance. It is difficult to be as clear as to the precise degree of relative emphasis of the other approaches, since they are in earlier stages of development.

2. **Regardless of the intent of the various approaches, they may better succeed in addressing one function more than the other. Thus, the approaches should be judged on their actual as much as their intended outcomes.**

All the approaches depend on the assembly of one or more data bases. These data bases can all support to some degree the data-development function of income accounting. Therefore, even if outside observers are not interested in a particular aggregate income adjustment proposed by the approach, they still may find the assembled data to be of significant value.

3. **The approaches differ significantly in their complexity and coverage.**

The U.S. (BEA) approach is narrowly focused on expenditure data while the Dutch, UNSO, and Peskin frameworks cover a wide range of data reflecting environmental-economic interaction and resource depletion. The Norwegian, French, and Repetto approaches appear to fall somewhere between these two extremes.

4. **The differences in complexity and coverage reflect not only the relative emphasis on the two major functions of national accounting but also different policy objectives.**

Thus, for example, the Norwegian system is well suited to support the Norwegian desire to manage their resources of petroleum, timber, hydro-power, and fish. The U.S. approach, with its emphasis on expenditure data, supports the analysis of the macro-economic effects of environmental policy. The Repetto approach addresses sustainability issues in developing countries. The Dutch approach appears to be designed to address how detailed environmental-economic interactions may affect sustainable growth paths in a highly developed country.

5. **While these approaches may have very different structures, reflecting their different emphases and policy objectives, they may be very similar in their data requirements. Thus, extensive debate over the relative merits of each approach, as a prerequisite to implementation, may be unnecessary or even counterproductive.**

The Dutch (Hueting) approach, the UNSO framework, and the Peskin framework, for example, appear to differ substantially in appearance. However, satisfying the data needs for any of these three approaches would automatically satisfy a large percentage of the data requirements for the other two (as well as the data needs of the less complex Norwegian and Repetto approaches). The implication of this finding is that efforts at implementation, for example, in developing countries, could begin before final decisions are made as to which approach will better suit the country's needs. The incremental costs of adjusting the data or gathering new data

to satisfy the requirements of an alternative approach may not be so large as to justify delaying at least initial efforts at data gathering.

6. **Because of missing information--especially regarding data development costs--it was not possible to determine the cost-effectiveness of the various country efforts and the implications of these efforts for policy-making.**

Unfortunately, with respect to most of the approaches surveyed, the available written material is only suggestive of the data and analytical capabilities that are required to implement these approaches. These written materials fail to indicate the actual state of data gathering and implementation in the various countries. In particular, there is a lack of information on those data development processes that are required to support the "successful" approaches and those that would be required to support the systems still under development. In addition, with the notable exception of Norway, there is a lack of specifics as to how these systems contribute to the policy process.

Information on policy needs and costs are required in order to draw conclusions about the cost-effectiveness of an accounting approach. There may be a real possibility that some the of the suggested approaches are far more sophisticated and expensive than is necessary to meet policy needs in an efficient manner. Similarly, other, less sophisticated approaches may not be able to meet policy requirements. To determine whether either situation is the case, specific policy objectives should be linked to specific data needs and the costs of meeting these needs carefully estimated. The most appropriate accounting approach is the one which satisfies actual and potential policy needs at least cost.

Conclusions and Implications for Developing Countries

It is difficult to deduce clear messages for developing countries from this survey since most of the programs are still in early stages of development. Of course, one could draw an inference from the very fact that the only countries that have established empirical records of "success" over a significant period (i.e., ten or more years) are Norway and the United States--two countries with the least ambitious resource accounting programs (See Figure 2). (Japan could also be included, although the recent data sets are not official products of the Japanese government.) However, rather than concluding that "simpler is better," the more appropriate message for developing nations is to not let their ambitions outrun their capabilities in terms of data generation and analysis.

There are two reasons why "simpler may not be better." In the first place, there is no obvious connection between the complexity of the design of the

framework or system and the effort required for its implementation. Implementation costs depend not only on design complexity but also on such factors as sectoring detail and desired accuracy. Initial implementations of the relatively complex Peskin framework were far less expensive than implementations of the rather straightforward cost accounting practiced at the U.S. Bureau of Economic Analysis (BEA), since the BEA placed a higher premium on data accuracy and sector detail.

A more important reason that "simpler may not be better" is that there is no obvious connection between the complexity of a system and its value as an efficient data framework. A simple, relatively inexpensive data system that fails to facilitate the policy process is no bargain. Similarly, a complex, relatively expensive accounting framework that generates far more data than are needed is no bargain either.

Presumably, valuable information for developing countries will emerge over time as resource and environmental programs mature in the industrialized countries. Of particular interest will be any successful valuation methods and data development techniques. However, since the best accounting approach for any particular developing country will depend on the country's information needs and on the resources the country is willing to devote to data development and implementation, the experience of the industrialized countries should not carry too much authority. Even if all of the efforts in industrialized countries were ultimately judged as unsuccessful, that fact alone carries only limited implications for a developing country with different policy objectives, arising, perhaps, from significantly greater resource and environmental problems. Similarly, a record of success in a wealthy industrialized country may have no implications in a country with meager data development resources.

Since the conditions for success in resource and environmental accounting are likely to be country-specific, there is little point in waiting for the industrialized-country experience to mature before a less-developed country decides to embark on its own program. There is also no particular reason to make a firm pre-commitment to any one of the industrialized country's chosen accounting approaches. The similarity in data coverage suggests that initial data collection can proceed before a country makes a final decision as to which approach is most appropriate. Given the relative severity of resource and environmental problems in the developing world and, therefore, the relative seriousness of the deficiencies in the standard economic accounts' ability to reflect these problems, a productive strategy for developing nations might be to initiate their own, low-cost pilot programs now.

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APPENDIX I

COUNTRY SUMMARIES

AUSTRALIA

Overview

Presently, there is no actual resource or environmental accounting project underway in Australia at either the Federal or state level. However, there is extensive interest in the subject as evidenced by two recent workshops on the subject held by the Department of the Arts, Sport, Environment, Tourism and Territories and by the Bureau of Rural Resources. In addition, the newly established Resource Assessment Commission plans to undertake some resource accounting for the purpose of developing an information system to support forestry models. (Letter from D. James to H. M. Peskin, Nov. 2, 1989).

In addition, there is some interest on the part of the Australian Environment Council (who sponsored a rather critical report on resource accounting by Clarke and Dragun, 1989) and the Commonwealth Scientific and Industrial Resource Organization (CSIRO).

Regarding possible implementation at an official level, the Australian Bureau of Statistics supports the development of satellite accounts as part of the revised SNA. However, they do not have plans to produce such Accounts for Australia at this time. (Letter from F.J. von Reibnitz to R. Chander, Nov. 15, 1989). Apparently, the Australian position is that only if the UN takes the lead and recommends satellite accounting, will they follow suit.

Discussion

There is clearly no official Australian position on resource and environmental accounting. A scan of several papers presented at the recent workshops indicates some caution on the part of the national accountants, which is not unexpected. However, as noted, the official statisticians do not oppose satellite accounts.

Perhaps more damaging to the prospects for resource and environmental accounting in Australia is the critical paper by Clarke and Dragun. This paper attacked the Repetto-Landefeld resource accounting approach as inappropriate for renewable-resource accounting. The principal criticism is that Repetto's approach equates depletion with true economic depreciation. With forests and fish stocks, however, it is well known that a reduction in physical size could imply an economic gain over the long run; and thus there could be economic appreciation rather than depreciation. While this criticism is valid, it does not prove the worthlessness of resource accounting. In the first place, the Repetto approach could be modified to accept other depreciation formulas. More importantly, as this survey indicates, Repetto's work does not represent the entire scope of resource accounting.

As far as future work is concerned, the Resource Assessment Commission plans to build a national multisectorial model with resources accounts providing some of the input data. Dr. David James will direct this effort. In addition, CSIRO is investigating the possibility of developing a set of resource accounts for agriculture in the Murray-Darling Basin and for forestry in Papua New Guinea. Both projects will be directed by Dr. Mike Young of the Division of Wildlife and Ecology in Canberra. Mike Young has also begun to prepare Repetto-type accounts for Australia from 1980 to 1989. Initial observations suggest that corrections for land and forest degradation are swamped by the inclusion of changes in stocks of mineral and other subsoil assets.

At a minimum, these studies should yield valuable data sets and, thus, fulfill, one of the major purposes of resource and environmental accounting. Practical results will go a long way towards offsetting academic criticism.

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CANADA

Overview

Statistics Canada is beginning a program on resource and environmental accounting with the following objectives:

- The design of a satellite account to the SNA which will cover both nonmarket, environmental resources and market resources.
- The construction of a natural resource account in physical terms, covering both economically recoverable reserves and ultimate reserves.
- The development of methods for valuing natural resources.
- The development of natural resource wealth accounts including measures of the value of depletion.
- Researching the role data on environmental quality might have on the proposed satellite account including valuation issues.
- Consideration of the including of environmental wealth "if sound imputations are possible."
- Consideration of "international practice" of altering national income aggregates to reflect resource depletion and environmental degradation.

(Letter from I.P. Fellegi to R. Chander, 11/6/89)

Working plans to implement these objectives consist of the following two elements:

1. Economic data on environmental protection will be deepened and broadened through new surveys. Existing data on capital expenditures for pollution abatement and control will be augmented with surveys on operating costs and costs per unit of abatement. Key sectors in environmental protection, such as integrated waste management firms, will be surveyed for the first time. (Funding is being sought for this work.)
2. A satellite accounting project on resources and environment has started. Its first products will be an annotated bibliography and a design paper for the accounts. The broad outline of the accounts can now be seen:
    - The base will be highly disaggregated data on quantity and quality of economic and environmental resources, covering stocks, stock changes (e.g. discoveries and net natural growth) and flows.
    - Valuation of these stocks and flows will permit construction of a satellite to the National Balance Sheet account that includes natural assets as part of national wealth. Imputing value for non-market assets will clearly require substantial research.

According to Kirk Hamilton, there are no plans to adjust any of the flow measurements in the SNA. That is, like most of the other national efforts, any new accounts will be viewed as "satellite" accounts, the purposes of which are

"(i) to provide an assessment of resource quantity and quality; (ii) to provide a framework for environmental data; (iii) to improve measures of sustainability by extending the measure of wealth." (Letter from Kirk Hamilton to Ernst Lutz, 2/18/90.)

There may be parallel efforts under consideration at Environment Canada. A recommendation to undertake a "case study" to develop a "new accounts framework" along the lines suggested by Bartelmus et. al. (1989) was made in a consultant's report. (Potvin, 1989).

Discussion

The Canadian approach apparently will combine elements of pollution-abatement expenditure estimation, such as is practiced in the United States, with resource accounting as is practiced in Norway. However, unlike the Norwegians (and, perhaps, more like the Repetto approach) there will be efforts at monetary valuation. The focus will be more on adjusting the national wealth accounts (rather than the current or "flow" accounts). However, it is recognized that the valuation of flows may be a prerequisite for the valuation of stocks.

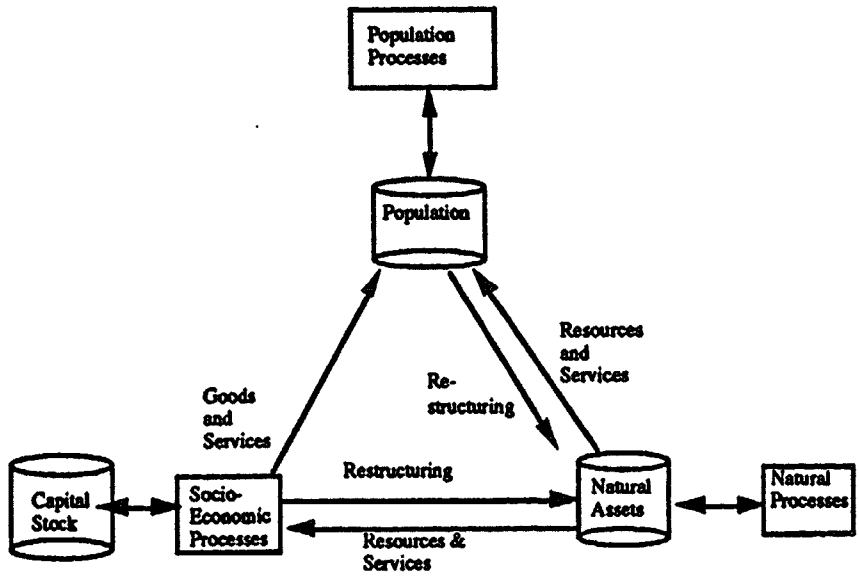
At this time, it is not clear how valuations will be made. In addition, the form of the accounting framework is yet to be determined. One possibility would be to base the framework on the Canadian Stress Response Environmental Statistical System (STRESS).

STRESS consists of 40 interrelated data sets consisting of "activity statistics", (causal) "stress indicators", (physical) "response indicators", "collective and individual responses", and "inventories of stocks" for eight activity categories: "generation of waste residuals", "permanent environment restructuring", "harvesting activity", "extraction of non-renewable resources", "environmental", "energy", "natural activity", and "population." (A. Friend, 1981).

While this system is quite comprehensive, it is important to note that all 40 activity-response data sets are in physical terms. As a result, while the system describes environmental-economic linkages, it does not do so in value terms. Therefore, it does not permit, nor was it intended for, direct modification of the SNA. However, it would appear that the STRESS system does provide much of the data needed to fulfill many of the intended resource accounting objectives of Statistics Canada.

A possible alternative to STRESS has recently been suggested by the Environment and Natural Resources Section of Statistics Canada (1990). This framework, known as the Population-Economy Process (PEP) model, views environmental-economic interaction of three classes of stocks (population, capital, and natural assets), each affected, in turn, by three types of processes: population processes, socio-economic processes, and natural processes. The following diagram describes these processes and their interactions:

Figure 1: Structural Diagram of PEP Framework



Source: Statistics Canada, 1990

This diagram suggests the need for three broad classes of data: data on stocks, data on processes, and data on interactions. Stock data require measurements on the state of certain variables such as population, ambient environmental quality, the size and quality of resources, etc. Process data, on the other hand, require measurements on the change in variables (e.g., population growth, economic growth, natural changes, etc.). Interaction data requires data on both the state and change in variables, but, in addition requires, what the authors refer to as "restructuring" information: analyses of the impact of human activities and population growth on the natural environment.

The view of environmental-economic interaction embodied in Figure 1 is reminiscent of the asset-based socio-economic framework suggested by Juster (1973). Juster also argues that all socio-economic activity can be traced back to the services of assets. In Juster's case, he defines five classes rather than the three in the PEP system: reproducible tangible wealth, reproducible intangible wealth, human wealth, natural resource wealth, and socio-political wealth.

While such broad approaches provide a general guide for the development of data and accounting systems, a much more specific framework is required to guide practical implementation. In particular, PEP leaves unresolved the critical question of how much detail is needed, both in terms of number variables to be measured and in the depth of analysis of "restructuring" interactions. Presumably, the Canadians will develop more pragmatic accounting approaches as they gain experience in their efforts to implement the PEP system.

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FRANCE

Overview

By far, the French have proposed the most ambitious resource and environmental accounting system: Les Comptes du Patrimoine Natural. Its ambitious structure stems from its two principal features. First, it is meant to cover, what is termed , the entire "natural patrimony", defined as ".the collection of the natural elements and of the system which they form and which are capable of being transmitted to future generations or of being transformed." (Archambault, p. 4) This definition is meant to exclude, at least, some portions of what is generally considered the natural environment--namely, those portions which cannot be transformed or appropriated by man. As examples of two such natural resources, Archambault suggests the deep ocean and the stratosphere. However, as both are undergoing some anthropogenic transformation, they could be justifiably included in the definition. The definition is also meant to exclude the "artificial patrimony", namely, man-made materials, buildings, etc. Yet, even man-made materials are covered if they have cultural significance or if they are closely connected to natural systems. Thus, ancient monuments, parks, and artificial lakes are included.

The second reason why the French approach is so ambitious is that each element in the above broadly-defined natural environment is meant to be described or analyzed in terms of its three basic functions: economic, ecological, and social. (Theys, p. 43) This broad descriptive coverage reflects the fact that the French approach is not merely an extension of social accounting to the realm of the natural environment, but is really meant to be part of a large environmental data system. This system is comprised of seven sections or "levels", ranging from sets of nonspecific data (Level I), to statistical breakdowns by air, water, and other sectors (Level II), to statistical summaries such as state of the environment reports (Level III), to the development and use of forecasting and simulation models (Level V), and eventually to the development of aggregate welfare indicators and a modified GNP (Level VI). Level V has only been partially implemented while Level VI has not been implemented at all. The Patrimony Accounts are placed in Level IV.

All the levels are intended to interrelate. Thus, the Patrimony Accounts are meant to use or, at least, be consistent with the same environmental data that support the state of the environment reports. At the same time, the Patrimony Accounts are intended to support both environmental and economic models.

To serve this role, the Patrimony Accounts consists of a number of separate sub-accounts, which, because they rely on a consistent data base, can be related to each other. These sub-accounts fall into three groups: physical accounts (comptes d'elements), geographical accounts (comptes d'ecozones), and "agent" accounts.

The physical accounts are rather like the Norwegian resource accounts in content. However, the presentation is different. The French have opted for a double entry system, showing sources one side of the account and uses on the other. The following simple example is drawn from Theys (1989, p. 43):

Figure 1: Example of Physical Account: Stock of a Commercial Forest, 1969 to 1979
(thousand 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	401.0	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

Source: Theys (1989), p. 43

The geographical accounts assemble data related either to ecosystems such as forests and wetlands or to some other areal definition such as geographical regions (e.g., coastal lands), political territories (e.g., provinces), or "abstract" concepts such as an imposed grid network. Archambault provides the following example using artificial data. The "Ecozones" could refer to, say, agricultural land, each broken down into three soil classes of different quality.

Figure 2: Example of Écozone account

Types d'écozones	Classes d'état	Stock initial	Réconci-liation	Stock initial réconcilié	Réaffectation nette des surfaces		Variations internes	Stock final
					Renouvellemt. natural	Pression des agents		
M1	Classe a	100		100		-20	-6	74
	Classe b	80		80	5	-10	4	79
	Classe c	30		30	20	10	2	62
	TOTAL M1	210		210	25	-20	0	215
M2	Classe a	1000		1000	-15	-10	20	995
	Classe b	800		800	-5		65	860
	Classe c	290	10	300	60		-85	275
	TOTAL M2	2090	10	2100	40	-10	0	2130
M3	Classe a	500		500	-65	30	3	468
	Classe b	400		400				400
	Classe c	160	-1	150			-3	147
	TOTAL M3	1060	-10	1050	-65	30	0	1015
TOTAL GENERAL		3360	0	3360	0	0	0	3360

Source: Archambault (1988), p. 10.

Finally the "agent" accounts refer to all accounting for those activities that link human activity to the natural environment. Agent accounts cover a wide range of stock or flow accounts. Their distinguishing feature is the identification of human owners and users. While certain accounts (e.g., water use accounts and pollution emission accounts) may be expressed only in physical terms, other accounts may include monetary values.

A simple example of a physical agent account is the following water use account. Similar "environmental satellite" accounts exist for the management of parks, hunting areas, maritime areas, and the generation and disposal of refuse.

Figure 3: Example of a (Physical) Agent Account

Amount withdrawn	Water		TOTAL	Amount returned	Water		TOTAL
	Ground water	Surface water			Ground water	Surface water	
General Public	1.7	2.6	4.3	General Public	1.0	3.3	4.3
Industry	2.1	3.4	5.5	Industry	1.5	4.0	5.5
Agriculture	1.1	4.1	5.2	Agriculture	4.0	1.2	5.2
Power stations		12.0	12.0	Power stations		12.0	12.0
Water bodies		2.0	2.0	Water bodies		2.0	2.0
	4.9	24.1	29.0		6.5	22.5	29.0

Source: French Delegation to OECD (1980), p. 27.

As an example of a more monetary-oriented account, the following accounting of land value is derived from data provided by Archambault. Similar accounts have been published in France since 1980. (Archambault, p.11)

Figure 4: Example of a (Monetary) Agent Account: Value of French land, January, 1980

	Area in millions of hectares	Average price per hectare (Jan. 1980)	Value in billions of francs
Agricultural land	32.1	22,200 F	712.9
Forests	14.6	14,000 F	203.7
Water, moors, quarries, etc.	4.3	5,300 F	22.8
Recreation land	0.2	68,000 F	10.8
Building sites	0.1	1,600,000 F	173.3
Railroad land	0.1	35,000 F	3.5
Indeveloped land	51.4	21,900 F	1,127.0
Developed land	1.5	800,000 F	1,200.0
Unregistered land	2.1	0	0
Total for France	55.0		2,327.0

Source: Archambault (1988), p. 12.

The plans are eventually to place similar monetary values on all physical stocks and flows.

Discussion

Not only is the French approach the most inclusive of those surveyed in terms of the elements of the environment and natural resources covered, it is also the most inclusive of accounting concepts. Virtually all the specific accounting concepts reviewed could be incorporated in the French system. Unfortunately, the available descriptive material does not indicate which accounting concepts will, in fact, be included. The problem is that this written material tends to focus on the broad structure of the French system, but it is short on specifics.

This lack of specificity is perhaps to be expected in a system still under development. It also reflects a desire to be "pragmatic" and "flexible." In the words of Theys, "The flexibility of the French system makes patrimony accounts resemble more of a general framework than a rigid system of accounts." (Theys, 1989, p. 44) However, as desirable as flexibility is, limited budgets require that some priorities be set for framework development. Accordingly, ".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." (Theys, 1989. p. 45)

Jean-Louis Weber suggests that these priorities reflect "present knowledge", the "willingness of policy makers", and the availability of "reliable, comprehensive, consistent, and regularly updated data sets." (Letter to Ernst Lutz 2/28/90) Thus, for the present at least, the patrimony acccunts themselves do not play a role in the setting of priorities. However, it should be noted that one purpose of resource accounting is to help identify which environmental and resource sectors are the relatively more important in terms of their effect on the economy. Unfortunately, uncompleted and partial frameworks may not be able to serve this function to the extent that important links between the environment and the economy are missing. The question is whether the French system is so large and detailed that major gaps in coverage will persist. If so, the system may be of limited use in determining which environmental-economic interactions are the more important for French economic and environmental policy.

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JAPAN

Overview

Currently, there is no official resource and environmental accounting effort on the part of the Japanese government. The last official efforts along these lines was completed in 1973 with the report of the Net National Welfare Development Committee.

This Committee, over a two-year period, developed a set of Net National Welfare (NNW) accounts somewhat similar to the Measures Economic Welfare (MEW) accounts developed by Tobin and Nordhaus for the United States in 1972. Recently, the Development Committee's NNW estimates were updated to 1985 by Professor Uno of the University of Tsukuba. Thus, a consistent set of Japanese NNW accounts exist for the period 1955-1985 for five-year intervals.

The NNW adjusts the conventional GNP in six ways. First, all investment is subtracted on the grounds that it does not add to immediate welfare. Second, there is an imputation made for the services of both governmental capital and consumer capital (durable goods). Third, there is an imputation for leisure time. Fourth, there is an imputation for nonmarket activities (primarily household activities). Fifth, there is a deduction made for the effects of urbanization. Finally, there are deductions made for the effects of environmental pollution. This last adjustment, of course, is the relevant one for this survey.

Two pollution adjustments are made which are similar to those suggested by Hueting. First, pollution abatement expenditures are subtracted from GNP. The investment component of these expenditures is first annualized. Also, it should be noted that the investment component of municipal sewage treatment costs were previously subtracted from GNP along with other investment. However, the services component of this investment is actually added back along with the estimates of the services of governmental capital.

The second environmental adjustment is to subtract "damages", estimated by the cost to reach governmental environmental standards. This adjustment is recognized as an approximation to true environmental damages, the calculation of which in money terms was thought to be too difficult.

It is not clear whether Professor Uno's recent updating of the original Net National Welfare Development Committee's figures includes both environmental adjustments. Uno's description makes no mention of any adjustment for pollution abatement expenditures. (Uno, March, 1988)

Discussion

As has been noted before, one problem in estimating damages by the cost of meeting standards is that damages are underestimated to the extent that standards are not established. A related problem is that when standards are not

established, data collection efforts may suffer. Thus, in the earlier Committee study, there were no estimates of damage due to stationary-source nitrogen oxides, ozone, heavy metals, etc. due to poor data. Data collection improved markedly in the 1970's , however. Therefore, it is not clear how much of the almost seven-fold increase in environmental damage report by Uno taking place between 1960 and 1970 is due to better data or to increased pollution.

There appear to be no plans to re-establish the work of the Net National Welfare Development Committee at an official level. This disinterest in resource and environmental accounting was addressed by Mr. A. Yoshikawa in a 1983 report to UNEP. Several explanations of past disinterest are offered. First, the lack of natural resource accounting is attributed to Japan's scarcity of natural resources. Second, there is disinterest among the environmentalist community perhaps due to an apparent fear that quantifying the economic impacts of environmental policy would be detrimental to that policy since "economics (gives) an indulgence to economic growth." (Yoshikawa, p. 4) Third, there is general disinterest among the community of economists as well due to (a) a reluctance to work on problems that won't impact on policy, (b) poor data bases, (c) limited publication opportunities, and (d) poor financial support. (Yoshikawa, p. 5)

However, while these factors may work against Japanese efforts to resume resource and environmental accounting, there is still some official interest in environmental-economic relationships as evidenced by some econometric modeling of environmental activity taking place within the Environment Agency. As is the case in Norway, there could be renewed support for resource and environmental accounting in order to provide a data base to support these modeling efforts.

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NETHERLANDS

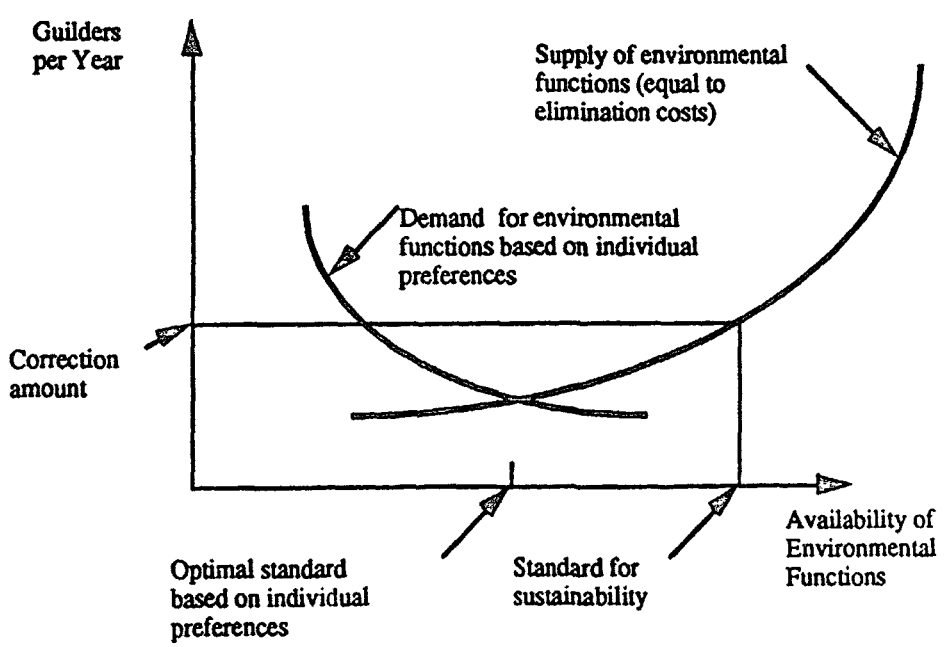
Overview

The Dutch are beginning to investigate ways to "make monetary estimates of environmental losses and depletion in order to confront the figures found with the figures of the standard national accounts." (W.F.M. De Vries' letter to E. Lutz, 07/20/90, and subsequent letter from Hueting to Lutz.) As this work is not scheduled to begin until later in 1990, there is, as yet, no official Dutch resource accounting approach. However, the approach they have in mind has been outlined in a paper by Roefie Hueting and Peter Bosch (Hueting and Bosch, 1989).

The scope of coverage is described in the Hueting book New Scarcity and Economic Growth (1980). In this book, Hueting attempted to construct shadow prices for environmental "functions" (or services of the environment), directly comparable to the prices of non-environmental goods and services that trade in ordinary markets. However, he did not succeed in his estimation of these shadow prices due to the inability to construct environmental demand curves that would be consistent with individual preferences for environmental functions. (Supply functions are supposedly easier to construct since they can be based on cost data.)

The Hueting-Bosch paper proposes to address this problem by replacing demand curves based on (unobservable) individual preferences with demand curves based on societal preferences consistent with sustainability goals as expressed by "politicians and organizations." These societal demand curves combined with supply curves will permit calculation of shadow prices and imputed values for the environmental functions. Basically, as shown in Figure 1, estimation of the intersection of the unobservable demand function based on individual preferences is replaced with a societal-determined curve. Furthermore, this curve is assume to be vertical, positioned at a level of control determined by scientific and technical considerations. In cases where sustainability considerations do not apply, the vertical standard is based on health considerations. Hueting believes this is the case with noise pollution.

Figure 1: Estimation of correction to GNP based on costs to meet sustainability standard



Hueting proposes to reduce GNP by subtracting the value of environmental damages or "losses" as measured by the costs of" technical measures and the reduction in activities necessary to meet the standards for a sustainable use of environmental functions." Reduction in activities is only taken into account when technical measures are not sufficient to meet the standard. While the cost estimates will include losses in value added of any curtailed economic activity necessary to achieve sustainability, there will be no offset for new activities that may come into being as a result of reduced threats to the environment. However, the contribution of induced new economic activity will be included in the future.

To effect these adjustments to the GNP, Hueting and Bosch envision the following 13-stage program:

1. Selection of activities causing most harm to the environment;
2. Compiling a framework for the calculation of the correction;
3. Inventory of data requirements and availability;
4. Selection of environmental problems to be analyzed (based on data availability) and selection of survey year;
5. Quantification of the source of the environmental problem in terms of emissions, use of space, soil, and the consumption of energy and other resources;
6. Quantification of the effect of the environmental problem on the environment;
7. Determining the level of environmental burden that is consistent with long-term sustainability (i.e., setting sustainability "standards");
8. Collecting data on cost-effective technical measures;
9. Determining necessary reduction in economic activities (if purely technical measures prove insufficient);
10. Determining the loss in value added for those activities that must be curtailed;
11. Determining the cost of both technical and activity-reduction measures, allowing for the fact that the elimination of economic activities may preclude the need for other technical measures;
12. Determining the extent that the costs of required environmental control measures are already included in the GNP; and
13. Comparing traditional national income with the estimated sustainable income level.

Discussion

As noted, this proposal, in its implementation, is a departure from the approach discussed in the New Scarcity book. Both approaches are based on the proposition that if economic activity results to losses of environmental function, the GNP should be reduced by these losses. In addition, in both cases the loss in functions are measured by the costs of restoring the functions to a level consistent with environmental standards--a pragmatic decision made in the belief that true environmental damage estimation is difficult or impossible.

The principal difference with this new proposal is in the determination of the standards. Exactly how standards should be determined and by whom are essentially unresolved issues in the Hueting book. With this new approach environmental damages and, by implication, environmental standards are defined in terms of the implications of these damages for the sustainability of

environmental functions. Moreover, the presumption is that the standards to obtain these sustainable levels can be determined non-subjectively, based on technical and scientific analysis.

It should be noted that Hueting's sustainability objective may not be exactly the same as sustainability objectives stated by others. (For a discussion of alternative interpretations of the term "sustainability," see Pezzy (1989)). In particular, the focus is on the sustainability of environmental functions as opposed to the sustainability of income and growth. While it is tempting to assume that one implies the other, it is quite possible for a society to obtain long-term, sustainable income levels while, at the same time, permitting the loss of one or more environmental functions. Only the most committed environmentalist would maintain that sustainable income and growth require the maintenance of each and every resource, each and every animal or plant specie, and each and every environmental amenity. Certainly not all environmental functions are necessary to support human existence.

In private communication, Hueting proposes a flexible definition of sustainability that supports the above view:

> Sustainability means that functions must remain intact so that all present and future uses remain available. As for renewable resources such as forests, water, soil and air it holds that as long as the regenerative capacity remains intact the functions remain intact, e.g., the functions "supplier of wood", "provider of secondary forest products", gene reserve", "regulator of the water management", "preventer of erosion","regulator of the climate", and "buffer of CO2 and heat" of forests, the function "drinking water" of water, the function "soil for raising crops" of soil and the function "air for physiological functioning" of air. Practically this means that, for instance, emissions of cumulating matters such as PCB's, heavy metals, nitrates and carbon dioxide may not exceed the natural buffering capacity of the environment and that the erosion rate may not exceed the regenerative power of the soil. As for non-renewable resources, such as oil and copper, "regeneration" takes the form of research and bringing into practice flow resources such as energy derived from the sun (wind, tidal, collectors, photovoltaic cells), the recycling of materials and the development of substitutes for these. (Private communication)

Yet, he also suggests that the ecological literature may provide the objective guidance for setting these technical standards. While this may be true in a general sense, it may be difficult for ecologic considerations alone to define standards in specific cases of environmental insult. For example, Hueting points out that the accumulation of toxics, heavy metals, and greenhouse gases is "incompatible with sustainability" and, according to the above quote, emissions should not exceed natural buffering capacity. But what if there is no natural buffering capacity?

Many of the very societies that have declared themselves in favor of a sustainable use of the environment have also called for increases in nuclear power generation. Unfortunately, a strict sustainability standard based on natural buffering capacity is incompatible with any nuclear power generation because even if entombed in lead and glass, nuclear wastes can never be totally "buffered" by the natural environment. Thus, avoidance of global warming may confront society with unpleasant choices that are not likely to be resolved solely on ecological grounds.

There is also a presumption in the Hueting-Bosch paper that a sustainability standard will be stricter than a standard based on current individual preferences of society. However, it is quite possible that for certain environmental problems, that a sustainability standard may be less strict than a standard based on current "wants." That is, the standard for sustainability could fall to the left of the individual preference "optimum" point in Figure 1.

An example might be provided by considering a sustainability standard for the discharge of BOD. Since the short-run negative effects of BOD discharges are often reversible, a standard based only on long-run sustainability or even health considerations may safely be quite weak but, nevertheless, socially disruptive in terms of what current BOD levels might mean for, say, recreational damage. Another example might be noise pollution.The level of noise level threatens health is possible to be much higher than the level most would find bothersome. Again, a standard simply based either on sustainability or even health considerations may be far weaker than most in the "current" generation would find desirable.

For these reasons, given the profound social implications of standard setting, one might hesitate before delegating the job of standard setting solely to technicians and scientists. And one might equally hesitate using cost estimates derived from such standards as a basis for adjusting the GNP.

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NORWAY

Overview

The Norwegian system of resource accounting is an example of physical accounting with links to economic activity. The system defines two types of natural resources: material resources and environmental resources. The former in further subdivided into mineral resources, biotic resources, and "inflowing" resources, by which is meant any resources immediately arising from the flux of solar energy (e.g., solar radiation, ocean currents) and the Earth's gravitational field. In addition, there are separate energy accounts that cover energy producing minerals (e.g., coal, oil, natural gas), certain energy producing biotic resources (e.g., fuel wood), and hydro-power, (that is, energy from the "inflowing" resource, flowing water).

Environmental resources mean those environmental assets that provide nonmarketed environmental services. The waste disposal services provided by the air and water would be an example of such environmental services. The corresponding environmental resources would be the troposphere and various water bodies. Both these assets, of course, generate other environmental services such as recreation opportunities, species life-support, etc.

As ambitious as the system may appear according to these very inclusive definitions, in practice the Norwegian system's coverage is far more modest. Thus, resources are confined to the major energy source, petroleum, and the minerals, iron, titanium, copper, zinc and lead; biotic resources are confined to forest products and fish, and the only inflowing resource covered is hydro-power. Moreover, the temporal coverage can be spotty depending on the particular resource: accounts for mineral resources exist for only a few selected years, while there appear to be uninterrupted yearly statistics on forests since 1970 and for fish since 1974.

The environmental resources accounts appear to be confined to a fairly rich set of land-use statistics and to data on the discharge of selected air pollutants (SO2, NOx, CO, CO2, volatile organics, particulates and lead) and two water pollutants (nitrogen and phosphorus).

The following table describes the general format of the material resource accounts. However, different aspects of the table receive different emphasis depending on the resource being described. For example, Part III, describing the uses of the resource, is quite detailed for energy resources and is quite simple for fish. In contrast, the environmental resource accounts lack a standard structure. They merely serve to describe one or more attributes of the resource, such as land use or emission levels and concentrations.

Table 1: Structure of material resource accounts

I. Reserve accounts	
Beginning of period:	Resource base Reserves (Developed, Non-developed)
	Total gross extraction during period
	Adjustments of resource base (New discoveries, reappraisal of old discoveries)
	Adjustment of reserves (New technology, cost of extraction, transport etc., price of resource)
End of period:	Resource base Reserves (Developed, Non-developed)
II. Extraction, conversion, and trade accounts:	
For domestic use:	Gross extraction (by sector) - Use of resource in extraction sectors = Net extraction (by sector)
	Import (by sector) - Export (by sector) = Net import (by sector)
	Changes in stocks
	Net extraction + Net import +/- Changes in stock.
III. Consumption accounts:	
	Domestic use (final use category, commodity)

(Source: Alfsen, et. al. 1987)

Part II and Part III of the table provide the links to economic activity. Indeed, were the accounts confined to Part I, the Norwegian system would not have met the criteria for inclusion in this survey. The use and consumption sectors referred to in the table are the same as those defined in the Norwegian economic accounts (30 to 140 industrial and final demand sectors, depending on aggregation). Indeed, as shown by Longva (1981) this sectoring detail permits the construction of physical input-output tables which, in principle, can be formally linked to the input-output tables underlying the Norwegian economic accounting framework. In practice, however, such tables are exceedingly difficult to develop. Not only must all resource flows be identified by the same set of consuming sectors, these flows need to be measured in the same common units. Thus, coal, oil, gas, etc. would have to be measured in common energy units, perhaps feasible for energy substitutes but far more difficult for dissimilar minerals such as iron and titanium.

Discussion

As mentioned above, the actual Norwegian system is far more modest in scope than a brief description of its structure would indicate. The limitation in coverage is not a defect of the system, but rather reflects a clear view of just what functions the system is to serve (as well as a realistic appreciation of the costs of data development). (As noted in the main report, societal and policy objectives are one of the three principal factors that explain the unique characteristics of data or accounting systems.)

It is not the intent for the Norwegian resource accounts to provide a better indicator of social welfare. For this reason, collection of defensive and pollution control expenditure data and monetization of physical flows, both of which would permit GNP adjustments have not been a priority. Rather, the resource accounts are viewed as a tool to help policymakers better manage the natural environment. While Norway is a "free enterprise" economy, the government exercises some influence through a number of fiscal and monetary instruments. This direction is guided by a number of econometric planning models. The scope of the resource accounts is largely determined by those resource issues that are likely to be of economic and political importance and the ability of the resource information to conform to the input needs of the planning models. On these points, the remarks of Lorents Lorentsen are worth quoting. Mr. Lorentsen has the primary responsibility for the development of the Norwegian resource accounts at the Central Bureau of Statistics.

> The CBS's work on natural resource accounting started with a broad scope on which resources should be accounted, ideally within a common framework. The work is now more concentrated on economically and politically important categories (mainly energy and pollution) linked to national accounting and macroeconomic models. The emphasis is more on forecasting and policy analyses, e.g, how should Norway most efficiently comply to international conventions on air pollution reduction. This development is perhaps a sign of maturity, and a recognition that not all accounts/statistics are useful and valuable. (private communication)

This position reflects a cost-benefit view of information. While increasingly desirable, as accounting systems expand in scope, the incremental benefits may soon lose out to their incremental costs.

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UNITED STATES

Overview

Official environmental accounting in the U.S. has been restricted to the assembly of data on pollution-abatement expenditures. (However, very recently the U.S. Environmental Protection Agency initiated a pilot project with the goal of establishing a set of environmental and resource accounts for the Chesapeake Bay Region. Because it assembles information of direct relevance to policy assessment, EPA has opted for an accounting structure similar to the Peskin framework described in Appendix III. As this project is just underway, it will not be further discussed in this survey.)

Prior to 1989, the expenditure data were assembled in parallel by two separate branches of the Department of Commerce: the Bureau of Economic Analysis (BEA) and the Bureau of the Census (Census). Census drew its data from a survey of about 20 thousand establishments (plants) in the manufacturing sector (SIC 20 and 30), while BEA drew its data from a survey of about 9-14 thousand companies in both the manufacturing and non-manufacturing sectors. Since 1989, both surveys are conducted by Census. Due to budget reductions, the survey of companies has been greatly reduced. It now only covers a sample of about 600 firms in the petroleum, electric utilities, and mining sectors. Thus, data collection has ceased for a number of national accounting sectors that previously had significant pollution abatement expenditures. For example, not covered are transportation ($90 million of expenditures in 1986) and trade and services (whose $260 million of expenditures in 1986). For comparison, mining, which is covered, spent $250 million in 1986.

The establishment data are published annually in 4-digit SIC detail and geographically by state and by Standard Metropolitan Statistical Area. The data previously collected by BEA has also been published annually (in current and constant dollars) for all business and non-business sectors defined in the national accounts. Presumably, this series will continue although data quality must surely suffer as a result of the cutback in the survey.

In its publications, the BEA is careful to follow U.S. national accounting definitions. Thus, for example, purchases by home owners of septic tanks is considered a business (not a household) expense, since U.S. accounting convention places the (imputed) income of owner-occupied housing in the business sector. Similarly, there is no distinction made between current and capital outlays for pollution abatement by governments since the U.S. national accounts do not make this distinction. The basic national accounting categories covered in the publications are as follows:

Figure 1: Pollution Abatement Expenditures–National Accounts Categories Covered

- Personal consumption
  - Durables
  - Nondurables
- Business
  - On capital account
    - Motor vehicle emission abatement
    - Plant and equipment
    - Other
  - On current account
    - Motor vehicle emission abatement
    - Plant and equipment
    - Public sewer systems
    - Other
- Government
  - Public sewer system construction
  - Other

In addition, some of the published data provide a further breakdown of nonfarm business:

Figure 2: Pollution Abatement Expenditures–Nonfarm Business Breakdown

- Manufacturing
  - Durable goods
    - Primary metals
      - Blast furnaces, steel works
      - Nonferrous metals
    - Fabricated metals
    - Electrical machinery
    - Machinery, except electrical
    - Transportation equipment
      - Motor vehicles
      - Aircraft
    - Stone, clay, and glass
    - Other durables
  - Nondurable goods
    - Food including beverage
    - Textiles
    - Paper
    - Chemicals
    - Petroleum
    - Rubber
    - Other nondurables

Non-manufacturing
- Mining
- Transportation
- Railroad
- Air
- Other

Public utilities
- Electric
- Gas and other

Trade and services
Communication and other

Publishing more detail would be possible, but given the size of the survey sample, reliability would be a problem.

In addition to the above sector breakdowns, the cost estimates are also identified by air, water, and solid waste. The establishment survey further asks the respondent to allocate expenditures by type of air pollutant: particulates; sulfur oxides; nitrogen oxides, hydrocarbons, carbon monoxide; and heavy metals, radioactive and toxic substances, other. It should be noted that the costs of control for many of these substances are not separable. Presumably, the respondent must determine how to allocate such joint costs since the instructions on the questionnaire do not address the issue.

The instructions do address another joint cost problem: situations where the control of pollution is due to process change and the introduction of new equipment. In this case, the respondent is asked to estimate what the process change and new equipment costs would have been were they lacking in pollution-control features. Only the incremental pollution-control costs are to be reported.

Finally, in order to obtain a true cost baseline, the respondent is asked to estimate the value of any materials and energy reclaimed in the pollution-control process.

Discussion

Of all the possible modifications that one could make to the conventional national accounts, the separate identification of pollution control costs is the least radical. In the U.S., these data have been used as inputs to models that analyze the effect of economic policy on the economy and on productivity. In contrast to their intended use in the Dutch, German, and UNSO frameworks, these expenditures have not been labeled as "intermediate" in the U.S. accounts. It was never BEA's intent to employ these data to generate a downward-adjusted GNP.

As modest as the U.S. resource and environmental accounting effort has thus far been, recent budget reductions will make it even more modest. Although the situation may change in the future, the U.S. at present appears to be following Japan and Norway in de-emphasizing the role of resource and environmental accounting.

As another example of this de-emphasis, it should be noted that there had been an earlier BEA effort to do resource accounting. This work was conducted within the Measurement of Well-Being Branch of the Bureau of Economic Analysis in the late 1970s. However, the program ceased after only one environmental publication (Landefeld and Hines, 1982). (It should be noted that the program generated other publications in the general area of nonmarket accounting.) Yet, there is a significant legacy in that the Repetto resource accounting methods draw on the Landefeld-Hines methodology.

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WEST GERMANY

Overview

The Federal Statistical Office of West Germany is "considering" the development of an environmental accounting system, independent of but capable of being linked to the national economic accounts. The FSO proposal memorandum of August, 1989, calls for a physical accounting of changes in the "actual state" of the environment. The economic linkage will be in terms of how economic activities affect the (physical) environment. Whether efforts will be made to value the physical accounts and generate adjusted GNP figures has not yet been decided, but it appears that a satellite approach will be preferred. Also, the FSO memorandum does not provide any information on the structure or coverage of these physical accounts except to indicate that they will include "spontaneous natural developments that are important for the environment and man." It is therefore not clear at this point what features the proposed environmental accounting system will have.

However, in private communication, Professor Udo E. Simonis of the Science Center in Berlin feels that the eventual system will reflect three different approaches: the Schafer-Stahmer approach (see below), the Leipert-Simonis "defensive expenditures approach," and the Wicke-Schultz "damage-cost approach."

The Schafer-Stahmer paper (March, 1988) focuses on the possible economic importance of environmental protection activities, broadly defined to include both pollution control activities and activities to defend against environmental insult. (Earlier work in Germany by Leipert also does not distinguish between both types of activities--a distinction that is made in the U.S. pollution-control literature.) Of particular concern to Schafer-Stahmer is the problem that expenditures for these activities may be double counted to the extent that these expenditures lead to indirect outlays for general economic goods and services. However, by identifying these environmental expenditures by consuming and producing sector, one can construct input-output matrices consisting only of these outlays and which are, thus, independent of the conventional input-output matrix. With these (sub-) matrices separately identified, and with the usual constant-coefficient assumptions, Schafer-Stahmer demonstrate that it is possible to distinguish between primary inputs devoted to environmental protection and total primary inputs or conventional value added. This value of primary inputs devoted to environmental protection could then be subtracted from GNP to yield an alternative GNP. However, even if one does not wish to make any GNP adjustments, the Schafer-Stahmer calculation is still useful in that it may provide a better indicator of the relative economic importance of environmental outlays than would a raw total of environmental expenditures, which will include double counting.

The accounting structure to support this model is reminiscent of the proposed UNSO environmental accounting structure. A distinction is made between external and internal environmental protection activities: that is, between environmental protection services purchased from others and environmental protection activities taking place within a sector. The former can be treated

by introducing an additional row in the input-output table showing an environmental protection sector that delivers services to all other producing sectors. (Schafer-Stahmer, Table 1) However, the treatment of internal protection activities is more difficult since the requisite goods and materials used for this purpose by any sector are supplied by many sectors. Schafer-Stahmer have managed (for 1980) to distinguish these purchases from other ordinary inputs and, thus, have been able to construct a separate input-output table covering (internal) environmental expenditures, which also includes, the row describing the external protection services. (Schafer-Stahmer, Table 2).

In other words, Schafer-Stahmer have been able to isolate all environmental control expenditures (including final demand and primary input expenditures) from the conventional input-output matrix. If **E** is the conventional input-output matrix and **G**, the pollution-control input-output matrix, a matrix, **F**, can be defined as their difference. Each of these matrices can be typically partitioned as follows:

$$\begin{bmatrix} A_{(E,F,\text{ or } G)} & FD_{(E,F,\text{ or } G)} \\ VA_{(E,F,\text{ or } G)} & 0 \end{bmatrix}$$

where **A** is a square matrix of industry input-output flows; **FD**, a rectangular matrix of final demands (consumption, investment, exports, and governmental activities; and **VA** a rectangular matrix of value added inputs (labor, profits, capital consumption allowances, and imports). Dividing **A** by industry output totals yields the usual input-output coefficients. These are the conventional coefficients for A_E. That is, they measure input per unit of output. Obviously, for A_G, the pollution-control input-output matrix, these coefficients measure pollution-control input per unit of output.

The approach in the Leipert-Simonis paper (1990) is simpler in that pollution-control expenditure information is presented in tabular form rather than in matrices. However, as a trade-off, the data development effort is clearly easier and they are, thus, able to generate annual time series beginning in 1975. As is the case with the U.S. pollution-abatement expenditure series, both capital and operating expenses are estimated. The Leipert-Simonis paper also reproduces damage estimates using the Wicke-Schultz "damage-cost approach" (1986). These estimates are not further discussed here because the Wicke-Schultz paper is not available in English.

Discussion

As noted, the available written material (in English) does not provide any details of the proposed FSO accounting system. Therefore, it is not clear to what extent the concepts in the papers by Schafer-Stahmer, Leipert-Simonis, or

Wicke-Schultz will be adopted. On the assumption that some of these ideas will find their way into the German system, the following comments are in order.

Firstly, it should be noted that the Schafer-Stahmer or Leipert-Simonis adjustments to the conventional accounts are very conservative in that they cover economic activities that are already covered in the conventional accounts, although they are not separately identified. The adjustments do not cover any non-market services of the environment or any damages to these services ("loss of function" in the Hueting terminology). Nor do they cover natural and environmental resource depletion and degradation. Thus, these accounts only will partially meet the objectives of the FSO.

Although the suggested adjustments appear far less ambitious than those suggested, say, by the French, their implementation--especially the Schafer-Stahmer implementation--is hardly trivial. In particular, identifying the source (by sector) of "internal" environmental control outlays would seem a near impossible task since such separate identification is not a feature of ordinary business accounting. In fact, even if the accountant wishes to separate purchases according to whether they are for environmental control or for ordinary business purposes, it may not be possible to do so in principle. Often pollution control is accomplished by the introduction of more modern capital that jointly serves the purpose of pollution control and ordinary production. As the costs of such capital are, thus, "joint", it is not clear that anything other that an arbitrary separation is possible. In view of these problems, one is curious about the methods used to generate the data behind the input-output tables in the Schafer-Stahmer paper and whether these methods are feasible in developing countries. It appears that the Leipert-Simonis approach would be easier to adopt.

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APPENDIX II

OTHER APPROACHES[1]

Peskin

Overview

The accounting framework of Henry M. Peskin was developed as part of the now defunct Measurement of Economic and Social Performance program of the National Bureau of Economic Research. The purpose of this program was to develop improved measures of economic and social performance by expanding the national income and product accounts of the United States.

The Peskin framework (Peskin, 1989) thus is a modification of the U.S. accounting framework and, therefore, lacks the detail (and ambition) of the proposed UNSO approach of Bartelmus, van Tongeren, and Stahmer, which is more closely tied to the input-output style of the SNA.

Peskin's approach is to treat all assets--both marketed and nonmarketed--symmetrically. Thus, the environment is viewed as providing services to both intermediate and final demand sectors. At the same time, there may be negative output due to externalities associated with the consumption of these services (e.g., disposal services lead to pollution). This negative output is added (negatively) to final demand.

As with the Repetto approach, all assets are depreciated, including natural resource wealth. Along with marketed asset depreciation, this depreciation is subtracted from GNP to produce an adjusted NNP. The GNP, itself, is not affected by depreciation but it may be affected by the negative and positive values of nonmarketed environmental services. However, Peskin's primary interest is not in GNP adjustment. He demonstrates that several possible adjustments are consistent with the accounting framework, but he endorses none of them.

Instead, Peskin puts forth his framework as an information system for accounting for the linkages between environmental asset use and the use of other, marketed or nonmarketed, assets in the economy. Of critical importance is the fact that, lacking markets, the unit value of environmental asset services depends on the production and preference functions of the user. Thus, the consolidated framework allows for dual valuation--one for the input side and one

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[1] As noted in the main report, these approaches are included for reasons of comparison and because they illustrate accounting approaches different from those surveyed in Appendix 1. There are additional environmental and resource accounting efforts taking place in countries other than those surveyed. (See page 2, footnote 1). These are not described because the author is not knowledgeable about their details. While some of these efforts may duplicate approaches discussed in this paper, there is the possibility that some innovative ideas have been overlooked.

for the output side of the accounts. To maintain accounting balance, there is a balancing entry equal to the arithmetic difference between these two values. Peskin shows that the size of this balancing entry is proportional to the amount of economically inefficient allocation of environmental assets.

The valuations, in turn, are based in the neo-classical economic principal of consumer sovereignty. Thus, the value of input and final demand use is based on the willingness-to-pay for this use. Negative output or damage is estimated by the willingness-to-pay to avoid this damage. In practice, the willingness-to-pay estimates are based on procedures drawn from the benefit-cost literature.

The Peskin framework was implemented with U.S. data for two years, 1972 and 1978. However, the only environmental asset services covered were the disposal services to industry provided by air and water. Furthermore, the implementation did not include any calculation of natural resource depreciation. A typical example of the resulting consolidated income and product account is shown as follows:

1978 Consolidated National Income and Product Account
(billions of 1972 dollars)

Input			Output	
1. Compensation of employees and proprietors (incl. rental income)		1447.2	14. Personal consumption	1350.8
2. Profits with inventory valuation and capital consumption adjustment		167.7	15. Gross private domestic investment	351.5
a. Profits before tax	84.5		16. Exports	207.2
b. Profits after tax	121.5		17. Imports (-)	217.5
c. Inventory valuation & capital consumption adjustment	-38.3		18. Governmental goods &	435.6
3. Net interest		109.5		
NATIONAL INCOME		1724.3		
5. Transfer payments		9.2		
6. Indirect taxes		178.1		
7. Subsidies (-)		4.2		
8. Statistical discrepancy		3.3		
NET NATIONAL PRODUCT		1910.7		
9. Environmental depreciation (-)		NA		
MODIFIED NET NATIONAL PRODUCT				

10. Capital consumption		216.9			
11. Environmental depreciation (+)		NA			
CHARGES AGAINST GROSS NATIONAL PRODUCT		2127.6	GROSS NATIONAL PRODUCT		2127.6
12. Environmental services (-)	43.9		19. Environmental damages (-)	46.6	
a. Air	29.6		a. Air	31.6	
b. Water	14.3		b. Water	15.0	
c. Land	NA		c. Land	NA	
13. Net Environmental Benefit	-2.7				
MODIFIED CHARGES AGAINST GROSS NATIONAL PRODUCT		2081.0	MODIFIED GROSS NATIONAL PRODUCT		2081.0

The unaggregated data behind the consolidated accounts have been used by a number of U.S. governmental agencies to support various policy analyses. The fact that disposal and damage estimates are based on willingness-to-pay concept makes the data useful for benefit-cost assessments of policy. In addition, since the underlying data were identified in substantial geographical detail, they have proved useful for analyzing the distributional implications of policy alternatives.[2]

Discussion

Although not as detailed as the UNSO framework, the Peskin framework does make significant demands on data. For example, there must be complete coverage of environmental asset use by sector. For the U.S. implementation, this coverage required data on pollution discharges and prospective costs for avoiding these discharges by 3- and 4-digit Standard Industrial Classification. Adapting this framework to relatively data poor developing countries would probably require greater aggregation.

In addition, it is not clear that the neo-classical framework would meet developing country needs. In particular, the consumer sovereignty principle may underestimate the value of assets to the extent that this value derives from benefits to future generations. It may be necessary to find alternative valuation principles.

It should be noted that, like other systems surveyed (e.g., the Norwegian, French, and Repetto approach), the implementation procedure usually requires the

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[2] These analyses are in a number of government reports. However, some of the findings have been reproduced in journal articles. See, for example, Peskin (1986), Crosson, et al., (1986), Gianessi, Peskin, and Young (1981a and 1981b), Gianessi and Peskin (1980), and Gianessi, Peskin, and Wolff (1979).

assembly of physical data sets. Even without resolving valuation issues, these data sets can be valuable. In the case of the Peskin framework, financial support was provided by several policy agencies in the U.S. government who were primarily interested in these data sets. Since they were developed with a comprehensive accounting goal, the coverage of these sets was far more complete than the coverage of the sets readily available to these agencies.

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Repetto

Overview

The resource accounting activities of Robert Repetto and his colleagues at the World Resource Institute have relatively limited objectives: the accounting for the value of the depletion of those natural resources that generate marketed output. The intent is to adjust conventionally-measured income for this depletion in order to obtain a better estimate of sustainable income. Moreover, the intent is also to eliminate the asymmetrical treatment of capital depreciation between marketed capital and natural resource capital.

The focus is not on the general environment. No adjustments are made for pollution or environmental degradation. In addition, no subtractions to GNP are made for current environmental expenditures. Furthermore, the method used to calculate natural resource depletion, based on the method of Landefeld and Hines, is very simple. Essentially, estimates of the physical change in resource capital, through use, discovery, and (if applicable) natural growth over the accounting period is multiplied by the average net unit value of the resource. The net value is essentially equal to sales minus production costs and, thus, approximates economic rent.

Perhaps because of the modest objectives and the simplicity of the implementation approach, the Repetto approach has a record of successful implementation in Indonesia, and further studies are planned or are currently in progress in the Philippines, Costa Rica, and China.

Discussion

While the Repetto approach has been widely hailed in the popular press, it is not without its critics. Some (e.g., Clarke and Dragun, 1989) feel that the Landefeld-Hines approximation is inappropriate for renewable resources, since it is possible that short-run physical reductions in these resources could actually increase the value of remaining stock and, thus, yield negative depreciation or capital gain. As noted in the main report, El Serafy also finds the procedure inappropriate for non-renewable resources as well on the grounds that the depreciation procedure does not allow for re-investment of proceeds.[3] Because of this, El Serafy asserts that the calculated net income is too pessimistic in that it underestimates true sustainable income. Furthermore, he feels that the procedure fails to adjust gross income correctly. Several critics (e.g., Roger Sedjo (private communication) and Peskin) feel that Repetto's procedure is too partial in that it does not sufficiently capture the value of investment that may replace the depleted resource (a criticism that in certain respects is similar to El Serafy's). Thus, for example, depleted forests may be replaced with productive grazing lands. Finally, it should be noted that the procedure assumes the existence of economic rent that can be attributed to the

[3] See page 11 of the main report.

scarce natural resource. However, such a rent will not be observable if there is uncontrolled access to the resource--the so-called "commons" problem. Over-exploitation of the resource drives the market value of resource rents to zero.

None of these criticisms is "fatal." Clarke and Dragun's criticisms could be met with more sophisticated depreciation approaches and, in El Serafy's case, the use of alternative income aggregates. However, a response to the criticism that the approach is too partial would require the use of a much more comprehensive accounting framework: one that could trace both private and public investment that would replace depleted natural resource assets. Yet, adopting such a framework may have slowed the pace of or even prevented implementation. Finally, if there is a "commons" problem, the unobserved rent could be replaced with a rental value under an assumption of optimal restricted access. However, such an optimal value is not observable; it must be modeled.

Thus, Repetto's approach may illustrate a dilemma. One the one hand, we can make progress over the conventional accounts with respect to the treatment of natural resources and the risk of making misleading assessments of the true state of natural resource wealth. On the other hand, we can try to avoid making such misleading assessments by trying to be more comprehensive and by the development of models, but at the risk of making slower progress.

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United Nations Statistical Office

Overview

Staff from the United Nations Statistical Office (UNSO), with collaboration of Carsten Stahmer, have recently suggested the development of a system of satellite accounts, covering natural resource and environmental activity. (Bartelmus, Stahmer, and van Tongeren, 1989) These accounts are designed to link with the SNA and, if implemented, would permit the construction of several alternative measures of aggregate economic activity. As of now, these accounts do not have an official standing but the framework paper will be the basis for a draft manual and for two case studies to be undertaken jointly with the World Bank.

In contrast to the Norwegian effort and more like the French, the objectives are rather broad: "segregation and elaboration of all environment-related flows and stocks of assets of traditional accounts"; "assessment of environmental costs and benefits"; "elaboration and measurement of indicators of environmentally adjusted or sustainable income and product"; and "linkage of physical resource accounting with monetary environmental accounting and balance sheets." At the same time, the UNSO also wishes to follow "as far as possible the principles and rules established by the SNA." In particular, they wish to adhere to the SNA's (current) coverage of productive activity ("production boundary"). As will be discussed below, this goal may be in conflict with some of their broader objectives.

The essential features of the framework can be found in the following consolidated GDP account. (The figures are taken from the paper by Bartelmus, Stahmer, and van Tongeren, 1989.)

Figure 1 : Consolidated Adjusted UN GDP Satellite Accounts

GDP	293,337
{Consumption	217,437
Investment	76,630
Exports	73,797
(Imports)}	(74,527)
Environ. protect. services included in final demand	19,023
GDP adjusted	274,314
Environmental cost	51,839
{ Loss of non-renewable assets	25,322
Loss (gain) to renewable assets	(30,098)
Environ. assets used up	95,193
Natural disaster and degradation of private assets}	(38,578)
SUSTAINABLE GDP	222,475
Capital consumption	26,366
SUSTAINABLE NDP	196,110

As has been frequently suggested by others, final demand environmental protection activities are shown as intermediate and, thus, are subtracted from conventional GDP. However, household protection activities appear to be subtracted at two different places in the framework. If they are classified as "household environmental protection activities", they are subtracted from conventional GDP to yield "environmentally adjusted" GDP. On the other hand, if they are classified as "consumption of households required to deal with environmental change," they are apparently included with other "environmental costs" and are thus subtracted later. Specifically, consistent with the suggestions of the Dutch, Japanese, and Germans, "environmental costs" (or, in U.S. usage, "damages") are shown as a further reduction in conventional GDP to yield "sustainable" GDP. However, the composition of these "environmental costs" is somewhat unusual.

In the first place, along with pollution and other insults to the environment, these costs include environmental and natural resource asset consumption and degradation. Other investigators (e.g., Peskin, Repetto) would include such depreciation with the depreciation of ordinary assets. In the second place, the "costs" include natural growth of renewable assets and destruction of private assets due to natural disasters. Some may feel that defining these items as environmental costs (or "damages") is confusing. Finally, inspection of the subtotals reveals that all pollution damage and other environmental insults are treated as if their total effect is to reduce the quantity or productivity of environmental and natural resource assets. This treatment blurs a useful distinction between "direct-interaction" and "asset-utilization" environmental externality problems. (See below).

Supporting the above consolidated accounts is a large "use" table that breaks down many of the totals by producing and final demand sector. Of particular interest is the breakdown of environmental protection outlays by consuming sector and environmental "costs" by sector of origin.

However, not shown are those intermediate and final-demand sectors affected by environmental insults. In addition, there is no separate entry for the consumption of environmental services by sector. The implicit assumption appears to be that damages ("costs") are equivalent to these services. In other words, the value of waste disposal to the steel industry is assumed equal to the value of the damages caused by the steel industry's pollution. The implication of this assumption is discussed below.

It should be noted that the Bartelmus, Stahmer, and van Tongeren framework is not the only framework suggested by the U.N. In particular, the Population Division of the Department of International Economic and Social Affairs in 1982 suggested the introduction of environmental accounting through an expansion of a social accounting matrix (SAM). (U.N., 1982)

The SAM framework displays flows of expenditures and receipts by sectors, each of which can be grouped under "account" headings (e.g., factors of production, institutions, production sectors, commodities, rest-of-world). The proposal is to add to these groupings an environmental sector or "account" with

an "output" row showing the demand for environmental goods and services by institutions, by production sectors, and by the rest of the world. There would also be an "input" row to this sector showing "expenditures" for these services by production and institutional sectors. Unfortunately, the paper lacks detail on how these "expenditures" would be determined. However, one could imagine that they might be based on imputed values of the environmental services to the consuming sectors. If so, the system would share a basic similarity with the Peskin framework.

Also consistent with the Peskin framework is the introduction of an explicit environmental sector. This approach is in contrast with that of Bartelmus, Stahmer, and van Tongeren who wish to adhere to the conventional SNA production boundary.

Discussion

The Bartelmus, Stahmer, and van Tongeren framework is a major advance over simpler, more consolidated frameworks in terms of its ability to trace inter-industry effects of environmental change. Of particular usefulness is the fact that reductions in environmental and natural resource capital are not viewed in isolation. Any offsetting increases in non-environmental capital are clearly displayed.

However, there are a number of potential problems with the framework that, hopefully, can be addressed in future revisions.

In the first place, while strict adherence to the SNA sector boundary has its value, one wishes that they would have taken the opportunity to introduce an explicit household production sector. While the neglect of nonmarket household production may not have serious consequences in industrialized countries, nonmarket production constitutes a major share of economic activity in developing countries. This household activity may have direct consequences for the environment and environmental policy. Fuelwood gathering is an obvious example.

Of equal importance, especially for practical implementation, is the lack of a "natural" sector. By not having such a sector, all environmental damages are, by definition, attributed solely to human activities. Unfortunately, when one is affected by poor air or water, the defensive actions taken are likely to be the same regardless of whether the pollution has natural or man-made origins. To neglect "nature" as a source of pollution overstates the likely benefits of policy actions directed against human activities.

Another possible problem with the framework is the failure to distinguish between services provided to economic sectors by the environment and damages (or "costs") to the environment by these sectors. The single "environmental cost" entry implies that these values are the same. Moreover, if, as the authors suggest, these damages are to be valued in terms of their cost of elimination, it implies that the opportunity cost of environmental policy is exactly equal to the policy benefits. These assumptions make it impossible for the authors

to use the framework for an "assessment of environmental costs and benefits"--one of their stated objectives.

A third problem is the assumption that all environmental "costs" can be viewed as if their effect is to degrade environmental and natural resource capital. While many (some might say most) insults to the environment have this "asset-utilization" effect , many so-called environmental externalities have more of a "direct-interaction" effect. (The terminology is from Mohring and Boyd, 1971.) Thus, for example, noise pollution is probably more usefully analyzed in terms of its direct effect on individual utility functions than on its effect on the rate of depreciation on human and environmental capital. (Admittedly, it could be treated in terms of its affect on the depreciation of capital, but it would be awkward to do so.) It would be more useful for the interpretation of the damage data if Hueting's distinction between "quantitative competition" (e.g., asset utilization) and "qualitative competition" (e.g., direct interaction) for services of the environment could be maintained.

There is also the question of why the depreciation of environmental assets are treated differently from the depreciation of non-environmental assets. Of course, if economic activity destroys environmental and natural resource capital, GDP will not be sustainable. Thus, the motivation for defining (environmentally) "sustainable GDP" is understood. However, the GDP is equally un-sustainable if economic activity serves to destroy machines, factories, and, of course, human capital. The sustainability-distinction between natural resource capital and other economic capital is only meaningful if natural resources are assumed to have no substitutes--a highly controversial proposition. Moreover, maintaining this distinction may make it more difficult to get these ideas accepted by non-environmental economists. A better strategy might be to highlight the similarities between natural resource/environmental capital and ordinary marketed capital rather than their differences.

There are also a number of questions concerning data demands and implementation specifics that can be raised about the Bartelmus, Stahmer, and van Tongeren framework. For example, is the intention to distinguish between "internal" and "external" pollution-control activities along the lines of the German framework? How will household defensive expenditures be distinguished from ordinary consumption outlays? How easy will it be to apply such a comprehensive framework in data-poor developing countries? Presumably, these and other data and implementation issues will be addressed in the proposed World Bank pilot projects.

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APPENDIX III

DEFICIENCIES IN THE NATIONAL ACCOUNTS

National economic accounts, a framework for the systematic organization of economic data describing a nation's economic condition, exist in one form or another worldwide. Governments have found these accounts indispensable for purposes of organizing the data necessary for the analysis and design of economic policies and for gauging the success of these policies.

While national accounts have a long history, their initial widespread use by resulted from the policy demands engendered by the Great Depression and by World War II. As their popularity with Governments has grown, the general public has also begun to become more familiar with the accounts and especially certain aggregate totals drawn from the accounts such as the Gross National Product (GNP). GNP along with other economic data such as price and employment statistics are widely looked upon as indicators of how well a nation is doing.

However, along with the growth in popularity has been a growth in criticism of the accounts--not so much of their use as a data system but more often their use as indicators of national well-being. Coinciding with the surge of interest in the environment in the 1960s and early 1970s, alleged inadequacies regarding the GNP's ability to reflect the environment and, more generally, the "quality of life" were the subject of a number of articles and newspaper editorials. More recently, the criticism has shifted towards alleged weaknesses in the ability of the accounts to reflect the possible deterioration of a nation's resource base. As a result, the economic activity measured in the accounts may not represent sustainable activity over the long run.

There are three additional deficiencies with the standard national economic accounts that may result from their inadequate treatment of the environment and natural resources: the conventional accounts provide a poor measure of social and economic performance, the conventional accounts treat different forms of national economic wealth inconsistently, and the conventional accounts ignore important variables explaining economic activity. These three deficiencies will be discussed in turn.

1. Inadequacies as a measure of social and economic performance[1]

One of the most frequently heard criticisms of the conventional national accounts is that they respond poorly (some would say "perversely") to changes in environmental and resource conditions. Certainly, it is true that pollution, congestion of parks and wilderness areas, and the depletion of natural resources are oft n unfortunate side effects of economic growth. Thus, it is disturbing to much of the public that economic data drawn from the national accounts point in a positive direction. To make matters worse, often the conventional economic

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[1] The author realizes that when used together, either the word "social" or "economic" may be redundant, depending on how broadly each term is defined.

indicators poorly reflect efforts to defend against environmental insult and efforts to clean up the environment. If, for example, resources in the economy are not fully employed, it is quite likely that any increased expenditures on medical services or for household cleaning due to increased pollution levels will result in an increase in economic activity and, thus, an increase in GNP. On the other hand, efforts to clean up the environment could lead to a decrease in GNP (measured in constant prices) to the extent that these expenditures are "current account" outlays borne by business and, thus, divert resources from ordinary output.

Of course, it could be argued that over the long-term, a clean working environment and a sufficient stock of natural resources are necessary for healthy and sustained economic growth. Thus, the potential "perversities" suggested above may only exist in the short- or medium-term. However, because of the popular fixation on the GNP as the indicator of current social and economic well-being, the argument that if environmental conditions become bad enough, GNP indeed will eventually go "in the right direction," will not satisfy the critics.

2. **Inconsistent treatment of income and wealth.**

Criticisms of the national accounts as indicators of well-being have been readily dismissed by academic economists and those national account statisticians who feel that the accounts are simply a record of a nation's production and were never intended to be an indicator of social and economic well-being. They may argue that if the press, the public, and the politicians persist in believing otherwise, the problem is with public attitudes and their lack of understanding, but not with how the conventional accounts treat the environment. On the other hand, the criticism that the standard accounts do not provide consistent treatment of income and wealth may have more support among economists.

More specifically, the assertion is that the standard accounts inconsistently exclude information needed to comply with conventional definitions of "income." Conventionally, income is defined as the sum of consumption expenditures plus investment (where "investment" also includes net foreign investment defined as exports less imports). However, the conventional definition further distinguishes between gross investment and investment less depreciation, or net investment. Accordingly, we distinguish between gross income and net income, where the latter is defined as consumption plus net investment.

While most economists feel that there is no income aggregate that fully measures economic well-being, many would argue that net income, as opposed to gross income, comes closer to the mark, since it better represents the amount society can consume after allowing for the production of resources necessary to maintain society's stock of capital. Gross income, in contrast, may not be sustainable to the extent that its level is supported by a diminishing capital stock and thus does not comply with the Hicksian definition of income adopted

in most national accounting frameworks including the SNA.[2] Consequently, one important entry in the standard economic accounts is "depreciation," which allows the translation of gross income (or product) to net income (or product).

The inconsistency arises because the conventional national accounts measure the depreciation of certain forms of capital, such as plant and machinery, but neglect to account for the depreciation of other forms of capital such as natural resources and environmental capital, as represented by the nation's stock of clean air, water, soil, wilderness areas, non-renewable resources, etc. As both environmental and natural resource capital are crucial to the production of goods and services--especially in heavily resource-dependent developing countries--neglecting this sort of depreciation necessarily means that net income is overstated. Of course, one could point out that other forms of capital depreciation are also neglected in the standard accounts. Of particular importance is the neglect of the depreciation of (as well as investment in) human capital, even though the services of this capital (that is, "labor") accounts for most of a nation's income.

It should be pointed out that while several critics of conventional accounting practice wish to address the inconsistencies arising from the failure of the accounts to cover the depletion of natural resource and environmental capital, they still wish to treat such capital differently in their suggested accounting modifications. The issue of whether natural resource and environmental capital "deserve" special treatment is addressed in Appendix I.

3. **Neglect of important determinants of economic activity.**

An important function of the national accounts is that they serve as an information system containing those statistics that determine and define the nation's economic activity. Thus, even if one were unconcerned about the accounts failure to treat environmental concerns adequately or about possible inconsistencies in the definition of income, one might still fault the conventional accounts if it is believed that they are not fulfilling their informational role. Specifically, one could point to the neglect of the services of natural resources and the environment. After all, these services influence production and consumption activities in much the same way as the services of human capital, plant, and equipment, which are already measured in the accounts.

In its role as an information system, the economic accounts provide a snapshot of the economy's "production function": an instantaneous picture of the

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[2] See Hicks (1946). (References are found in main report.) It should be pointed out again that no single accounting aggregate--whether it measures gross income or net income--is entirely satisfactory for the measurement of economic performance. For example, two countries can have exactly the same net income but where one country consumers it entirely while the other saves half. The fact that the latter country has the potential for future growth, while the former does not, is not captured in the income aggregate.

transformation of factors of production into product and services. Neglecting environmental and natural resources distorts the picture of production in two ways. It overlooks the production of some undesirable outputs (e.g., pollution) and leaves out a number of crucial inputs to both desirable and undesirable product.

This lack of a full accounting of all inputs and outputs complicates the nation's economic and environmental policy process. The availability of key environmental and resource inputs may be crucial in determining whether economic goals will be reached, especially in less-developed, resource-based economies. Thus, neglecting these inputs in national income accounting could lead to less optimal policies than would otherwise be the case.

Yet, even in industrialized, non-resource based economies, while the neglect to account for environmental or natural resource inputs and outputs may not have as dire a result, it may hamper the ability to develop an integrated policy approach directed towards certain resource and environmentally dependent sectors. For example, we are unlikely to gain a full understanding of the response of the agricultural sector to agricultural policies without a complete accounting of all the significant inputs and outputs, both marketed and environmental, that are involved in agricultural production.[3]

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[3] For a discussion of nonmarket factors and agricultural productivity, as well as bibliography of related references, see Peskin (forthcoming).