THE POLICY IMPLICATIONS OF NATURAL RESOURCE AND ENVIRONMENTAL ACCOUNTING

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Abstract

Increasing concern about environmental degradation, resource depletion and the sustainability of economic activity have made the development of natural resource and environmental accounts an area of significant activity. Yet, little attention has been devoted to asking exactly what ends do these accounts ultimately serve.

The primary goal of this paper is to examine, through a series of country case studies, the linkages between the development of these new elements of national accounts (broadly conceived) and the proposed or actual policy used that these accounts are designed to meet. The case studies reveal a variety of motivations which underlie attempts by governmental departments or national statistical offices to incorporate environmental concerns into national accounting practice. This is followed by an assessment of the empirical experience obtained from a number of existing studies.

The paper concludes with some general inferences regarding the lessons to be learnt regarding future green accounting efforts in both the developed and the developing world.

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1.Introduction

Increasing concern about environmental degradation, resource depletion and the sustainability of economic activity have made the development of natural resource and environmental accounts an area of significant activity in both developed and developing countries. The primary goal of this report is to examine, through a series of country case studies, the linkages between the development of these new elements of national accounts (broadly conceived) and the proposed or actual policy uses that these accounts are designed to meet.

The National Income and Output accounts of individual nations have traditionally served two functions. First, they act as a record of the level and nature of economic activity in the country. As such, they are an essential ingredient of economic planning, whether of the now largely defunct central planning kind, the *dirigiste* form still favoured in many countries, or the free, or nearly free, market kind. Second, they have widely been regarded as offering some kind of indicator of the 'standard of living' of a nation's population. Gross National Product (GNP) per capita, for example, is a widely used measure on its own, or as part of a wider 'development index' (UNDP, 1992).

Over the last few centuries interest in one or other measures of national income has varied according to purpose. The very earliest investigations in England in the 16th Century appear to have been motivated by a concern to discover what was happening to external trade because of a balance of trade scare (Mitchell, 1988). Subsequent partial investigations were prompted by the need to pay for various wars and by the ongoing preoccupation with the need to maintain naval resources. The very first attempts at comprehensive 'political arithmetic' were for England by Sir William Petty and Gregory King. King's estimates for 1688 are reproduced in Deane (1955) and Deane and Cole (1962) and seem to have been promoted by a new tax on births, burials and marriages. These early measures were of the 'wealth of the nation' and were motivated by a concern to know how that wealth was generated. It seems fair to say that this remained the motivation until more recently when interest in comparing human wellbeing within a country over time, and between countries, developed. In short, there is a modern preoccupation with the links between measures of *income* and measures of *human wellbeing* or 'welfare', an outcome also of the emergence of welfare economics as a comprehensive subdiscipline of economics just after the Second World War.

It is now widely recognised that the conventional way of measuring GNP provides a fairly poor indicator of human wellbeing. The degree of error is especially

influenced by the extent and importance of non-marketed activity. Such activity may involve the unrecorded production of goods - the labour of women in the home and fetching water and fuelwood, and the supply of environmental goods such as amenity, for example - and unrecorded production of 'bads', such as environmental pollution and resource depletion. These concerns reflect the wider concern with GNP, or, more accurately, *net* national product (NNP), as a measure of wellbeing. It is no accident that the earliest efforts to adjust conventionally recorded GNP were made at the time of the environmental revolution of the late 1960s and 1970s when the pursuit of economic growth was itself being questioned (see, for example, Nordhaus and Tobin, 1972). Today, the focus has shifted, although not completely, to an acceptance of growth in value-added as a legitimate objective, but without growth in materials and energy usage - an underlying condition for 'sustainable development' (WCED, 1987).

The result has been a flurry of research and activity to produce measures of 'green' national income for developed and developing economies alike. Broadly, two approaches have developed:

(a) those where sets of resource and environmental accounts in non-monetary units either accompany conventional GNP accounts, or appear separately -so-called *satellite accounts*; and

(b) those where resource and environmental changes are monetised and are then used to adjust the conventional GNP measure - *adjusted GNP* or *extended monetised accounts*.

This report is not concerned with the debate over how best to estimate a green income measure or develop satellite accounts, although we offer a brief overview and synthesis, as far as that is possible, of the competing methodologies.[1] Nor is it concerned with the empirical results of 'green GNP' exercises, although we illustrate some of the findings with empirical estimates of 'green' national income.

The report has two main purposes:

The first purpose is largely descriptive. We wish to know how the *practical* process of developing green income accounts has developed in those countries where there is significant government or government sponsored

[1] For useful discussions of the debate see Ahmad *et al.* (1989); Hamilton (1991); Lutz (1990); Hartwick and Hageman (1991). On the pure theory of an ideal national income measure, see Maler (1991); Hartwick (1990); and Weitzman (1976).

activity. We have not investigated countries where we know there is significant *research* into environmental accounting outside of government. The dividing line is not always a clear one but, by and large, we take official activity or sponsored activity to signal some kind of political commitment to green accounting. Supplementing this description of official activities is a review of empirical studies that have been carried out both by governments and research institutions.

The second purpose is to ask *what use* green accounts may serve. It is arguable that the race to develop green accounts has run ahead of a well defined purpose. If so, green accounts could be a method looking for a purpose. To test this rather negative hypothesis we visited a number of countries to see how they saw the development of green accounts.

The end results are interesting. It seems clear that there is no *one* vision of the purpose of green accounts: different countries are developing them for different purposes. Our concluding section classifies those purposes and the experience to date. For example, some countries seek a 'sustainability indicator', others aim to use green accounts for persuasive purposes, i.e. to raise the profile of environmental issues. Some are more concerned with wealth measures than 'true' income accounts. Some appear to have no well-defined goals in develop-ing the accounts and are reacting to the general level of activity elsewhere, perhaps because they wish to be seen to be doing something rather than nothing. And perhaps because there is no *one* consensus methodology, some countries appear confused by the debate and have accordingly been rather inactive.

We believe that there are lessons to be learned from the assessment in this study and set those out in the concluding section. While the precise legal status of Agenda 21, approved at the Rio Earth Summit in June 1992, remains unclear, it is widely regarded as being 'international soft law' (Johnson, 1993), i.e. as containing moral if not legal obligations. Chapter 8 of Agenda 21 calls on governments to:

'..expand existing systems of national economic accounts in order to integrate environment and social dimensions in the accounting framework, including at least satellite systems of natural resources in all member States' (8.42).

It seems clear that governments will respond to this call in various ways. This report shows how various countries have developed their accounting systems so far and suggests the lessons to be learned.

2.The Competing Methodologies

The reasons for wishing to augment or alter the national accounts to reflect resource and environmental concerns are quite varied in the literature: the accounts measure the goods but not the "bads" from economic activity; the treatment of environmental protection expenditures is questionable; the depreciation of environmental assets and commercial natural resources is not measured; environmental and resource assets are not included in national wealth, nor are environmental liabilities; and no measure of the *sustainability* of economic development is provided by the accounts.

Gross domestic product (GDP) is based on the standard national accounting identity, that total income (wages, salaries, supplementary labour income, and profits) equals expenditure (household expenditures, investment, government expenditures, and exports less imports), where to the extent possible all measurements are based on observable transactions in the market. Because of this limitation to transactions in markets, many alternatives or supplements to national accounts have been proposed. However, few standard definitions exist for these alternatives. *Natural resource accounts*, as typified in Norway (CBS Norway, 1989), represent an attempt to achieve complete and consistent physical accounts, in both stocks and flows, of a nation's endowment of commercial resources: the usual account categories include opening stocks, extraction/harvest, revisions, growth, discoveries, and closing stocks. *Environmental accounts* are much more diverse, including measurements of quantities and qualities of resources lying outside the market system.

The response by national accountants, environmental economists and others to the perceived limitations of the national accounts has been to develop two broad approaches to dealing with these problems. One solution offered is the design and construction of *satellite* accounts, linked to the standard System of National Accounts (SNA) but not fully integrated with these accounts, in which physical and monetary data are typically combined. The second approach is the development of altered national accounting aggregates, or the development of new aggregates, in which monetary values are assigned to environmental variables and new measures of income, product and wealth are produced.

According to UN guidelines (United Nations, 1992), satellite accounts "stress the need to expand the analytical capacity of national accounting for selected areas of social concern in a flexible manner, without overburdening or disrupting the central system". Because of their *ad hoc* nature, there are no firm methodologies for the construction of satellite accounts. These accounts can address (among other

possibilities): (i) expanded notions of production and products; (ii) extended or more detailed delineation of income; (iii) measures of the uses of goods and services, and sectoral breakdowns of these uses; (iv) assets and liabilities; (v) financing; and (vi) development of new aggregates or indicators. Since they lie outside of the core system, satellite accounts can, and typically do, include physical measurements as well as monetary. The important condition is that such new accounts have clear linkages with the standard SNA, typically through the Income and Product Accounts or the Input/Output Accounts; these linkages facilitate the analysis of environment-economy interactions in the case of environmental satellite accounts.

Typical examples of environmental satellite accounts that have been, or are in the process of being, developed include:

•Natural resource accounts, measuring stocks and flows of resources, including extraction/harvest, discoveries, revisions, and sectoral breakdown of uses.

•Pollution emissions accounts, tied to economic activity levels through the Input/Output accounts.

•Detailed accounts of environmental protection expenditures, with possible breakdowns by sector, pollutant and receiving medium.

Chapter 4 provides examples of satellite accounts, and Chapter 5 gives some details of the UN satellite System of Environmental and Economic Accounts (SEEA).

The development of satellite accounts is in some sense uncontroversial, since they are designed to elaborate or add to the SNA, with specific goals and uses in mind. The resulting accounts can therefore be judged according to whether they are internally consistent and whether they meet the established goals. The only problem with this approach may be when the goals and purposes for developing the accounts are not clearly set.

On the other hand there is abundant controversy surrounding the development of new or altered national accounting aggregates, based largely on unresolved theoretical and methodological issues. The problems in this domain fall into roughly two parts: the treatment of commercial natural resources in the accounts; and the procedures for incorporating environmental or non-commercial assets and changes in these assets.

A key concept in this area is that of net product, i.e. gross product less depreciation of assets. Weitzman (1976) provided an important theoretical development when he showed that net national product (or domestic product - the distinction is not critical in what follows) is equal to that constant level of product whose present value equals the present value of consumption along an efficient path for a competitive economy. Solow (1986), Hartwick (1990) and Mäler (1991) have generalized these ideas to the case of exhaustible resources and environmental amenities. Hicks (1946) provided a common-sense view of the importance of net income and product: he defined true income as being that income which is in excess of capital consumption. The extension of this Hicksian notion to include depletion of natural resources seems quite logical.

The gaps and inconsistencies in the SNA concerning commercial natural resources are well-defined and, it can be argued, tractable. Stocks of natural resources are supposed to be measured as part of tangible assets in the National Balance Sheet Accounts (NBSA) (United Nations, 1977). To date no national statistical office has produced such accounts, largely because of the methodological difficulties encountered, including the definition of resource extent and valuation of the stocks so defined. The guidelines for the NBSA treat changes in wealth from one year to another as a reconciliation item, so that there is no direct linkage between changing values of resource assets and net income or product. An advantage of the wealth accounting approach to commercial resources is that depletion, discoveries and revaluations of resources are treated within a consistent framework. A wide range of authors (see below) have suggested that income and product should include the effects of resource depletion to give a better measure of "true" or "sustainable" income. Since resource rents are measured implicitly in the existing SNA, as some combination of excess returns to capital in the resource sectors and government royalties, this argument has some merit. The difficulties centre on the basis for valuing resource depletion and the correct methodological treatment of resource discoveries.

The problems involved in treating (non-commercial) environmental resources in the accounts are more daunting, not least because of the self-imposed limits of the SNA. The System of National Accounts was designed to measure activity rather than welfare (in the sense that there are many non-market sources of welfare), and, as far as possible, it was intended to incorporate observable transactions in the economy in these measurements. As a result, the SNA reflects changes in environmental assets, and their causes and consequences, only indirectly. These indirect effects include environmental protection and rehabilitation expenditures by businesses, governments and individuals, changing values of economic assets (both positive and negative) resulting from environmental change, costs incurred

treating polluted environmental inputs, health treatment costs resulting from environmental deterioration, and use value of the environment in the form of recreational expenditures. A major problem is that these indirect effects are not explicitly identified or causally connected with changes in the environment.

It seems clear that to incorporate the effects of environmental change fully in our accounting systems will require the expansion of concepts such as National Income into a welfare measure, in which a monetary valuation of the stream of benefits that society derives from the environment is attempted, and is added to traditional measures of income. Measuring changes in this stream, combined with explicit measurements of how traditional income alters as a result of environmental change, would provide the linkage that is sought between human welfare and the environment, with monetary values as the numeraire. The progress made in environmental economics, where it has been shown that environmental amenities can fit the standard model of consumer preferences and utility maximization (see, for instance, Cropper and Oates, 1992) and where a variety of methods to elicit willingness to pay for these amenities have been developed, is encouraging in this connection - but there are dissenting voices with regard to this point as well, notably Hueting (Hueting and Bosch, 1990).

It should be noted, however, that expanding traditional national income measures into welfare measures is not straightforward. Eisner (1989) has written a substantial book on the types of adjustments required, including in particular the conversion of the value of purchases of durable items into the value of the flows of services these provide.

Most of the approaches to incorporating environmental resources (as distinct from commercial resources) into the national accounts that are described below fall into two camps: (i) those that assume that a value of environmental damage is arrived at by some unspecified means, and is then deducted from net product; and (ii) those that assume that changes in the stream of environmental benefits can be measured as, or in some way related to, current expenditures on environmental protection. Neither approach bears an obvious resemblance to the expanded welfare measure just described.

What follows is a brief description and assessment of the main lines of thought on environmental national accounting. Three basic identities are presented below, followed by notes explaining and evaluating the key points. It is useful to summarize the approaches according to whether they are intended to alter GDP (gross domestic product as conventionally defined), NDP (conventional net domestic product), or national wealth (denoted NW) as measured in the National

Balance Sheet Accounts, including a measure of natural wealth. gGDP and gNDP are the new "green" (g) product aggregates:

(1) $gGDP = GDP + ES \pm ED_1 - DE - IR$

(2) $gNDP = NDP + RD - DEP - ED_2$

(3) $NW = NFA + TA_H + TA_N$

Where:

ES- environmental services
ED- environmental damages
DE- defensive expenditures
IR- invested resource rents
RD- resource discoveries
DEP- depletion of resources
NFA- net financial assets
TA- tangible assets

We consider the component parts of expressions (1) - (3) in sequence:

ESPeskin (1989) advocates augmenting GDP by a measure of *environmental services*, viewed chiefly as waste disposal services, which are provided free of cost by the environment. However, to the extent that producers use these services without paying for them, then it is arguable that their value already shows up in profits and therefore in GDP.

ED_1*Environmental damages* can be either added or subtracted. Peskin views the externalities associated with producers availing themselves of the services of the environment as a *deduction* from welfare and therefore a *deduction* from GDP, in spite of the national accountant's insistence that the accounts do not measure welfare. Harrison (1989) takes the opposite tack: since gross product includes the consumption of assets by definition, conventional GDP is understated because it does not measure the consumption of environmental assets. Note that this would require the estimation of a dollar value for total environmental deterioration, including that which was prevented as a result of current abatement expenditures.

DE*Defensive expenditures* are expenditures on environmental protection undertaken by households (Juster 1973) and governments (Herfindahl and Kneese, 1973). It is argued that environmental expenditures by households do not increase welfare but merely preserve the status quo (e.g. not getting ill from environmental pollution). To the extent that these household expenditures are uncoerced, revealed preferences would indicate that households judge that their welfare is increased by making them. Where these expenditures are a response to a decrease in environmental quality, then arguably it is the value of the deterioration of the environment that should be measured and deducted from net product (or added to gross product as Harrison would have it) rather than household expenditures per se. Mäler (1991) has reached a similar conclusion by more formal arguments. The contention that government environmental protection expenditures (e.g. on waste management) are essentially intermediate in character and should be deducted from domestic product can also be criticised. The value of GDP cannot vary simply as a result of sectoring: if a government waste management activity were privatized and its services sold to producers, then after adjustments to taxes and prices nominal GDP should be unchanged.

IREl Serafy (1989) calls for the deduction of hypothetically *invested resource rents* from GDP, arguing that true income from a non-renewable natural resource is that constant stream of income that can be obtained from investing a portion of the rents from exploitation in a fund (a suitable programme will ensure that rents in excess of the portion invested will be identically equal to interest on the fund at the point of exhaustion). Hartwick and Hageman (1993) show that this is equivalent to valuing the charge in the present value of the resource stock as a result its - i.e. it is a true user cost.

RDTurning to the measurement of net domestic product, Repetto *et al.* (1989) reason that in order to maintain consistency between product and wealth accounts, augmented to include natural resources, the full value of natural *resource discoveries* should be added to net product in the period in which they are made. Discoveries are therefore like investments. It is arguably more correct to view a resource discovery as an increase in the stream of income that can be obtained in the future - therefore an increment to wealth. Hartwick (1990) developed a model in which discoveries are similarly added to net product, but

this results from his specification of exploration costs as a function of stocks of resources. Weitzman (1976) showed formally that an unanticipated resource discovery does indeed increase the amount of sustainable product and income, but by less than the full amount of the discovery in the period it was made.

DEP*Depletion* of natural resources is the major adjustment to net product suggested by Repetto *et al.* (1989). Depletion is valued as the total of resource rents taken in the accounting period (the "net price" approach) or, in the case of soil erosion, as the present value of foregone production. Repetto notes that the Hotelling rule, that resource rents in an efficient market will increase with a rate of change equal to the interest rate, will yield this valuation of resource depletion. The United Nations (1993) suggests valuing depletion using either the user cost or net approaches approaches.

ED_2As an alternative to deducting *environmental damage* from gross product, Bartelmus *et al.* (1989) suggest deducting it from net product as a type of asset consumption. The basis of valuing this asset consumption is as the cost of returning the environmental asset to its state at the beginning of the accounting period. Cost-based approaches have several problems, including establishing least-cost values to achieve the desired degree of environmental improvement, and dealing with process changes that produce both cheaper products and less pollution. More fundamentally, since it is the change in the present value of the flow of environmental benefits that is theoretically the correct adjustment to net product, using costs to estimate this may be a very poor substitute. Hueting and Bosch (1990) offer an alternative methodology in which environmental deterioration is valued as the costs that would be incurred to achieve sustainable use of the environment (rather than merely preserving its state, as in Bartelmus et al.). Similar criticisms apply and there is the additional problem of defining environmental standards that are consistent with sustainability.[2]

Provisional UN guidelines (United Nations, 1992) suggest contingent valuation as an alternative basis for valuing environmental degradation, but without discussing how, or whether, this can be applied to the

[2] For example, such "sustainability standards" would be consistent with critical loads, or zero damage, concepts.

environment as a whole.

NFA Turning finally to measures of national wealth, *net financial assets* are an important component of total wealth. For an open economy the different between financial assets and liabilities is equal to either net claims on foreign assets or net foreign indebtedness. The scale of investment of resource rents by OPEC producers in Europe and North America indicates the significance of this type of wealth where domestic investment opportunities are limited.

TA_H *Human-made tangible assets* are the familiar elements of reproducible capital: machinery, equipment, buildings and infrastructure. The Hartwick rule (Hartwick 1977) states that, under suitable conditions of substitutability, investing resource rents in reproducible capital will permit a non-declining stream of consumption into the indefinite future. Building up human-made assets to match the drawing down of natural resources, thereby preserving wealth, fits the criterion for weak sustainability described by Pearce *et al.* (1989).

TA_N *Natural tangible assets* are measured by the dollar value of commercial resources (minerals, energy, forests and fish) and environmental resources (natural environments providing non-market services including waste disposal and amenity value). Scott (1956) first suggested expanding the national balance sheet account to include commercial resources. The problems in doing this include defining the appropriate measure of extent (proven reserves, i.e. those that can be produced profitably at current prices and costs, would be the correct measure) and, in the absence of markets for publicly held resource deposits, deriving values for these deposits. Measuring the wealth value of non-market resources is clearly subject to many of the difficulties identified previously. Hamilton (1991) has argued that total national wealth per capita is a useful measure of sustainability. Pearce *et al.* (1989) point out that there is limited substitutability between certain critical natural assets and human-made assets, which argues for maintaining the value of at least some natural assets constant or increasing as a condition for sustainability.

There is not yet a consensus view on the treatment of resource and environmental issues within the national accounts, as the variety of terms in expressions (1) to (3) attests. As noted earlier, the approaches to resource depletion and discoveries appear tractable: what is required is the application of some theoretical rigour

combined with practical experience. We are still a very long way from being able to construct an expanded welfare measure that includes the changing flow of services we derive from the environment and, moreover, this would entail stepping outside the self-imposed bounds of the SNA. Practical first steps may include establishing ways to measure explicitly the effects of environmental change that currently are only measured indirectly in the SNA.

3.Country Case Studies

Since the primary focus of this study is on the applications, purposes and policy uses of resource and environmental accounting, a selection of European countries that are leading practitioners in the field, or are currently considering entering the field (in the case of the UK), were selected for in-depth assessments of the background, methods, and actual or prospective uses of these new accounts. In addition, because of the expertise available at CSERGE, additional case studies for Canada and Brazil were carried out based on contacts from London. The list of case studies is as follows:

1. Brazil
2. Canada
3. France
4. Germany
5. The Netherlands
6. Norway
7. The United Kingdom

Case Study 1: Brazil

Recent studies providing natural resource accounts at a national level have been produced in Brazil (Serôa da Motta and Young, 1991; Serôa da Motta and May, 1992; Serôa da Motta, Mendes, Mendes and Young, 1992). These studies were sponsored by the United Nations Development Program (UNDP) and co-ordinated by the Institute of Applied Economic Research (IPEA), the research agency of the Brazilian Planning Ministry. These are pilot studies intended to provide methodological guidelines for future work of the Brazilian Institute of Geography and Statistics (IBGE), which is the central source of statistics at the national level including the National Accounts.

Data and Methods

Studies were carried out for individual resources: minerals, forests and urban domestic use of water. The theoretical foundation is the accounting system proposed by Peskin (1989) which was intended to derive environmentally adjusted aggregate product measures. The water use estimates follow this scheme strictly in terms of environmental losses and the services provided by water. It was assumed that the rents from mineral and forest resource depletion are already included in the profits or royalties received from these activities. Therefore, only environmental

losses are estimated for these resources.

As a consequence of being a pilot project which does not cover all issues relevant an environmental accounting exercise, the results were not aggregated into one measure of Brazilian "green" GDP. Instead, the results of each case study were compared to the corresponding national figure: gross mineral production for mineral depletion, gross agricultural production for forest depletion, and private consumption for water losses and services.

Mineral and Forest Accounts

The studies dealing with mineral depletion (Serôa da Motta and Young, 1991; Young, 1992) considered only the more economically important ores and fuels. The studies used secondary data collected regularly by the National Department of Mineral Research (DNPM), the National Council of Petroleum (CNP) and the IBGE. Therefore, clandestine activities, such as the "garimpos" of gold and tin in the Amazon, were not covered. The depletion estimates were produced for the period 1970-1988, using both the depreciation ("Repetto") and user cost ("El Serafy") approaches.

The study on forest depletion (Serôa da Motta and May, 1992) charged environmental losses to the agriculture sector (which includes ranching) for 1970-1980. This sector was thought to have accumulated extraordinary profits as a result of the extension of the agricultural frontier. The valuation technique employed was the average price net of costs. The absence of data and valuation techniques for biodiversity issues was the main reason for limiting the loss estimates to timber depletion. The extent of deforestation was estimated using vegetation-cover maps from IBGE, based on information coming from the RADAMBRASIL project and the agriculture censuses. Rents were estimated using FOB export prices of timber products from the External Trade Agency (CACEX) and average extraction costs from the economic censuses.

Water

The environmental services, and losses of services, from urban domestic water use were estimated separately (Serôa da Motta *et al.* 1992), following the methodology proposed by Peskin (1989). The losses were calculated using estimates of lost production due to premature death, lost of days of work, and medical expenditures, caused by water-borne disease organisms for the period 1970/1989. The diseases considered were gastro-enteritis, poliomyelitis, typhoid fever, cholera, amoebiasis, esquistossomosis and shigellosis. These diseases were related to water pollution by

dose-response functions estimated in multiple linear regressions using socio-economic variables and water quality parameters.

The valuation technique employed was based on human-capital theory. Production losses owing to morbidity were calculated using average daily income and the number of work-days lost. Economic losses due to mortality were calculated from average monthly income and the probability of employment for persons between the ages of 10 and 85. Health expenditures for the treatment of water-borne disease were estimated as the average cost of hospital treatment.

Data on mortality and morbidity were provided by the Data Bureau of the Social Welfare System (DATAPREV). The average income and mortality tables were obtained from annual household surveys (PNADs) of IBGE. Pollutant emissions were calculated with information from the Brazilian Association of Sanitary Engineering (ABES), PNADs and assuming a daily per capita discharge coefficient of 54g of BOD.

The environmental services of water were estimated by the amount of investment needed to collect and treat urban domestic sewerage over the period 1970-1989. The data to calculate the needed investment came from the National Plan of Sanitation (PLANASA), Caixa Econômica Federal (State Housing Society - CEF) and engineering companies. The percentage of non-treated sewage was estimated using information from ABES.

The series of annual investment in water and sewage treatment was calculated by applying alternative values for the opportunity cost of capital (5%, 10% and 15%) to the estimate for the average stock of capital needed each year.

Results

Results for mineral resources varied widely according to the methodology employed. Estimated sustainable income (net value added less resource rentals) using the depreciation approach (Repetto *et al.* 1989) ranged up to 9054% of the product of the Brazilian mining industry. The estimates of sustainable income employing the user cost approach (El Serafy, 1989) varied from 86% to 98% of the conventional product.

The main reason for the large discrepancies was the substantial discoveries and revaluations of mineral resources during the 1970s and 1980s. In the Repetto methodology these discoveries and revaluations are added directly to net product, so producing wide variations, while the much smaller adjustments in the El Serafy

methodology led to a smoother series.

For the forestry accounts the discrepancies between the results from the alternative methodologies were important but not as high as in the mineral accounts. The results obtained show that the deforestation process leads to considerable losses even if the value of native forests is counted only as timber. They also highlight the acceleration of forest depletion during the 1980s over the whole country, pointing out that deforestation is not a problem restricted to the Amazon.

Results from the water accounts indicated that the costs of investments in water and sewage treatment matched the benefits in terms of reduced health care costs if a low discount rate (5% or less) is assumed. These results are highly sensitive to the incidence of infectious disease during the period studied: the recent cholera outbreaks in Brazil, for instance, would have doubled the estimate of health care costs.

Applications

The Brazilian environmental accounting experience is still at a preliminary stage. The main objective to this point has been to explore alternative methodologies and the meaning of the results, accepting that these are still very crude figures. The accounts therefore have not been used in more policy-oriented applications.

However, in spite of their preliminary nature, these figures have stimulated interest in developing a system of national statistics on the environment and natural resources. IBGE is interested in continuing this work, and establishing a systematic effort in environmental accounting in Brazil.

Case Study 2: Canada

Efforts on resource and environmental accounting in Canada began as a small research programme at Statistics Canada, where the traditional national accounts are compiled. With the publication in December 1990 of *Canada's Green Plan* as the overall framework for Canadian environmental policy, a commitment was made to substantial funding of this accounting work.

The Green Plan adopted sustainable development as the guiding principle for environmental policy. The result of a public consultation process, the plan has several guiding principles: explicit recognition of the environment-economy relationship; efficient use of resources; informed decision-making; and the use of an ecosystem approach. The priority issues in the plan, the subject of direct actions, included: clean air, water and land; sustaining renewable resources; expansion of protected areas; the quality of the Arctic environment; global environmental security; and dealing with environmental emergencies.

In addition to dealing with specific issues, the plan placed major emphasis on providing a better basis for environmental decision-making at all levels. It therefore addresses seven key areas related to decision-making: environmental science; environmental information; environmental education; legislation and regulation; economic instruments; decision-making processes and institutions; and partnerships in environmental protection. Under the Environmental Information Initiative of the Green Plan, adopted by Cabinet in January 1992, Statistics Canada was given funding for the development of new environmental components of the national accounts. This funding builds from (Can) $500 thousand in 1992 to $1 million in 1997 - once the developmental phases are completed it is expected that ongoing base funding for the programme will be forthcoming.

Statistics Canada is the national central statistical office. It reports to a separate Minister responsible for the statistical system, and there is a statutory separation of the activities of statistical office from the policy ministries, to ensure the impartiality of the information that is collected and published.

The accounting work at Statistics Canada is based in the National Accounts and Environment Division (NAED), which is responsible for the national income and expenditure accounts, the balance sheet and financial flow accounts, the provincial economic accounts, and the environment statistics programme. The latter programme was amalgamated into the division in the Spring of 1991 as part of a concerted effort to increase the economic orientation of the environmental statistics work at Statistics Canada. Placing the new resource and environmental accounting

work in the NAED ensures that questions of the compatibility and integrability of the new accounts with the existing national accounts can be dealt with directly within the division.

The national accounts work, including environmental accounting, is subject to the advice and oversight of a National Accounts Advisory Committee made up of academic experts and senior economists from major institutions. This committee provides advice directly to the Chief Statistician. NAED also receives advice, jointly with Environment Canada, from a public advisory committee on State of Environment Reporting, which is regularly apprised of progress on the accounting project.

Goals and Specific Projects

The resource and environmental accounting work was established with a range of goals, as expressed in the Memorandum to Cabinet concerning the Environmental Information Initiative. A key goal was to make progress towards measuring sustainability; it was emphasized that this is an extremely complex concept to measure, but that expanding wealth accounts to measure natural resources would be a useful step in this direction. Extending the wealth accounts is also viewed as filling a major gap in the statistical system: while it is a cliché to say that Canada is resource-rich, there is no comprehensive set of data quantifying this and allowing the comparison of the magnitude of natural versus human-made wealth. A further goal was to permit analysts to construct better measures of net product and net investment, making allowance for resource depletion. Sectoral analysts, particularly for the resource industries, expressed the need for more information on the value of resource stocks (to better represent the balance sheets of resource sectors) and their grade (which could help to explain trends in productivity. Finally, a general need to provide information for policy analysis, and environment-economic modelling in particular, was expressed.

The accounting project under way at Statistics Canada has multiple components to meet these disparate goals, all based on a number of precepts. As the developer and builder of the standard national accounts the agency does not foresee, at least until there is wider international agreement, any changes to the traditional national accounting aggregates; the exception to this is the wealth account, where the UN System of National Accounts already contains provision for valuing unexploited resource stocks. It is recognized that physical data can provide a useful adjunct to the dollar flows of the existing accounts. Finally, monetary estimates of the value of damage to the environment from human activities are not explicitly part of the accounting project, although research in this area is foreseen; conversely,

accounting for current and capital expenditures on environmental protection is a component of the project.

The following description of the resource and environmental accounting project is adapted from the Memorandum to Cabinet establishing the programme. All of the work is viewed as being developmental, with the intention to establish regular publication of the new accounts beyond 1997.

The National Accounts Environmental Components (NAEC) are designed to integrate data and relevant indicators on the stock, value and use of natural resources in the socio-economic system and on the amounts and type of wastes and pollutants generated by producers, consumers and governments, and the related costs and management practices. The data contained within the NAEC will be sufficiently disaggregated to reflect as accurately as possible the original information on which they are based, to be of use in a variety of analyses of environment-economy linkages by the public and private sectors. The four basic accounts that would eventually form the National Accounts Environmental Component are as follows.

The natural resource stock accounts will, to the extent possible, integrate natural resources into the System of National Accounts (SNA). Because natural resource value and depletion are excluded from the SNA, Canada's wealth is underestimated, national productivity measures are incomplete, and Net Domestic Product does not take account of the running down of Canada's natural resources. Constructing these accounts entails the following steps:

1)The Wealth Accounts will be expanded to include the value of Canada's natural resources. Major methodological issues to be dealt with include the estimation of resource rents, and the calculation of wealth values that are consistent with other measures in the SNA.

2)These estimates of Canada's natural resource capital will be used in an attempt to complete national productivity measures. This would have an impact mostly on the mining sector productivity estimates which are currently distorted by this data gap.

3)Fundamental research on how to estimate the economic depreciation of natural resources in order to better integrate with the current NDP measures will be undertaken in collaboration with Canadian natural resource economists and international statistical agencies.

4)To support these activities, a physical inventory of natural resources will provide information on availability and also on the additions and 'losses' to the inventory through new discovery, natural processes and extraction/harvesting.

By 1995, two natural resource accounts, one non-renewable (petroleum and gas) and one renewable (forestry), will be used as pilot projects to develop and test the conceptual framework. The policy departments involved in these areas will be consulted.

The natural resource use accounts will provide information on what natural resources (marketed resources such as petroleum or non-marketed resources such as water) are used, how they are used or transformed, and who is using or transforming them. This sub-component would expand and complement the Input-Output Accounts (I/O) (part of the SNA). It will support research on how demand and technology influence the demand for natural resources, and support policy formulation and assessment by providing relevant indicators.

These accounts will be implemented by 1994 for energy use in the Canadian economy. They will provide information on energy intensity in Canadian production and consumption activities.

The waste and pollutant output accounts will integrate existing information on the negative by-products from production and consumption activities: the generation of wastes and pollutants, what type of wastes and pollutants are generated, and the management and fate of these wastes and pollutants, including recycling activities. The Input-Output Accounts provide information on the production and destination of all marketed goods and services by industry and economic sectors. This system would be expanded to include the production and destination of non-marketed outputs consisting of wastes and pollutants. This integration would allow the production of indicators on the generation of wastes and pollutants in relation to other economic variables at the industry or commodity level, such as CO_2 emissions by industrial sectors over time or the CO_2 emissions induced by all stages in the production of goods and services. These accounts, like the preceding ones on natural resource use, will provide basic inputs to policy models linking economic activity to physical flows in the environment.

The conceptual framework for these accounts will be defined by 1994. The full implementation of the waste and pollutant output accounts depends on data availability. Major industries currently provide information on emissions of pollutants.

The environmental expenditures accounts will provide information on expenditures on environmental protection, rehabilitation and clean-up. This sub-component will measure the economic costs associated with the management and disposal of wastes and pollutants by industry and economic sector - again the I/O accounts will provide the basic accounting framework. These cost accounts will complement the waste and pollutant accounts.

As is obvious from this description, the accounting work in Canada can be viewed as a combination of: (i) expanding wealth measures within the existing SNA; (ii) constructing natural resource accounts; and (iii) establishing satellite accounts, linked to the I/O system, on physical resource flows, pollution and waste emissions, and environmental protection costs.

Applications and Prospective Uses

Applications of this accounting work to date have been limited to the areas where the work is most advanced: the energy flow satellite account, measuring physical flows of energy by I/O sector; and the greenhouse gas (GHG) emissions accounts, estimating GHG output by I/O sector. These have contributed to:

- Construction of a computable general equilibrium model by the Department of Finance to examine levels of carbon taxation required to achieve target emission levels.

- Initiation of a modelling exercise by Environment Canada to simulate a variety of scenarios for GHG emissions with regard to Canada's commitments under the Climate Change Convention at Rio.

- Preparation of a study (still in progress) on the distributional consequences of a hypothetical Canadian carbon tax.

Immediately identifiable potential applications of the new accounts include:

- Inclusion of expanded measures of national wealth and depletion-adjusted measures of net investment in the Green Plan-mandated annual report of the Minister of Environment to Parliament on the state of Canada's environment and progress towards sustainability.

- Use by the Province of Ontario, which is contributing to a pilot wealth account for forests, in establishing measures of timber and non-timber

values for the province's forest resources. The accounting system may also provide macro-level indicators of forest resource development.

- Construction of pollution emission models at Environment Canada, the Department of Finance, research institutes or by private providers of modelling services.

- Development of policy models to examine the differential industry and sectoral impacts of economic instruments to control environmental pollution.

In addition to natural resource departments (both federally and provincially), the Department of Finance, and various subject-matter divisions of Environment Canada, the Economics Directorate of the latter department is potentially an ongoing user of the new accounts as they are developed. As an example, the current programme of the Economics Directorate includes work on:

- the means to foster sustainability;
- the potential for applying economic instruments;
- competitiveness issues associated with environmental protection;
- trade and the environment.

The Canadian resource and environmental accounting work aims at a reasonable balance between the more esoteric (measuring sustainability through wealth accounting) and the practical (the satellite accounts on resources, pollution and costs of protection). Expanded wealth measures could not be expected, *per se*, to have much direct impact on the development of macroeconomic policy, although the ancillary data for these accounts will benefit resource sector analysts. On the other hand these measures may be useful in the hands of the Minister of Environment in reporting on Canada's progress towards sustainability. The satellite accounts under development would appear to provide ample scope for policy analysis and the development of policy models on the linkage between the environment and economic activity.

Case Study 3: France

The French system of patrimony accounts is perhaps the most comprehensive and ambitious design for environmental accounting of any OECD country. The

patrimony accounts are a set of interlinked accounts (primarily in physical units) organized into three broad areas:

Element accounts are established for individual resources such as underground resources, continental waters, soil, the atmosphere, sea water, flora and fauna. The basic idea of these accounts is to keep track, in suitable physical units, of the evolution of the stock of these resources. Transformations owing to human activities or natural phenomena account for the difference between initial period stock levels and end of period stock levels.

Ecosystem accounts have the purpose of monitoring the health or well-being of ecosystems as opposed to tracking the evolution of the stock of an individual resource. These accounts rely heavily on satellite images describing the area covered by different ecosystems. There is also an effort to construct indicators that describe the general "health" of the system, for example through a diversity indicator.

Agents accounts record the interactions between man and the environment and have the same classification as national accounting categories (i.e. households, government, corporations, etc.). They record both physical data, such as the extraction of a resource by man, and monetary data, such as the expenditure on pollution abatement technologies. Of special importance in the agents accounts are the environmental satellite accounts linked to the System of National Accounts. These record the corresponding expenditures made in the economy to protect and improve the environment.

The three main categories of accounts described above are interconnected. For example, the stock of a single resource could be disaggregated by the ecosystems in which it is found. Similarly, the extraction of a resource could be recorded in the corresponding element account, ecosystem account, and in the agent accounts.

Goals

The main goal of the French patrimony accounts is to form a consistent information system for environmental monitoring and management. In particular, it is intended to set guidelines and help coordinate the data gathering process so that environmental information from different sources are compatible. Its scope is the environment as a whole (marketable resources, non-marketable resources, ecosystems, etc.) and the level of detail is from the local and regional level to the national level. Implicit in the highly disaggregated nature of these accounts is the intention to provide precise information for "fine tuning" environmental

management.

The emphasis is on physical units of accounts rather than monetary valuations, primarily because of the perceived difficulty of establishing monetary values for detailed and diverse environmental goods. In addition, it is felt that physical indicators permit social and ecological criteria, and not just economic, in environmental decision making. However, since the construction of aggregate sustainability indicators (not in monetary terms) is also an objective of the French system, the aggregation of data measured in highly differentiated physical units is a formidable problem when monetary valuation is abandoned. There has been an effort to develop non-monetary weights for the aggregation of physical data into indicators.

One of the goals for the environmental satellite accounts is as a source of information for making international comparisons regarding the efforts made by different countries to enhance or improve environmental quality.

There is no explicit intent in this work to alter any of the economic aggregates of the national accounts to reflect resource depletion or environmental degradation. However, the flexibility and thoroughness of the information system is designed to assure the possibility of such an exercise if desired, since physical data are a necessary input to economic valuation (Weber, 1989). Aggregate indicators of economic sustainability are clearly not a priority of the French system.

Implementation

In order to implement the system, the Interministerial Committee on Natural Resource Accounts was established in 1978. This committee was formed by members of a variety of state institutions, including the Statistical Office (INSEE), the Ministry of the Environment, the National Museum of Natural History, the Ministry of Agriculture, as well as universities. The work of the committee was published in 1986, containing accounts for water, forests, soil, land use and wildlife (Commission Interministerielle Des Comptes Du Patrimoine Naturel, 1986). In addition, satellite accounts showing the environmental expenditures made in the economy have been established for water, wastes, national parks, and hunting (Ministere de L'Environnement et INSEE, 1986) following the guidelines of the Statistical Office of the European Community (EUROSTAT).

Of the accounts published in 1986, the inland water accounts were the most detailed and the closest to the ideal accounting model outlined above. As an example, therefore, these accounts will be described briefly.

The element or resource account for inland waters is an input-output table showing resource availability, inflows and outflows within the system, and the withdrawals and final uses for the year 1981 (Commission Interministerielle Des Comptes Du Patrimoine Naturel, 1986; Weber, 1988). The agent account for inland waters shows the use of the resource by sector according to national accounting classifications (i.e. households, industry, agriculture, etc.).

In addition to the resource and agent accounts for inland waters, quality accounting was also developed for this resource. However, the scope of water quality accounting was small, covering only the drainage basin of the Vire River. Water quality accounting consisted of weighting the volume of water according to chemical and physical measurements (BOD, COD, etc.) to arrive at a quality index. This was done for the Vire River basin for the years 1972, 1976 and 1981.

The final part of the patrimony account for inland waters is a satellite account showing the annual expenditures on sanitation, purification and infrastructure investments related to water.

Applications and Prospective Uses

Although the efforts to create a system of patrimony accounts in France began formally in 1978, with the initial results published in 1986, there has been little use of the accounts in concrete environmental management decisions. In part this is due to the inherent complexity of the proposed task, the lack of data, or at least suitable data, and the experimental nature of the Interministerial Committee's efforts. Funding for the committee's activities amounted to US$ 100,000 in research funds (Theys, 1989) which was insufficient to establish a more developed patrimony accounting system.

One concrete application of patrimony accounting for decision-making occurred in 1985, regarding the state of forestlands in southern France. The widely-held public opinion was that forested land was decreasing in extent and volume. Forestry studies showed the opposite, but were too detailed and technical to be an influential source of information. Once the data from the technical studies were arrayed in resource accounts, however, the picture became much clearer, and could be portrayed to the public and decision-makers. The decision to build a new paper mill in the area was made, owing in part to the information provided by the resource accounts.

This example points to another, usually implicit, objective of the patrimony

accounts: to influence public opinion and policy makers. As Weber (1989) points out: "having some kind of information is important to convince policy makers; not having information is to policy makers equivalent to not having environmental problems".

There has been no significant development of the patrimony accounts since 1986. However, in 1991 the French Institute of the Environment was formed, under the authority of the Ministry of the Environment but with a degree of autonomy. This institute has recommenced the work on the French patrimony accounting system. The current pilot study, which has been allocated three full time staff members, relates to a new and updated set of water accounts (both of the resource and its quality), ecozone accounts using land use and land cover information from remote sensing images (in conjunction with the European Community CORINNE project), and satellite accounts on environmental expenditures within the framework of the EUROSTAT methodologies and classifications. INSEE, the French Statistical Office, is cooperating on the conceptual issues involved in the creation of this second generation of satellite accounts.

Case Study 4: Germany

The roots of the German programme on resource and environmental accounting go back at least to the establishment in 1986, by the Federal Ministry of the Environment, of a 3.5 million DM research project on the "Costs of Environmental Pollution - Benefits of Environmental Protection". The 10 research projects, involving economists, scientists and engineers, covered a diverse array of topics related to the effects of pollution: the cost of health care; costs of material damage; lost income of the fishing industry; the cost of water supply; treatment of polluted soil; costs of noise; lost income in the tourism and recreation industry; the economic significance of species and habitat loss; psychological costs; and finally, the demand for environmental quality. Annual estimates of these costs were provided in a series of reports published in 1991 by the Federal Environmental Agency, a research institute in Berlin. The Agency has continued to carry out research into the economics of the environment and "green national accounting" in which environmental effects are monetised.

In 1989 the Economic Affairs Committee of the Bundestag heard expert testimony urging the development of environmental economic accounting. The committee had requested the views of experts on, among other matters, two key questions concerning the relationship of the environment and the economy: growth as the goal of economic policy; and methods for ascertaining the ecological and social costs of economic development. Some of the experts felt that an ecologically adjusted indicator of the national product might shed light on the sustainability of economic growth. And there was virtually unanimous support for the initial thinking of the Federal Statistical Office on the development of a comprehensive accounting system for the environment and the economy. This accounting system would span the effects of human activities on the environment, the consequences for the environment, and the subsequent repercussions on human beings and their activities.

As a result of this impetus, the Federal Statistical Office began to design a system of Environmental-Economic Comprehensive Accounting (UGR, to give the German acronym), which was presented to the Federal Minister of the Environment. In 1990 the work programme was announced in a press release by the Minister, in which he called for a commitment to developing economic valuation of the environment, so that the environmental effects of economic development could be measured. The Minister announced the creation of a Scientific Advisory Council, consisting principally of economists, to advise his ministry and the Federal Statistical Office on methodological issues in valuing the environment and to provide a stimulus to this work.

The Advisory Council presented a report on environmental accounting to the Minister of the Environment in 1992, calling for an economic evaluation of the environment that "records the state and the development of the environment and portrays the correlation between economic processes and the environment". This was a call for a system that was broader than pure accounting approaches, partly because the Council felt that there were significant problems in expressing environmental data in monetary terms. Priority was therefore placed on collection and integration of physical data (e.g. on emissions and land use). The derivation of a single "eco-national product" figure, analogous to GDP, was not viewed as practical because of the important unresolved methodological issues.

The Scientific Advisory Council has become an ongoing body, continuing to provide input to the statistical office on the accounting work. It has urged continuing efforts on methodological issues, as well as the establishment of research programmes in a variety of subject areas, to be carried out by independent research institutes.

The work on UGR is being carried out by a specific sub-division (IV-E) of the Federal Statistical Office in Wiesbaden. The statistical office is independent of policy departments, acting as the central statistical office for the federal government. Separate federal legislation establishes each of the major data collection activities of the office. The work on UGR is not being carried out within the National Accounts Division, but there is a task force co-ordinating the efforts of the UGR sub-division, national accounts (especially the Input/Output sub-division) and the information systems division. There are currently roughly 13 professional staff working on various aspects of the project, but it was emphasized that, as of March 1993, all budgets are under review as the federal government comes to terms with the costs of re-unification in Germany.

Goals and Specific Projects

Environmental-economic comprehensive accounting is intended, according to the Federal Environment Ministry, to serve several broad purposes. There is a perceived need, on the part of the Minister and others, to supplement GDP figures with environmental figures, in order to reduce the exclusive focus on GDP in economic decision-making. Environmental accounts can feed into research on environment-economy interactions, spurring new work. The accounts can provide information to underpin new environmental proposals, which can then be used to persuade other ministries and the public of the need for these proposals, as well as providing a more general awareness on the part of decision-makers and the public

that wealth is reduced when the environment is harmed. The Federal Statistical Office sees the need to provide aggregate indicator-type information on the environment and the economy to policy makers.

One of the principal objectives of the UGR is to summarize and aggregate the wide variety of data pertaining to the environment and its links to the economy. The proposed system consists of five categories of information:

-environment-related economic activities (e.g. environmental protection expenditures;
-use of natural resources;
-use of the environment as a sink for residuals;
-spatial characteristics;
-the qualitative condition of the environment.

These categories are described below.

Environment-related economic activities include so-called defensive expenditures on controlling air pollution, water pollution, and waste management. The capital and operating expenditures of different economic branches on these protection activities will be broken down as sub-accounts of the existing national accounts. Although there are problems of estimation and allocation, expenditures on restoration of damage to materials or treating environment-related health problems would also form a part of this sub-account.

Use of natural resources includes data on the extraction and use of both living and non-living resources, commercial resources as well as environmental resources such as air, water, and solar energy. Both extraction or harvest of domestic resources and the use of domestic and imported resources will be measured in physical units in this account. These flows of resources will be classified according to their associated sectors in the Input/Output accounts. Linked to the flow accounts will be asset accounts, and materials balances will be constructed to provide a link to the residual emissions accounts.

The account for **use of the environment as a sink for residuals** will be based on estimated emissions by branch of economic activity - a model of emissions by industries and economic sectors will therefore be developed, along with calculations of the amount of emissions that are treated, recycled or emitted directly into the environment. In addition to emissions associated with production and consumption, the disposal of consumer durables will also be tracked in this sub-account.

Spatial characteristics accounts will relate to land statistics, including land use and land cover. Characteristics to be measured will include both quantities (areas) and qualities. Also attempted will be a measure of the effects of human activities on the size of ecological units (urban encroachment, and so on). The development of this account is being closely linked with the task force set up by the UN Economic Commission for Europe on resource accounting, one of whose pilot projects is on land accounts.

The qualitative condition of the environment account will include quantitative measures such as concentrations of pollutants in environmental media and in living organisms. Temporal and regional averages of individual measurements will be constructed, as well as index numbers.

The approach to valuing environmental damage in the accounts, for both pragmatic and theoretical reasons, shares much in common with the work in the Netherlands, and in fact joint work with the Central Statistical Office of the Netherlands is being initiated in the area of CO_2 emissions. The basic idea is to attempt to measure the difference in marginal costs between use of environmental resources at current rates and at rates that constitute an "environmentally safe standard". Expert opinion on what constitutes such a standard for different receiving media and ecosystems will be sought. Being able to value environmental damage is viewed as an important aspect of being able to aggregate and summarize the plethora of environmental data, as well as to provide figures that are comparable with other economic data.

There is a strong element of building an environmental information system, in addition to an accounting system, in this work. It is intended that three different types of data, or data layers, be constructed: (i) basic data that are close to the primary statistical material; (ii) evaluation of the statistical data; (iii) additional monetary valuations or weightings to provide indices.

One of the specific development programmes under way at present is a project to measure environmental protection expenditures by governments in Germany.

Applications and Prospective Uses

While the uses of the UGR accounting system are prospective at this point, given the early stage in its development, a number of possible applications were identified by the Federal Environment Ministry. Waste issues, including regulations on recycling and the possibility of a waste tax, are important in

Germany and will have an impact on competitiveness and income distribution - UGR may have a role to play in analysing these issues. The system may similarly find use in another major policy issue, that of curbing CO_2 emissions, where the implications for transport policy in particular may be important. Accounting for the distribution of the costs of environmental protection will provide input to analyses of the burden of these costs. More broadly, the accounts may provide basic information for the analysis of the links between environmental standards, competitiveness and trade. Finally, the issue of transboundary pollution (both incoming and outgoing) is an important one in Germany, and one where the accounts could provide basic information on emission rates linked to economic activity levels.

At the Federal Environment Ministry there is a section dealing with Economic Aspects of Environmental Policy. In addition to the general analysis of issues concerning environment-economy linkages, this section has particular responsibility for the study of economic instruments for environmental protection. Additional policy concerns include trade and the environment, the promotion of advanced technologies for environmental protection, and environment-economy issues in Eastern Germany. While environment-economy modelling is not carried out at the Ministry, there are research institutes involved in this work. All of these subject areas represent potential domains of application of the UGR accounting work.

Case Study 5: The Netherlands

The Dutch Central Bureau of Statistics (CBS) and the Ministry of Housing, Physical Planning and Environment (VROM) are devoting resources to the investigation of environmentally adjusted national accounts. There is no legislative requirement for either project, which are separate ventures (although linkages and collaborations do exist). It is envisaged that the outcome of this work will constitute an important tool in the understanding environment-economy interactions, although there is some uncertainty as to a specific directions of the research.

The CBS has the ultimate responsibility for assembling national accounts in the Netherlands and most of the conceptual work on adjustments occurs there. Approximately 50 people work on land-use and environmental statistics within the CBS. The actual work on environment adjustments to the national accounts has fewer human resources directed towards it. The work is a pilot project and so very much in the research stage. Several alternative indicators will be considered under the broad heading of 'resource accounting'. There is a general interest in generating results, the usefulness of which will subsequently be judged by policy-makers.

The CBS project was conceived about one-and-a-half years ago and is due to report in the spring of 1995. The work at VROM is an on-going project on the development of environmental indicators of which satellite accounts is a component. In what follows foremost attention will be given to the work undertaken by the CBS. Where appropriate the work of VROM will be discussed.

Natural Resource Accounting

The basis of much of the accounting work is to provide a more coherent framework for existing environmental statistics. Whilst being useful indicators of the state of the environment, the feeling is that these statistics are too diverse. Hence, the CBS (and VROM) seek a framework whereby these statistics can be interpreted and more general questions can be answered. The long term aim is to link environmental data to a more integrated scheme of environmental accounts and national accounts in physical terms. The environmental statistics collected by the CBS are published in *Environmental Statistics in the Netherlands 1993* (CBS Netherlands, 1993). A chapter is devoted specifically to natural resource accounting which has a distinctly 'Norwegian' flavour. These accounts are presented for various resources as pioneered by the Norwegian CBS (see, for example, Alfsen *et al.* 1987).

Satellite Accounts

(a) Physical Framework

De Boo *et al.* (1991) have shown how physical environmental statistics can be linked to an national accounting matrix. The information in this matrix relates to annual flows - when aggregated these flows yield GDP and NDP. (No work on balance sheets has yet been presented.) The work is based upon developments in the use of social accounting matrices (SAM). The matrix provides a conceptual framework whereby the economy's interactions with marketed and non-marketed flows of services from environmental assets is presented in a manner consistent with the established System of National Accounts (SNA) and hence broadly compatible with the UNSO SEEA. An advantage of this approach is that while it is presented in an aggregated form, the components of the matrix can be disaggregated. In this way, any particular cell of interest can be 'magnified' to obtain more detailed information (where such information is available). A complete set of accounts in this vein would require more data than presently available so that at this time an incomplete table would have to be used (de Boo *et al.* 1991). This will place some constraints on the usefulness of these accounts.

(b) Monetary Valuation

In theory, the physical data in an accounting matrix can be transformed into monetary values. The difficulty in taking this step is the familiar one of finding the appropriate respective shadow prices by which to obtain these values. If valuation is possible then closer comparison can be made with the accounting aggregates that are familiar to decision-makers. In this respect, much attention has been given to trying to calculate an aggregate measure of sustainable income, underlying which is the much quoted Hicksian definition of income (Hicks, 1946). This calculation forms part of the CBS project.

The CBS takes no particular stance on valuation at this time but the methodology set out by Hueting has received close attention (see, for example, Hueting, 1989). The basis of this approach is a rejection of valuation techniques derived from standard economic theory. One contention is that, no matter how sophisticated these techniques might become, the theoretically correct shadow prices for environmental services (where no price is observable in a market) will not be found. In cases where market prices can be observed, it is claimed that the valuation methods suggested by for example, Repetto *et al.* (1989) and El Serafy (1989) are inconsistent with sustainability as they imply the use of a positive discount rate and depletion of the resource.

In view of this critique a rationale for a different approach is sought. It is argued that individuals and society have revealed a preference for sustainability through the public pronouncements of politicians in various national and international forums. The definition of sustainability used here the sustainable use of each environmental function. Hueting and Bosch (1992) recognise that the value of performing this for every conceivable problem is impracticable and so judgment must be exercised in the selection of those problems. In the case of the Netherlands, these key issues are the greenhouse effect, atmospheric ozone depletion, ground level ozone, natural resource depletion, acidification, eutrophication, land-use, desiccation, and soil pollution.[3] The main stress is upon problems of environmental degradation rather than depletion (resources are considered to be only a small part of the wealth of the Netherlands).

Once these problems are identified the problem is to find a standard based upon behaviour consistent with sustainable use of the function in question. Criteria consistent with this behaviour are sought by reference to scientifically set standards.[4] This in turn is taken as justification to define sustainability as a 'scientific concept'. Calculating the resulting 'avoidance cost curve' involves two elements. Firstly, the cost of technical measures to reach the sustainability standard must be established. These will differ according to the function analysed, be it for nonrenewable or renewable resources. Uncertainties in this approach include rates of recycling, development of substitutes, technological progress, carrying capacities and critical loads. Secondly, it may be the case that the scope for such methods is limited. In this instance the cost of shifting economic activities to less environmentally burdensome counterparts is calculated - so-called 'structural measures'.[5]

This method does have some parallels with the UNSO SEEA outlines. Van Tongeren *et al.* (1991) and Bartelmus *et al.* (1992) express similar doubts concerning methods to measure, say, willingness-to-pay for non-marketed

[3] These are not necessarily in any order of importance.

[4] Such as from ecological research.

[5] Hence in the case of global warming it is estimated that 50% of the required measures can be achieved via technical measures (Hueting and Bosch, 1992). Hueting et al (1992) have calculated that a 1% shift in the volume of environmentally burdening activities to those involving less environmentally burdening activities involves a negative effect on income of 1.5%. Hueting et al (1992) also mention the need to look at levels of population consistent with sustainability when all else fails.

environmental services. They, in turn advocate using avoidance costs which may be based upon the state of the asset pertaining at the beginning of the accounting period, but which could also refer to a standard (although neither is necessarily consistent with Hueting's 'sustainability').

In the aggregate, Hueting *et al.* (1992) claim to obtain a measure of the difference between measured GDP and the GDP consistent with the sustainable use of the environment. The difference is the cost of achieving sustainability (Hamilton, 1991). This measure is seen by the CBS as an indicator of environmental losses in money terms rather than a 'green GDP' per se, although analogies with such aggregates might be attempted. Its role is therefore envisaged as an alternative macroeconomic indicator that stands along side the conventional aggregates. On this basis decision-makers can judge policy relevance and the sustainability of current economic activity.

Defensive Expenditures

Defensive expenditures also feature in the analysis. Within VROM, interest in the measurement of these expenditures arose from a parliamentary request. These are referred to as the 'costs of environmental measures'. Simulations concerning the projection of future defensive expenditures have been undertaken and used in government planning and are used in all environmental programmes. The data used for this are prepared by the CBS. Simulation exercises are also undertaken by the National Institute of Environment and Health (RIVM) in Bildhoven.

Defensive expenditures are considered by the CBS to be more accurately termed the 'costs and financing of environmental improvement'. It is estimated at present that these expenditures are about 3% of the Dutch GDP (CBS, 1993). This broadly concurs with similar studies of other developed economies, such as by ECOTEC (1993) for the UK.

Monetary outlays for environmental control, and the compensation of the loss of environmental function and for the repair of environmental damage can be analysed within the national accounting matrix of de Boo *et al.* (1991). It is interesting to see that many of the controversies surrounding the appropriate treatment of defensive expenditures appear to be 'resolved' using a modelling approach (Proops, 1991). Damage to the environment is recorded as negative income. Any resulting expenditure to restore these losses is counted as an offset to the losses and hence positive income. The de Boo *et al.* analysis emphasises that these expenditures are not just a cost but that individuals and society derive benefits from them.

The International Perspective

International trade in natural resources and waste and transboundary pollution are of significant interest to the CBS. Progress here is contingent on the availability of data, particularly in the case of pollution (de Boo *et al.* 1991). Hueting *et al.* (1992) look at the various frameworks by which these issues can be analysed, addressing the practicality of each. To address policy considerations, the focus is on the pollution embodied in imports and exports rather than environmental quality itself. Interest in this work has been shown by the Dutch Ministry of Foreign Affairs on the 'import' side of this story. Gilbert (1992) shows how a variant of Hueting *et al.* (1992) can be applied to analysis of the incidence and origins of cadmium in soil in the Netherlands.

Uses and Users

There is general uncertainty concerning this crucial question, owing mainly to the early stage of the research. To some extent, expected uses are implicit in the very fact that research is taking place. This is emphasised in that the approach advocated by VROM is motivated by an 'issue-orientated' agenda. Important local and global issues are identified and analysed from this view. Once an issue is identified it can then be assessed as to what information is required to 'solve' this problem. Adjusted national accounts can be seen in this context. The perception is that environmental resources are being 'squandered' (Adriaanse, 1993). As part of an 'Environmental Policy Plan', those working within VROM have developed environmental indicators where various key problems are identified and analysed through the determination of 'target groups' (although this is not yet part of accepted policy). Trends in environmental problems (such as solid waste, eutrophication and noise) have been examined and the 'sustainability' of each group judged. It is believed that from this approach some sort of index can be derived allowing aggregation.[6] These results are to be published widely, as, despite a high degree of public awareness, specific information and knowledge is lacking.

The main role of the CBS is to supply statistics and prepare national accounts. It has no modelling responsibilities itself but supplies data to be used in this respect, such as to the Dutch Institute for Environmental Protection. However, de Boo *et al.* (1991) offer a framework that can be used in subsequent modelling exercises.

[6] De Boo *et al.* (1991) speculate that if such an index or indices can linked to a index containing standard SNA information some tentative first steps might be made as to which direction a society is heading without the need for valuation of environmental assets.

This is in the spirit of SAMs, so that the distributional consequence of effects can be analysed rather than just the general incidence of these effects. Interaction between the CBS with users in government and academic institutions does occur. The major users of this framework and data are expected to be national government organisations and in particular strategic planners within VROM. Some interest is anticipated regarding avoidance cost curves, which are viewed as real compensation for environmental losses by VROM. There seems to be support for valuation via the standards approach of Hueting *et al.* (1992) as this option offers a tractable method of valuation that promises to deliver an estimate of 'sustainable income'. This is largely consistent with VROM's advocation of the setting of standards where ecological carrying capacities are violated (VROM, 1991).

Here the work of the CBS and VROM is in some respects complementary. Adriaanse (1993) will contain some estimates of critical loads which when combined with CBS data will be used to calculate avoidance cost curves. VROM (1991) describes sustainable development as a 'guiding principle' for Dutch government policy and in this respect economy-environment linkages have emerged as important issues in decision-making circles. Adjustments to national accounts are viewed as only one component of an overall strategy concerning environmental policy plan within VROM.

Comments and Conclusions

At this stage the CBS is investigating a number of ways to integrate environment-economy interactions into national accounts in a systematic fashion. The work has so far shown how environmental statistics in the Netherlands can be transformed into 'Norwegian style' physical accounts (CBS Netherlands, 1993) or a satellite accounting framework that can be developed - the potential for valuation can be assessed subsequently (de Boo *et al.* 1991).

It is this proposed valuation that provokes the most controversy. The particular definition of sustainability as chosen by the authors would appear to be of crucial importance here. Politicians and interest groups, mirroring the wishes of individuals and society, have revealed a preference for sustainable development in the Netherlands. Whether or not these statements can be taken to correspond to a societal preference for the sustainable use of **all** environmental functions is open to debate.[7] If this were the case then all environmental assets and their functions

[7] Peskin and Lutz (1993) entertain the possibility that preferences for an individual environmental function might plausibly be greater than that indicated by a sustainability standard.

would be deemed to be critical in the sense described by Pearce *et al.* (1989). There may well be arguments in favour of the specification of standards but it is not clear that they can be (or need to be) justified on the above sustainability criterion.[8]

[8] The argument used is that the analysis proceeds upon an assumption inferred from some observation. As long the assumption is made explicit then the approach remains legitimate.

Case Study 6: Norway

The interaction between the macro-economy and the environment is the most important characteristic of the Norwegian approach to resource and environmental accounting. Even where monetary valuations are not presented, the Norwegian physical resource accounts are closely linked to macro-economic models used for planning Norwegian social and economic growth.

The work on the Norwegian Resource Accounting System (NRA) was initiated by a Parliamentary demand at the end of the sixties. After some pilot experiences, the Central Bureau of Statistics (CBS) assumed the responsibility for the NRA in 1978, working in co-operation with the Ministry of Finance and the Ministry of Environment. The first results were presented in 1980, and more recently a yearly report has been published by CBS containing data and analysis of the current status and forecasts of the environment and natural resources.

The most frequent reference in the Norwegian literature concerns the use of NRA for macro-economic planning purposes. However, the way it was incorporated in the Long Term Plans has changed over time. In the beginning the emphasis was to establish a system for resource budgeting. Efforts were concentrated on methodological issues, concerning the relationship with the conventional System of National Accounts (SNA), and a relatively large number of resources were covered: energy, fisheries and land use, and less detailed accounts for minerals and forests. The structure was based on a division between reserves, extraction, transformation and use accounts for each resource. The focus reflected the preoccupations of the seventies, when there was much more concern about oil price shocks and the possible exhaustion of depletable resources.

During the 1980s this perception gradually shifted to an increasing emphasis on environmental degradation problems. A pragmatic approach was assumed, in order to concentrate efforts in resource accounts which could be used in macroeconomic and other planning tools. The NRA now focus primarily on only two resources, air pollution (clean air is viewed broadly as a natural resource) and energy, and the other resources (fisheries, minerals and forests) receive less attention. The land use account was abandoned because its high costs were not matched by similar benefits in application to planning issues, at least at the macro level.

The effects of acid rain and other air pollution issues on the domestic economy, and the leading position of Norway in international agreements on reducing emissions explain part of this change. Emission projections are an output of the macroeconomic models, based on emission/output coefficients estimated using

actual data. Energy resources (oil, gas and hydropower) are still important: electricity represented 4% and oil and gas activities represented 17% of 1992 Norway's GDP, respectively (CBS Norway, 1993). These two issues are treated in an integrated way, since emissions from energy use are an important source of air pollution.

Natural Resource Accounts

The NRA is a system of natural resource accounts expressed in physical units used mainly for planning and forecasting purposes. The resource accounts are divided into two categories: (i) the material accounts refer to resources which can be extracted or harvested from nature - forestry, fishery and mineral resource accounts are already in use in the NRA; and (ii) the environmental accounts which deal with changes in environmental quality.

The material accounting information consists of the reserve or stock accounts, the material flow accounts, and analyses of present and future resource uses (Alfsen *et al.* 1987; Sæbø, 1993). The accounts for reserves (mineral resources) or stocks (biotic resources) include the previous status, change in physical units owing to discoveries or natural growth (only for stocks), extraction and revaluations. The material flow refers to the balance from extraction, exports/imports, conversion and use. Finally the analyses cover the indirect use of resources (for example, estimating the amount of energy required for each good and service covered by the SNA using input/output models) and projections of resource use for each sector defined in the macroeconomic models developed at the CBS.

The environmental accounts measure changes in environmental status or quality owing to the pressure or stress caused by the extraction and use of natural resources (focused on the material accounts). They consist of two parts: emission accounts, including discharge and waste; and status accounts, which give a survey of environmental status at one point in time and changes between two points in time (Sæbø, 1993).

Adjusted GDP

Adjusted GDP or other kinds of indicators that can provide a synthetic measure of sustainability are not a goal of the Norwegian accounting system. Two reasons are given for this. First, the incorporation of monetary values for environmental issues is seen as theoretically incompatible with the purpose and character of the SNA, based on value added in market transactions. Second, adjusted ("green") GDP is considered a very indirect and nebulous way of coming to grips with

environmental problems (Aaheim *et al.* 1991, p.7). To quote the CBS: "In preparing an environment-adjusted domestic product as an aid to an integration of economic and environmental policies, the persons preparing the statistics have to make a long series of subjective assessments of values. This implies that the statistics may contain a number of political evaluations, which will not necessarily be obvious to those who are to use the data. Thus it is possible that conditions which require a balance of different considerations may become more obscure. On the basis of the above considerations, CBS has chosen not to recommend the preparation of an environment-adjusted domestic product", (CBS Norway, 1992 p.153).

Instead, the emphasis is on several environmental indicators, expressed in physical units (Alfsen *et al.* 1992b). These indicators can be helpful in monitoring specific policies and can be used together with macroeconomic indicators, such as GDP, the inflation rate and the unemployment rate.

Recently some efforts have been developed to give monetary valuations to oil resources and other depletable resources. There are also models trying to estimate benefits from air pollution control (Alfsen *et al.* 1992a) and other environmental policies. The purpose of the latter is to study the establishment of a tax system on the use of environmental resources, based on the 'polluter pays principle'. However these exercises are still at a preliminary stage and they are not incorporated in the 'core' of the NRA.

Satellite Accounts

Since the NRA is not intended to change the conventional measures of GDP in Norway, it is best considered as a kind of satellite account. In fact the material flow described in the resource accounts is closely linked to the national accounts, with the difference that material accounts are kept in physical units while the SNA uses monetary units.

The recent introduction of monetary values into the material accounts sharpened this linkage. However, the definition used by NRA technicians is different: they call this work "analysis", not an accounting exercise. The idea is that this kind of work is distinct from conventional national accounting because it deals with ex-ante (expectation-based) values. Therefore the assumptions and interpretation are distinct from conventional national accounts analysis where ex-post (actual) observations are used.

The criterion used to define a separate account is its relevance for policy purposes.

Since only a few resources are significant for planning or other macro-analyses, there is no intention to construct a total national wealth measure - even if generic references to national wealth as an indicator of future consumption possibilities appears as a long term goal (Royal Norwegian Ministry of Finance, 1989 p.74).

Defensive Expenditures

Norway intends to estimate public expenditures for environmental protection, including expenditures on energy conservation and expenditures broken down by type of pollutant and receiving medium.

Modelling/Planning

The main use of NRA is to supply inputs to the medium and long term economic models prepared by the CBS for the Ministry of Finance. These models are crucial for the elaboration of Norway's Long Term Plan, which provides the guidelines for government policies.

Resource and environmental issues in Norway are integrated into existing economic planning procedures. There are two basic macroeconomic models: the medium term model (MODAG) and the long term multi-sectoral general equilibrium model (MSG). Versions of these models have been augmented to include energy and air pollution variables - data on process related emissions are obtained from the State Pollution Control Authority (Alfsen, 1991 p.4).

These models provide forecasts of energy demand and emissions, employing constant coefficients calibrated for a base year and exogenously altered to account for planned environmental control measures in the forecast period. As a consequence, projections of domestic energy demand and air emissions can be obtained whenever an economic scenario is constructed with little extra effort.

The models are also useful for estimation of the benefits of pollution control policies. One example is an attempt to estimate monetary benefits from air pollution control owing to changes in the labour-productivity function. However, this kind of exercise met difficulties in forecasting foreign air emissions, which are in some cases responsible for more than 90% of the total pollution in Norway. It seems that advances in this application will be linked to improvements in data coverage in neighbouring countries.

Resources Analysed

Energy

The energy accounts give annual information on reserves, extraction, conversion and end use of energy (mainly oil, gas and hydropower), measured in physical units. Since its inception, energy accounts have been a priority in the NRA: in the first instance to provide data to optimize the use of domestic sources of energy and more recently for estimating emissions to air.

The hydropower accounts were required to elaborate the domestic energy demand forecasting models - the models in use during the 1960s and 1970s were based on very crude hypotheses. The motivation for the accounts was economic, in order to optimize water supply for hydroelectric use, but also environmental, with the desire to conserve rivers as free from development as possible (Aaheim *et al.* 1991).

Oil and gas activities are extremely important for the Norwegian economy, and therefore the NRA report for 1990 (CBS Norway, 1991) presented some estimates of petroleum wealth. However, the uncertainties in economic variables (future prices and costs) and physical variables (actual size of the stocks) were viewed as making these estimates too crude for policy planning, and they do not appear on the 1991 report (CBS Norway, 1992).

Air Pollution

The air pollution accounts also receive priority in the NRA. They contain annual inventories produced by CBS Norway with the cooperation of the State Pollution Control Authority (SFT). The components covered are sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), volatile organic components (VOC), particulate matter, lead (Pb), methane (CH_4) and nitrous oxide (N_2O). Emissions are classified to thirty economic sectors and the following end uses: stationary combustion, industrial processes and evaporation.

There is no need for primary data on emissions for the whole series: emission data are based on the end use part of the energy accounts and other information, including data on process emissions from large industrial plants (Aaheim *et al.* 1991 p.3). For more recent years the emission inventories have been calculated on the basis of surveys of energy consumption. Consumption of the different forms of energy is distributed between the different purposes within each economic sector using a macromodel (MODIS IV). Consumption is then multiplied by emission coefficients tied to the form of energy and type of industry (CBS Norway, 1992 p.62).

Fisheries

Fisheries accounts consist of stock inventories, classified by type, age and geographic location. Since the end use of fish is restricted to a few sectors related to household consumption and foreign demand, there is no intention to elaborate the consumption part of this account. The difficulty in estimating foreign demand, the main destination of Norwegian fish production, explains why fisheries accounts have not been considered germane to macroeconomic planning. Their relevance is more related to localized problems of potential scarcity.

Forests

As in the case of fisheries accounts, forest accounts do not receive priority in the NRA. They contain information on productive area, volume and the health of the stock, with the emphasis on reserves and extraction. Again there is a lack of macroeconomic use of these data, and the high level of aggregation constrains their use for forest management purposes.

Land Use (Agriculture)

Land use accounts received priority at the beginning of the NRA project, leading to the production of a large amount of information. The objective was to develop a system for land use planning at the county and municipal levels. Statistical and cartographic data were collected in a national land survey based on about 6000 sample points (a very expensive exercise). The results were used in some national level agricultural programs, but the main applications were for local and regional planning. Consequently this account was discontinued as an ongoing survey at the national level, although there is some continuing work by other institutions at the local level. The CBS has recently focused on the discharges of nitrogen and phosphorus caused by agricultural runoff, to help meet Norway's obligations to reduce these dis-charges to the North Sea by 50 per cent by 1995, with 1985 as the base year.

Minerals

Minerals other than oil and gas are not particularly important in Norway. As a result, mineral accounts receive little attention. Estimates of mineral reserves were produced at an early stage. However, falls in prices curtailed extraction. There is

some minimal updating of these accounts but they do not appear in the "Natural Resources and the Environment" annual reports.

Other Resources

The 1991 Natural Resource Report (CBS Norway, 1992) introduced three new sections: waste water treatment plants, wastes, and environmental indicators. The first of these presents the results of a survey of municipal waste water treatment plants made in 1990, while the second gives an overview of quantities of waste and waste management in Norway. Environmental indicators were developed and presented for the following environmental effects and conditions: climate change, depletion of the ozone layer, health, noise, eutrophication, damage to forests, damage to fisheries, contamination, recreation, wilderness, and biological diversity. This set of response indicators will be supplemented by a set of stress (cause) indicators, including figures for emissions, in the next few years.

Status and Administrative Information

The NRA is an ongoing program started in 1974 in response to a special request of the Storting (Parliament). The CBS has been responsible for the NRA since 1978, with the budget initially sponsored by the Ministry of Environment. Since 1983 Natural Resource Accounting has been a core task of the CBS. The CBS is subordinate to the Ministry of Finance.

The NRA generally uses secondary data collected by other institutions directly involved with environmental problems, mainly the State Pollution Control Authority (SFT). Special surveys are required when new kinds of information are demanded, and these can become ongoing surveys if there is a need for periodic updating.

A particular characteristic of the CBS is that it is responsible for economic research, analysis and modelling as well as being a statistical office. There is an internal division of work: the Division of Resource Accounts and Environmental Statistics deals basically with collecting and organizing data, and the Research Division develops economic analyses and models.

Because the CBS is responsible for developing macroeconomic planning models for the Ministry of Finance, the institution is very close to the policy-makers. That proximity is also a characteristic of the NRA programme, thereby establishing a connection between the staff of the Ministry of Environment, historically linked with the NRA, and the Ministry of Finance, end users of the models developed at

the CBS. This organization explains much of the success Norway has had in introducing environmental issues into conventional economic planning. This is also the reason why there is little interest in constructing very elaborate accounting and modelling exercises: the average dimensions of the models, thirty production sectors and forty commodities, reflect a compromise between the goal of supplying detailed sectoral information and the Ministry of Finance's need for a manageable model (Alfsen, 1991 pp 6-7). Extremely dis-aggregated data are not considered particularly useful for macro policy-making.

Purposes and Applications

The main purpose of natural resource accounting in Norway is to provide data and other analytical tools for policy analysis and decision-makers. Monitoring is also an objective, specially on issues where Norway has signed or is proposing international agreements on emissions to the air and the North Sea. Modelling is seen as the easiest way to provide information for both applications, without the need for exhaustive surveys on energy use and emissions every year. Public information is a byproduct of such work, but is not considered its main mission.

The guidelines for the NRA are pragmatic: data should never be collected and processed unless they have a policy application. As Alfsen (1991) notes:

> "The point is of course to avoid putting much resources and effort into detailed modelling of 'inessential' phenomena, while at the same time making certain that the statistics gathered are useful and treated in a disciplined manner. There is almost no limit to the amount of environmental and economic statistics or analyses 'needed' by someone somewhere. (...) At this stage of development, it is more important to be pragmatic and consistent within an integrated approach to the planning problem, than to be sophisticated with regard to more partial problems." (p.1).

This pragmatic approach justifies the limited scope of resources considered. Furthermore, aggregate measures of sustainability are not a goal: they are not considered helpful for policy decisions (and many theoretical objections are also presented by the Norwegian).

An indirect consequence of the resource accounting work in Norway is the creation of a channel of communication between the staff of the Ministry of Environment and other institutions, particularly the Ministry of Finance. The NRA is a common interest for both of these institutions, institutions usually having opposite points of view on environmental questions.

Case Study 7: The United Kingdom

In 1989 the UK Department of the Environment commissioned a study on sustainable development as part of its continuing response to the Brundtland Commission Report of 1987 (WCED 1987). The 'Pearce Report' (Pearce *et al.* 1989) contained a section on green national income accounting which recommended (a) significant effort at developing environment-economy indicators, and (b) progress on the development of measures of 'sustainable income'. In separate and unpublished recommendations, however, the report also cautioned about the priority that should be attached to elaborate green account-ing exercises given their cost and the need to develop other accounting exercises as well. However, the Report was produced before the Rio Summit and before the establishment of the Commission for Sustainable Development. The UK Government (1993) is preparing a lengthy submission to the CSD and is considering its position on 'sustainability indicators', including green income measures.

Independently, the UK Central Statistical Office, which is in overall charge of the production of government statistics, had launched a modest project to provide first 'experimental' estimates of physical accounts and monetary accounts (Bryant and Cook, 1992). Estimates of oil and gas depletion are based on the El Serafy approach to user cost. Defensive expenditures on land reclamation and other environmental expenditures are deducted, but no estimates are provided for environmental degradation generally. Table 1 shows the results.

Currently, the Department of the Environment has a task force investigating the development of green accounts. Discussions with the task force suggest that it sees the development of integrated monetary accounts as taking 'many years', but that sets of natural resource accounts would be valuable for (a) forecasting purposes and (b) as ingredients of reports to the Commission for Sustainable Development.

Table 1:Experimental Monetary Accounts for the UK

Gross Domestic Product 1990	£479,452 million
less: oil depletion gas depletion	 £ 3,793 £ 1,855
less: land remediation defensive expenditures on: water air other oil pollution removal	 £ 240 £ 6,700 £ 2,400 £ 5,300 £ 1
equals Sustainable Domestic Product % difference from GDP	 £459,163 4.2%

Source: adapted from Bryant and Cook (1992).

4.The Empirical Experience with Resource and Environmental Accounting

The following is a brief review and analysis of published attempts at constructing natural resource accounts, satellite accounts, and/or altered national accounting aggregates. This chapter will highlight the significant data and methodological problems that governments can expect to face as they approach the development of natural resource and environmental accounts.

Australia

Young, M.D. (1993) Natural Resource Accounting: Some Australian Experiences and Observations, in E. Lutz (ed.) Toward Improved Accounting for the Environment, The World Bank, Washington DC.

Natural resource accounting has been identified as one of 15 possible policy changes to promote (ecologically) sustainable development in Australia. The development of these accounts is in the early stages. In fact, Young claims that there is a fair amount of scepticism towards modified national accounts as an aid to environmental decision-making.

Young attempts to calculate a 'green' GDP by taking account of the use of renewable and nonrenewable resources use in production. Given data collection problems, many of the entries are based on 'guesstimates' which were designed to be 'environmentally generous'. The valuation method used is Repetto *et al.* (1989) although the document presents adjustments as modified GDP.[9] The agricultural sector accounted for almost 5% of Australian GDP in 1987-88.[10] Estimates of habitat decline and land degradation (erosion and salinity) were in the region of 0.6% to 1.6% of GDP during the period 1980 to 1989 (average 0.8%). The adjustment to GDP is therefore small.

The extraction of nonrenewable resources is a larger component of economic activity in Australia. Repetto's treatment of discoveries is used, allowing adjusted GDP to be greater than conventional GDP in any year. This is indeed found to be the case in all but two of the years during the period covered (1980-1989). Young says that this would provide very poor signals for environmental and resource management. This need not lead to a rejection of resource accounting, but to more

[9] The value of human-made capital depreciation is not deducted.

[10] This includes farming, forestry, fishing and hunting.

a recognition that there are methodological issues to be resolved such as the treatment of discoveries. In addition, Young appears to include price changes in the adjustment, whereas these are usually presented in reconciliation accounts or balance sheets as a capital gain/ loss. Young also makes several suggestions to improve the usefulness of adjusted accounts.

(a) Given a population growth rate of 2% in Australia, GDP per capita should be stressed. (Of course this tells us nothing concerning how this GDP is actually distributed.)

(b) National accounts deal mainly with marketed activities. As such they are an indicator of the level of economic activity and not a measure of welfare. Social costs and benefits should not be neglected where the non-marketed value of services from the environment might be expected to be significant.

(c) Concentrate on regional or sectoral accounts. Geographical Information Systems (GIS) could provide data for maps of the annual costs and benefits of land use within a region. Interestingly, whilst local land administrators and resource managers support aggregated accounting systems, they opposed a GIS-based system which would indicate the impacts of particular projects. Young envisages that this system would be able to answer an array of questions such as the likely effects of conservation programmes on land use.

Canada

Anielski, M. (1992) Resource Accounting: Indicators of the Sustainability of Alberta's Forest Resources, Paper presented to the International Society of Ecological Economics Conference 1992, Stockholm.

Anielski presents pilot physical and monetary accounts for forest resources in Alberta, covering the period 1964-1990. The intention is to gain information on the sustainability of the services that natural capital (i.e. here, the stock of Alberta's forests) provides.

The construction of physical accounts involves the calculation an opening stock (area x volume per unit area). The relevant flows are mean annual increment (MAI), harvest, natural loss and afforestation. The trend of the net closing balance is shown to have been increasing steadily over the period, where the closing stock in 1990 was 8% greater than in 1964. (Old growth area has declined because of 'disturbances' - i.e. fire, insects and land-use change). These figures are dependent on the accuracy of data on MAI which can be checked by periodic inventories. Anielski states that sufficient information exists to construct comprehensive timber accounts for Alberta.

These accounts can be further linked to the conventional SNA through valuation of physical volumes and flows. The price of timber is subject to large fluctuations and this is reflected in the values obtained for the stocks and flows measured. The value of closing stocks therefore fluctuated year to year, although in each year (apart from 1980 and 1981) the value of harvest was exceeded by the value of growth. In this sense, Alberta's forest resources have been managed sustainably, although the value of this growth is not a component of currently measured domestic income accounts in Alberta. Values for non-marketed services are also considered, although no calculations are undertaken in this study. Extensions to measure the value of services such as amenity, carbon fixing and the provision of wildlife habitat would be interesting and go some way toward actual measurement of total economic value.

Born, A. (1992) Development of Natural Resource Accounts: Physical and Monetary Accounts for Crude Oil and Natural Gas Reserves in Alberta, Statistics Canada.

This study is part of a project to develop National Balance Sheets Accounts for Canada that include natural resources as assets. Born presents measures of

Alberta's oil and gas established reserves in terms of both volume (physical) and value (monetary) during the period 1951 to 1990.[11] The theoretical background to the adjustments receives detailed attention with thorough discussions of the methodological issues involved, including the 'meaning' of economic rent and the validity of the various assumptions underlying it's measurement (i.e. homogenous resource stocks, perfect competition etc.).[12]

The central aim of the paper is to present adjustments in the context of wealth accounts. Reconciliation tables represent wealth accounts for Alberta's natural gas and oil resources showing opening and closing stocks. The closing stock balances of net tangible assets is equivalent to the opening stock plus the exploration costs plus volume changes plus price changes (all valued at market price, except for exploration costs and depletion). Exploration, development and operating costs all need to be deducted to obtain the rental value from which the discounted values of opening and closing stocks can be derived. This includes a normal return to capital (imputed to avoid double-counting in the wealth accounts), which Born interprets as the replacement cost value of the net capital stock, depreciation and the average yield on long-term corporate bonds. Depletion is then valued at some imputed ecological value and adjusted to a current (undiscounted) market value. The proportion of this rent in the wellhead price varied from about 37% to 74%.

The values of oil and natural gas derived reflect both the fluctuating prices for resources and diminishing stocks. For example, the reserve value for natural gas has increased since 1982, again reflecting decreasing stock and the collapse of natural gas prices in 1986. Born finds the assumptions of the Hotelling model too restrictive, given the data for Alberta. Therefore, the current net price is not appropriate for valuing future production although it does provide some basis for comparison with other studies. The present value approach is claimed to be the most consistent with wealth accounts.[13] This allows the separation of the value of

[11] Alberta is the largest producer of oil and natural gas in Canada (i.e. in 1989 the value of it's production was 84% of the national total). It also has the largest reserves. Established reserves are recoverable under current technological and present and anticipated economic conditions. The SEEA convention of estimating proven reserves as the latter is considered too conservative for macroeconomic planning purposes.

[12] Rent is often estimated as the residual of the international price after all other factor costs incurred in extraction have been subtracted. Where marginal costs of extraction are increasing, the resource rent is the sum of Hotelling and Ricardian rents. The inclusion of the latter as depreciation is disputed (Hartwick 1982 and 1989, Hamilton, 1992).

[13] El Serafy's user cost method is also cited but this method offers no guidance as to how to value remaining reserves.

man-made capital employed by the industry from the value of the natural resource itself and the identification of capital gains and losses due to price changes.

The value of reserves are not apportioned to various institutional sectors of the balance sheet. These distributional aspects will be the subject of further work.

Costa Rica

Solorzano, R., de Camino, R., Woodward, R., Tosi, J., Watson, V., Vásquez, A., Villalobos, C., Jiménez, J., Repetto, R. and Cruz, W. (1991) Accounts Overdue: Natural Resource Depreciation in Costa Rica, World Resources Institute, Washington DC.

The World Resource Institute produced a natural resource accounting exercise for Costa Rica (Solórzano *et al.* 1991). The accounting framework basically follows WRI's previous work for Indonesia (Repetto *et al.* 1989). The estimates of stocks and stumpage values are more detailed and sophisticated, but cover only the losses of the main services obtained from the resources depleted: forestry, soil and fishery.

The forestry account presents the loss of immediate and future timber in physical and monetary values, using stumpage values estimated separately for hard, soft and medium density timber according to distance from processing sawmills. The soil erosion account covers the loss of principal nutrients for plant growth, based on the volume of soil erosion and the cost of its equivalent in fertilizer terms. For fisheries, only the loss of the principal species in one important fishing area (Nicoya Bay) are considered, using a bioeconomic model estimated econometrically to calculate the change in sustainable harvest levels and resource rents with increasing fish effort. All expected future damages are capitalized into present values and added to the depreciation figures.

The main results are summarized in Table 2. Forest resource depreciation was deducted from gross forestry product, soil depreciation deducted from agricultural value added and fishery depreciation from gross fishery product, generating respective net product series. It is interesting to note that the net forestry product series is negative for almost all years, a result which lacks a comprehensible theoretical explanation.[14]

[14] The net price method is based on an assumption of an optimal extraction path. However, if the net product income is negative, it is clear that producers do not follow optimal or efficient criteria for extraction. On the other hand, negative product or income is meaningless in terms of the identities of National Accounts.

Table 2:GDP, Resource Depletion And "NDP"
Costa Rica - 1970/1989
Constant 1984 Colones, millions

Year	Forestry		Agriculture		Fisheries		Total	
	GDP	"NDP"	GDP	"NDP"	GDP	"NDP"	GDP	"NDP"
1970			21044	19104			93446	82513
1971			19277	17403	139	132	94382	81858
1972			20278	18292	138	131	100912	89173
1973			23570	21488	163	158	116525	103366
1974			23835	20655	197	203	122740	108144
1975			25503	22518	196	212	125393	111155
1976			26960	24429	244	277	132310	118940
1977			31513	28960	219	284	143990	130285
1978	2829	- 1123	31258	28908	567	679	153124	138900
1979	3059	- 2861	29713	26792	763	856	160598	143277
1980	3024	- 2258	28668	25580	641	779	161894	145132
1981	3029	357	36804	33973	652	646	158237	145216
1982	2189	251	35220	32100	751	652	145932	134928
1983	2527	- 4143	33679	30794	586	503	154481	139815
1984	3071	- 4446	34540	31512	865	699	163011	147438
1985	2917	- 4776	31879	28614	1268	995	169299	153374
1986	2968	- 8703	37057	34560	1225	839	177327	158365
1987	2746	- 4920	33615	31320	1466	663	186019	170846
1988			37309	34687			207816	181352
1989			39459	36883			231289	205362

Source: Solórzano *et al.* (1991)
* Excludes conventional capital consumption allowance.

India

Parikh, K., J.Parikh., V.K.Sharma and J.Painuly (1992) Natural Resource Accounting: a Framework for India, Indira Gandhi Institute of Development Research, Bombay.

The Indira Gandhi Institute of Development Research in Bombay (Parikh *et al.* 1992) has prepared an investigatory report on natural resource accounting for the Indian Ministry of Environment and Forests. A framework is established and is aimed explicitly at measures of human wellbeing. It includes (a) approaches to estimating non-market sector (NMS) activities such as biofuels, and (b) natural resource accounts (NRAs). The report recommends an action plan based on immediate priorities. These include assessing the physical environmental impacts of selected production and consumption activities, including the informal sector, and physical accounts for soil, air, water, forests, biodiversity and various non-renewable resources. After that, economic valuation should be investigated with the aim of ultimately securing integrated economic and environmental accounting (IEEA), as called for in Chapter 8 of Agenda 21.

The purposes of the exercises are listed as:

(a)to keep track of the resource base and the state of the natural environment a general *monitoring* function;

and

(b)to remind people of the environmental consequences of economic activities and hence to 'alter our perception of what kind of development is desirable and, in turn, the policy choices we make' (Parikh *et al.* 1992 p.2)- a *persuasive* function.

Outline schema are presented for adjustments for NMS accounts and NRAs, but little physical data and no economic data for India as a whole are reported.

Indonesia

Repetto, R., Magrath, W., Wells, M., Beer, C., and Rossini F. (1989) Wasting Assets: Natural Resources in the National Accounts. Washington: World Resources Institute.

The most well-known natural resource accounting study is the pioneer exercise by the World Resources Institute (Repetto *et al.* 1989) for Indonesia. Changes in the stocks of natural resources (oil, forests and soil) are considered in the capital account as well as the changes in man-made capital: decreases are treated as depreciation, and increases as capital formation.

The valuation principle assumed for oil and forests (timber) is the net price method: rents are determined by the international resource commodity price less all factor costs incurred in extraction. This implies that domestic and international markets for the resource are assumed to be perfect, and optimal paths of extraction follow the Hotelling Rule. Opening and closing stocks in each period are multiplied by the respective rent, and the variation between each represents the (dis)investment in natural capital.

Soil erosion received a different treatment: the loss of potential future farm income is considered equivalent to the depreciation of an economic asset. Incremental erosion due to human intervention is estimated in physical terms by the difference between per-hectare loss on forest land and on dryland farming (*tegal*). Yield-erosion relationships are also estimated, with the farm income declining linearly as erosion increases. The one-year costs of erosion are then capitalized to obtain the total present value of the future stream of productivity losses associated with the erosion in that year, which is considered to be the economic measure of soil depreciation.

The results from the three resource accounts are aggregate into one measure of "natural capital domestic investment" ("NDI"), which is added to the GDP (Table 3). The new aggregate is named "NDP", but it is still an incomplete measure of net domestic product because it ignores the depreciation on man-made capital. The figures are usually below the conventional measures, however in 1971 and 1974 the "NDP" is higher than the conventional GDP, owing to oil discoveries and price changes.

Table 3:GDP, Resource Depletion And "NDP"
Indonesia - 1971 to 1984
Constant 1973 Rupiah, billions

Year	GDP	Resource Depletion	"NDP"
1971	5545	+ 1126	6671
1972	6060	- 100	5967
1973	6753	- 279	6474
1974	7296	+ 2605	9901
1975	7631	- 1121	6510
1976	8156	- 684	7472
1977	8882	- 1711	7171
1978	9567	- 1607	7960
1979	10165	- 2219	7946
1980	11169	- 2663	8506
1981	12055	- 2215	9840
1982	12325	- 1764	10561
1983	12842	- 2870	9972
1984	13520	- 2330	1118

Source: Repetto *et al.* (1989)

Japan

Uno, K. (1989) Economic Growth and Environmental Change in Japan: Net National Welfare and Beyond, in Archibuji, F. and Nijkamp, P. (eds.), Economy and Ecology: Towards Sustainable Development. London: Kluwer Academic Publishers.

The estimation of environmental damages at a national level in Japan is linked with efforts to obtain a Net National Welfare measure (NNW) in line with the framework developed by Tobin and Nordhaus (1972). The starting point is the conventional concept of GDP and then welfare adjustments are made.

The first NNW estimation was carried out by the Economic Council of the Government of Japan in 1973, covering the period from 1955 to 1970. The results were subsequently updated, covering the period up to 1975. Finally, a third attempt at NNW estimation was made by Uno (1989), bringing the figures up to 1980 and 1985.

The main adjustments in the latest version are:

- Government consumption: only education, health, social security and welfare services are considered in the NNW estimates. Other government expenditures are excluded because they are considered defensive expenditures or to maintain consistency with earlier calculations.

- Personal consumption: defensive expenses and purchases of consumer durable goods are excluded, the later being replaced by an imputation of their services.

- Capital investment: investment in plant and equipment, social overhead, and housing are excluded and replaced by imputations of their services.

- Leisure time: the value of leisure time is imputed based on average wages per hour, adjusted by age, group and sex.

- Non-market activities: the value of domestic services of housewives is imputed based on the average wage of female workers.

- Environmental damages: the social costs of environmental pollution are estimated by the expenses necessary to recover a "normal physical environmental level" in terms of air pollution, water pollution and waste treatment. The direct monetary estimation of damages is considered theoretically a better approach but it

could not be undertaken because of the lack of data.

- Losses due to urbanization: although the scope of the possible negative effects may be larger, only increasing distances for commuters and traffic accidents are imputed. The former comprises the physical and mental fatigue caused by increased commuting hours, and the latter provides valuation of deaths and injuries based on the "value of life" and the average value of compensation in case of accidents.

The results (Table 4) show that the gap between NNW and GDP increased during the whole period, an interesting addition to the debate raised on whether or not economic growth in Japan contributed to improving human well-being.

Table 4:NNW and GNP: Japan
1955 to 1985 in constant 1970 Yen, billions

1955		1960	1965	1970	1975	1980	1985
GNP	17268	26183	41591	72144	93260	118105	143387
NNW	18036	23128	32116	47548	74231	90646	103781
Govern. Expenditures	1199	1374	2254	2988	3865	4283	4887
Personal Consumption	10427	14706	22168	32097	43003	54009	61700
Govern. Capital Serv.	62	99	169	317	559	756	1103
Durable Goods Services							
Leisure Time	91	195	755	2342	4187	5270	6183
Non-market Activities	4871	6098	7325	10509	16759	18961	20816
Environmental Damages	1876	2388	4068	7213	12707	12571	13079
Urbanization	-38	-1037	-3735	-6805	-5729	-3932	-3103
Losses	-452	-695	-889	-1113	-1119	-1272	-1514

Source: Uno (1989)

Mexico

Van Tongeren, J., Schweinfest, S., Lutz, E., Gomez Luna M. and Guillen, F. (1991) Integrated Environmental and Economic Accounting: A Case Study for Mexico, in Lutz op cit.

The study case for Mexico (Van Tongeren *et al.* 1991) was carried out in 1990 and 1991 jointly by the United Nations Statistical Office (UNSO), the World Bank and the National Institute of Statistics, Geography and Informatics of Mexico (INEGI). It was the first empirical experience with the overall analytical framework developed in UNSO's Draft Handbook on Environmental Accounting (United Nations, 1990), providing two measures for the Environmentally-Adjusted net Domestic Product (EDP) for the year 1985.

The so-called System of Economic and Environmental Accounts for Mexico (SEEA) was constructed by an expansion of the conventional structure of the National Accounts. The main innovation is the enlargement of the asset boundary, including oil depletion, degradation concerns (water and air pollution, soil erosion, ground water use and the deposit of solid wastes), land use concerns and deforestation. The EDP measures are obtained by deducting the environmental uses related to depletion, deforestation and land use from NDP (EDP1), and by deducting the cost of degradation from EDP1 (EDP2).

Three approaches were used to value the accounts in physical units. The depletion figures were obtained by calculating the value of the stock of assets by the net price method,i.e. the market value minus cost including a normal profit. Alternatively, the same figures are presented employing the user cost approach developed by El Serafy (1989). Finally, the avoidance cost approach was used for the valuation of quality changes in natural assets stocks.

The results are presented using an input-output scheme. Therefore, they show not only the macro effects of the depletion and degradation but they also identify the economic use of natural resources as well as the environmental protection expenses made by different sectors. Table 5 summarizes the main results. This table shows that net domestic product would be significatively affected if the changes in natural capital were considered: net accumulation would decrease from 11% of NDP to -15% if the most restrictive measure (EDP2) is adopted.

Table 5:NDP, EDP1 And EDP2
Mexico - 1985
1985 Mexican Pesos, billions

	NDP	EDP1*	EDP2
Net Product/ Expenditure	42060516	39662772	36448314
Final Consumption	34948897	34948897	34890558
Capital Accumulation, Net	4703654	2305910	-850209
- Economic Assets	4373654	4703654	4703654
- Environmental Assets		-2397744	-5553863
Exports-Imports	2407965	2407965	2407965

Source: Van Tongeren, J. *et al.* (1992)

New Zealand

Clough, P. (1991) Natural Resource Accounting for New Zealand's Indigenous Forests: Report to the Ministry of Environment, New Zealand Institute of Economic Research (Inc.), interim draft.

The feasibility of compiling pilot accounts for New Zealand's indigenous forests is considered in this report. The report also draws upon 2 documents prepared with regard to a more general application of natural resource accounts (NRA) in New Zealand (Wright, 1989, 1990). The study reviewed here represents an interim draft and actual presentation of accounts are lacking. The intention is to derive an NRA that shows stocks at given periods and the flows between these periods. Owing to the relatively small volumes of economically exploitable timber, much of the discussion is concerned with non-marketed values and the total economic value of the resource in question. The perception is that such accounts when constructed will remain outside the SNA: inclusion of the accounts would add little to aggregates, while the importance of the sector is derived from the non-marketed services that it provides.

Following this logic there is clearly dissatisfaction with the Repetto-style method, based on market prices for timber. Forests are divided into 3 classes - protected, non-commercially available and commercially available. The values of these classes are in turn divided into 4 components - extractive timber, externality user, amenity and option (non-use) values. Valuation problems exist although there are techniques to derive these values including stated preference (contingent valuation) and revealed preference (hedonic pricing, travel cost) methods. The possibility of double-counting arises where in some revealed preference techniques the value of amenity or recreational value has already been attributed to another sector (say, tourism). This is not a problem in microeconomic cost-benefit studies but arises in an aggregation exercise such as national accounting. Non-use values such as biodiversity present more complex measurement problems, although, for example, contingent valuation could be employed (Munasinghe, 1992). The author illustrates one measurement approach whereby forest classes are ranked according to their diversity based on a diversity count per unit area multiplied by abundance of this species per unit of area.

Papua New Guinea

Bartelmus, P. Lutz, E. and Schweinfest, S. (1992) Integrated Environmental and Economic Accounting: A Case Study for Papua New Guinea, in Lutz op cit.

The UNSO SEEA has been built on the premise that national accounts provide the most widely used indicators for policy-making, but that they neglect important long-term considerations. Papua New Guinea (PNG) was chosen for this case study as it is in the early stages of industrialisation - some 90% of the population live in rural areas. No original data were sought. With the limited resources available, the study aimed to pinpoint where problems might arise in building SEEA-type accounts.

Physical resource accounts can be linked to the monetary balance sheets and flow accounts of the SNA. Bartelmus *et al* undertake this for 2 elements, namely the identification of environmental protection services and of corresponding expenditures, and the inclusion of asset balances for produced and non-produced tangible assets. Public environmental expenditure by central government is a relatively small (but increasing) part of GDP in PNG - an average of 0.27% of GDP from 1986 to 1990 (current prices). This represented an average of 0.74% of the total government budget. It was not possible to determine who benefited most from these expenditures.

Monetary balances were prepared for subsoil assets using available data on net revenues and average reserve life expectancy per mine to obtain a value for an opening stock. The closing balance for 1989 is negative, owing to the closure to the largest mine in PNG (Bougainville) and a slump in mineral prices in that year. Bartelmus *et al.* suggest that the use of some long-term average price could avoid this problem. The value of depletion involved in the calculation of the closing stock forms the basis of an adjusted net value added (NVA1) and its sum total, ecological domestic product (EDP1).

UNSO has suggested measuring annual depletion using either the net price (Repetto *et al* 1989) and "user cost" (El Serafy 1989) approaches for measuring the value of depletion. Using a 10% discount rate and data on the life expectancy of mines the user cost measure was obtained for the years 1985 to 1990. These adjustments amounted to 1.4% of GDP in 1987 and 0.3% of GDP in 1989. These fluctuations where owing to discoveries and the closure of the Bougainville mine. Discoveries do not alter the adjustment as they are treated as 'other volume

changes' in the SEEA monetary balance sheets.[15] Price fluctuations are responsible for the large variations in net price from 1985 to 1990. The level of EDP1 is in the order of 1% to 9% lower than NDP.

Depreciation of renewable resources can be measured using a variant of the net price method - i.e. harvest minus net growth. Bartelmus *et al.* do not advocate the user cost method for these resources as the lifetime of the resource is potentially very long and hence user cost, very small. Where data are reliable, the calculation of this rent can give the government information concerning the appropriate level of taxes and royalties, given policy objectives. About 75% of the total land area of PNG is covered by forests. The forestry sector is in economic terms, relatively small (about 4% of GDP). Data on total forests are also sparse and unreliable, although some data are available in physical terms, conveying the impression that the amount of logged-over land has been increasing. Shifting cultivation has also been responsible for net deforestation over the period 1980 to 1990. A zero adjustment is proposed for fisheries rents, as it is estimated that annual catches are presently below maximum sustainable yields (although no estimates of fish stocks are available).[16]

Environmental quality in the SEEA is usually costed at potential restoration or avoidance costs. A supplementary approach is taken here, owing to the existence of compensation schemes for local environmental effects (i.e. 'markets' for welfare effects of environmental impacts in a particular area). Low and high bound annual estimates of impacts from sectors are derived based on assumptions as to the social value of the environment (from 1980 to 1990). These sectors and respective degradation values (in terms of % of NDP) are agriculture (forest clearing for cultivation) - 0.3% to 4.4%; forestry (logging activities) - 1.2% to 1.8%; mining (localised water pollution) - 1.3% to 3.8%; and the energy sector (hydropower) - 0.1% (one estimate). Clearly the assumptions made are very significant in determining the size of the adjustment.
The lower bound adjustments (together with the net price adjustments from EDP1) form EDP2, which is some 3% to 10% lower than NDP in the short time period studied. Whilst actual consumption did not exceed NDP as usually defined, it is greater than EDP2 from 1986 to 1990 (apart from 1988).

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[15] Discoveries are considered to be natural fluctuations and not the result of economic production.

[16] The fisheries sector contributes 0.3% to GDP. Bartelmus et al note that non-marketed (i.e. subsistence) output from fishing could amount to about 13% of GDP.

The Philippines

Cruz, W. and Repetto, R. (1992) The Environmental Effects of Stabilisation and Structural Adjustment Programs: The Philippines Case, World Resources Institute, Washington DC.

In previous national accounting studies, WRI have focused in detail on how to undertake adjustments to national accounts (Repetto *et al.* 1989; Soloranza *et al.* 1991). Here, the focus is on 'uses' and specifically the Philippines' experience with stabilisation and structural adjustment programmes. Conventional macroeconomic accounting frameworks do not consider the environmental consequences of such policies. In contrast, "natural resource accounting provides a macroeconomic framework for evaluating ecological decline" (p17).

Resource depreciation is estimated for forestry, soil erosion and coastal fisheries. Combined, these estimates averaged annually about 4% of GDP (and 20% of gross domestic investment) from 1970-87 (where the majority of this loss is accounted for by timber extraction). This was greater than external debt, increasing at a rate of 3.2% of GDP as indicated by a deteriorating balance of payments position. Cruz and Repetto see this increasing liability as symptomatic of the worsening balance sheet for natural assets. However, it is the debt issue that has received the most attention. Natural resources were run down and the proceeds used to finance consumption or inefficient investments or were lost in capital flight. The macroeconomic policy regime of import substitution and the distortion of domestic terms-of-trade in favour of industry led to negative net investment in the primary sector (i.e. agriculture) during the 1970's and early 1980's.

The 'conventional view' is that stabilisation and structural adjustment policies lead to the increased exploitation of resources the export of which earns precious foreign exchange. However, Cruz and Repetto contend that in the case of the Philippines this exploitation occurred before these policy regimes where imposed and therefore rents accrued to these resources prior to the shift in policy regime. Hence, even if market conditions favoured further exploitation, this historic legacy would result in supply constraints being encountered. The environmental impact of the policy shift was felt in the increased exploitation of open access resources which provide vulnerable ecosystem functions. Ultimately, overuse of marginal resources such as forest lands, mangroves and fisheries is unsustainable and activities are then transferred to other fragile areas. However, this exploitation is largely undertaken in order to provide subsistence for landless labourers and will be non-marketed. As such, national accounts will contain little or no record of

these activities and hence no rent can be imputed. In order to infer the full environmental effects of stabilisation and structural adjustment policies, information must be sought in addition to NDP adjusted for the exploitation of marketed natural capital.

Stabilisation policies are short-term measures to correct balance-of-payments and national budget deficits. Structural adjustment is aimed at longer term efforts to 'free up' factor markets and generally to dismantle inefficient intervention. Environmental consequences are not usually of paramount concern in these endeavours. Cruz and Repetto attempt to address the balance using a Computable General Equilibrium (CGE) model which includes land as a separate factor of production. Then the environmental effects of a combined policy of trade liberalisation and a 20% devaluation are considered. The policy leads to increased GDP but increases soil erosion, fishing (marginally), mining, logging and energy use. The model also points to policy prescriptions such as the levying of resource rent taxes as a way of raising revenues without inflicting 'pain' on the national economy, which would have the effect of encouraging conservation of marketed resource use.

Sweden

Hultkrantz, L. (1992) "National Account of Timber and Forest Environmental Resources in Sweden", Environmental and Resource Economics, 2: 283-305.

Hultkrantz (1992) presents environmental accounts for the forestry sector in Sweden. His adjustments are three-fold:

(a) an imputation for the value of the net change in the growing stock of timber, referred to as direct forest values. This is a stock adjustment - i.e. the value of the change in the forest stock as measured by timber rents.

(b) the value of (sustainable) activities such as berry and mushroom picking, meat from hunting game. These are service flows from the forest.

(c) Stock adjustments for the value of the change in non-commercial environmental assets. These assets are biodiversity, carbon sinks, exchangeable cations in soil (i.e. acidification) and lichen stocks (that provide the service of reindeer forage).

Hultkrantz finds that in 1987 there was a 'depreciation' in the stock of diversity of flora and fauna living in Sweden's forest habitats. Two separate methodologies are proposed to measure this change. The first is based on a contingent valuation study concerning the protection of 300 endangered species in Sweden (Johansson, 1989). The willingness-to-pay measure is then aggregated over the Swedish population. A total WTP of some 3.6 million SEK per year is inferred as representing the value of depreciation of biodiversity in 1987.

However, an alternative approach was based on the total area of protected land required to obtain a 'reasonable' level of protection for biodiversity. In Sweden it is estimated that this criterion would imply the preservation of habitats on 10% of total forested land as a *minimum* target. Currently, an estimated 5% of forested land in Sweden is protected in reserves (or for other reasons). To meet the 10% target, annual protection costs must be increased. An estimate of the timber rents foregone as a result of this additional protection results in a *higher* depreciation charge of 600 million SEK.

Tanzania

Peskin, H.M. (1989b) Accounting for Natural Resource Depletion and Degradation in Developing Countries, Environment Department Working Paper No. 13, World Bank, Washington DC.

The most part of this paper is devoted to an outline of Peskin's methodology behind the concept of Net Environmental Benefit. However, the final section does provide an adjusted account that imputes a value for the depletion of forest resources in Tanzania due to fuelwood collection. The author notes that perceptions of the usefulness of indicators such as national accounts ultimately depend on the ability to measure what people perceive to be of importance and in the context of the environment this will involve efforts to adequately measure changes over time in the stock of natural capital. A decrease in the goods and services that capital can produce over time is termed physical depreciation. As the stream of income produced by this capital is reduced it is also a case of value depreciation. However, value depreciation can also occur due to changes in tastes and technology.

The adjusted accounts presented by Peskin deal with the value of physical depreciation of forests in Tanzania for the year 1980 attributable to fuelwood production. Some imputation of the gross value of this production is already made in the Tanzanian accounts. This, Peskin believes is undoubtably an underestimate as it does not record a significant nonmarketed component (i.e. fuelwood collection for household use). There is also no imputation for depletion of natural capital. By multiplying an estimated 137 million working days per year spent collecting fuelwood by the minimum daily wage, a proxy for the value of depletion is obtained. The final imputation must be net of the value of regeneration of forest, the physical measure of which is the mean annual increment. The final figure obtained is 1906 million Tanzanian shillings which is about 5% of conventionally measured GDP in 1980 and considerably greater than the marketed imputation for fuelwood production in that year.

Thailand

Sadoff, C.W. (1992) The Effects of Thailand's Logging Ban: Overview and Preliminary Results, Thailand Development Research Institute.

In terms of GDP growth, Thailand has often been described an economic success story. These impressive growth rates have been achieved through a run-down of natural assets, although whether or not this is sustainable is open to question. Sadoff attempts to show how an adjusted national accounting framework can be used to analyse this proposition and the effects of Thailand's logging ban of 1989 in response to major flooding in 1988.

Making the appropriate adjustments for the user cost and net price approaches, Sadoff finds that the resulting average adjusted aggregates are 1.5% and 2.2% of GDP respectively over the period 1970 to 1990.[17] However, throughout the 1970's (the period of peak deforestation), whilst the level of adjusted domestic product is revised downwards, the modifications suggest that growth has been understated (although not significantly). From 1980, the value of total rents (however measured) declined significantly. In the absence of any evidence with respect to prices or extraction activity, this might be attributed to increasing costs as the forest stock dwindles. Since the logging ban, measured total rents have been almost insignificant, where rates of deforestation have fallen some 88% from pre-ban levels. There remains much illegal clearing. Commercial clearing has decreased by about 55% of 1980 levels.

Sadoff claims that the logging ban has led to increased rates of logging in neighbouring countries which do not practise Thai management practices. Some of these countries - notably Laos and Vietnam - have announced plans designed to stem these trends. In conclusion, it is stated that the ban has had little of the adverse economic costs claimed at the time but has also had little of the environmental benefits, as deforestation continues. The dissipation of total rents from 1980 on is perhaps some indication that timber resources have been used inefficiently. Finally, Sadoff contends that simulations using the values obtained in the study show that a more efficient policy would be a combination of sustainable management practices where logging is permitted and a tightening of the ban elsewhere. It is not clear that such conclusions can be made on the basis of the measurements offered in the study.

[17] Deductions are made from GDP. No account is taken of the depreciation of man-made capital.

United Kingdom

Adger W.N. and Whitby, M. (1993) National Resource Accounting in the Land-Use Sector: Theory and Practice, European Review of Agricultural Economics, 20: 77-97.

This paper is one of the few that uses results derived from stated preference studies in a national accounting framework. Using these techniques the (discounted) total economic value (TEV) of environmental services can be inferred, where the TEV is the value of the services of a resource and is the sum of direct use, indirect use and existence values. Adger and Whitby state that they are not couching these adjustments in terms of sustainable income but are instead providing an indication of the relative contribution of the agriculture and forestry sector to welfare.

The use of nitrogen in agriculture has grown considerably since 1978, leading to pollution of water resources in the UK. Hanley (1989) surveyed households in the Anglian Water Authority area in order to estimate the benefits of the abatement of agricultural nitrate pollution in terms of cleaner drinking water. This was valued at £13 per household, which gives an aggregate yearly benefit of the improvement of water quality of £10.8 million. The agricultural and forestry sector provides carbon fixing services for the emissions of other sectors (Adger *et al.* 1991). Using Anderson's (1989) estimate of a social cost of £31 per tonne of carbon and an estimate of net carbon emissions of -4.75 million tonnes, a value for this carbon credit benefit of £146.2 million was obtained. Positive externalities are also associated with landscape, wildlife and recreational benefits on public designated areas. The adjustment for positive flows of services from these areas in 1988 is £888 million.

The use of stated preference techniques is not without controversy - e.g. the existence of repeated large discrepancies between willingness-to-pay and willingness-to-accept measures of welfare (Knetsch, 1989). Aggregation to the national level has its own associated problems and may contain biases depending on the degree of substitutability or complementarity between, say, designated areas providing amenity values. For example, if these areas are substitutes, then estimated aggregate WTP will be overvalued.

In sum, Adger and Whitby find that adjusted Net Product is about 25% greater than conventional Net Product for the UK agricultural sector. This is due to the positive value of carbon fixing and water quality improvement. The only

deduction made is for defensive expenditures.[18] The authors do not estimate the change on the previous accounting period, so an assessment of net natural capital deterioration cannot be inferred. Many sources of degradation are excluded, as the authors admit (and this equally applies to other environmental services). The uses of the account are tentative but indicate that policies that degrade the countryside are likely to have larger welfare impacts than will be apparent by looking at the conventional accounts. This result only becomes apparent by emphasising the non-marketed services that the sector provides.

Bryant, C. and Cook, P. (1992) Environmental Issues and the National Accounts, Economic Trends, No. 469.

This paper represents an application of the various strands of resource accounting approaches to the UK. Physical data are assembled in a resource account under four headings - nonrenewable sub-soil assets (economically recoverable reserves of oil and natural gas, technically extractable coal), forests, air and water (emissions and disposals of pollutants rather than environmental quality itself). The data is assembled along the lines of UNSO SEEA in balance sheets for 1990 in both physical terms and, where possible, monetary terms.

Depletion is estimated for nonrenewable resources using both the net price and user cost methods, although the relative merits of either are not considered. The net price method is divided into two measurements - (1) the value of the change in the stock during the accounting period, while (2) uses the more usual method of taking the gross margin, net of extraction costs. It is not certain whether the former makes any allowance for a return to capital. Discoveries are not treated as negative depletion in contrast to Repetto (1989). In nearly all instances, as might be expected, user cost is a lower proportion of gross revenues of the sector than net price (1) which in turn is less than net price (2). In the case of the net price (2) approach, total rents for oil and gas were in the region of 0.5% to 6% from 1980 to 1990. All three methods are subject to fluctuations owing to the volatility of prices.

There is no calculation of rent for the coal industry. This is due to the difficulties in interpreting the meaning of 'net receipts' in the mining industry. As there are no profits in the sector, Bryant and Cook state that rents must be zero. This is

[18] These included payments to maintain landscape and wildlife amenity, as well as the promotion of recreation and education. Together, with an estimated £5.6 million in expendit-ures to clean up agricultural pollution and £9 million to meet EC standards for drinking water, these (non-household) defensive expenditures amounted to £57.6 million in 1988.

interpreted in another way with reference to the user cost approach. There are relatively large reserves of coal, although the problem of 'non-existent' profits arises here as well. One implication of these findings is that coal reserves should be reclassified as environmental assets - i.e. these reserves are not economically extractable.[19] No data on reserves for sand, gravel, gypsum, ball and china clay, limestone, granite, slate and salt are available. These extractive sectors contribute little to national output and the resources involved are relatively abundant.

ECOTEC (1993) estimated defensive expenditures in the UK to amount to about 3% of GDP in 1990 (half of which is accounted for by pollution abatement alone). Of this, government undertakes 94% of this expenditure. It is often suggested that these defensive expenditures be deducted from national accounting aggregates (Daly, 1989). As Bryant and Cook note, this should not be interpreted as conventional wisdom. It also yields a paradox in that a country that devotes more resources to, say, pollution abatement will have a lower level of GDP and NDP. However, abatement provides benefits over time in addition to the costs incurred in forgone consumption elsewhere and it is at least arguable that it might be treated as an investment in natural capital. Bryant and Cook seem to prefer to treat defensive expenditures as a proxy for environmental damage and then proceed to discuss the possible valuation of 'residual environmental degradation' -i.e. the value of damage that is not made good by defensive expenditures.

Environmental Resources Limited (ERL) (1992) Natural Resource Accounts for the UK, Department of the Environment, London.

Commissioned by the UK Department of Environment (DoE) to examine the potential use of natural resource accounts in the UK, this report develops pilot resource accounts for forestry, water and energy. The remit was to consider international experience in this field, develop the aforementioned accounts and examine the potential for the development of satellite accounts to the SNAs. ERL consider the uses of resource accounts as the "improvement of decision-making about natural resource and environmental management", "provision of information on natural resources and their uses as inputs to analytical models used for economic and resource planning" and the improvement of "measure-ments of national income and national wealth" (p2). In general, the perception is that the profile of environmental issues would be raised, although the decision makers

[19] Faber and Proops (1991) estimate the share of rent in the price of coal in 1990 and find this to be 10.1%. This is low relative to the findings for oil and gas (at 54.2 and 57.9 respectively) but indicates that total rents would have been positive in that year.

benefiting from this information are less clearly identified.[20]

A regional approach is taken in the construction of water accounts, in order to reflect the spatial variability of water supply.[21] One of the uses of water accounts envisaged is the prediction of water shortages. It is claimed that this necessitates the estimation of stocks of water and the absence of appropriate data and hence water shortages cannot be assessed. This assumes that the conceptualisation of water as a stock resource is the appropriate one. If however, we focus on the flow characteristics, precipitation, evaporation, run-off and abstraction, then water shortage could be assessed by examining some idea of annual maximum sustainable supply relative to annual use.

Finally, it is noted that the construction of energy accounts has been particularly useful in the Norwegian context. ERL also express enthusiasm for this emphasis, not least because of the relatively abundant data for this sector. Various energy sources are considered. The Digest of UK Energy Statistics provides physical data on coal, oil and gas extractions and reserves, which this report lists in a time series. An extraction, conversion and use table is shown based this physical information. The accounts are in physical form and there is no discussion of resource rents. ERL clearly favour natural resource accounting in the Norwegian mode, arguing that this information can and has been used as a predictive instrument rather than just ex post summaries (although there seems to be no particular reason why any accounting information could not be used for modelling and prediction).

USA

Daly, H., and Cobb, J.B. Jr. (1989) For the Common Good, Beacon Press, Boston.

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[20] For example, the report speculates as to whether the arrangement of existing data in an accounting framework would offer additional insight to resource managers. Admittedly, these agents are by definition, in a advantageous position to know the underlying data. We might speculate that the real beneficiaries would be decision-makers at, say, the national level where policies impinge on resource sectors. More generally, national accounts provide information that answers the questions that society thinks are important (Beckerman, 1979). These questions will change over time and naturally the framework will change.

[21] For example World Resources 1992-3 shows that annual internal renewable water resources (i.e. run-off) in the UK is 120.0 km^3 of which 24% is used each year. Although this use is relatively high it may not be too great a source for concern but obviously the danger is that regional disparities are hidden. That is, unless we can assume sufficient spatial substitutability (Dubourg, 1992).

Nordhaus, W. (1992) Is Growth Sustainable? Reflections on the Concept of Sustainable Economic Growth. Paper presented to the International Economics Society, Varenna, Italy, Oct. 1992.

Nordhaus, W. and Tobin, J. (1972) Is Growth Obsolete? Economic Growth. Fiftieth Anniversary Colloquium V. New York: Columbia University Press.

The construction of welfare-adjusted measures of national accounts was the subject of several academic studies in the United States (Nordhaus and Tobin 1972, Daly and Cobb 1989, Nordhaus, 1992). Sustainability issues are presented in those studies as an attempt to provide more 'realistic' income measures. However, their results vary widely.

The first work was the Measure of Economic Welfare (MEW) presented by Tobin and Nordhaus (1972). The major differences between MEW and GNP are:

- imputations for the value of leisure time, household work and the services of government and consumer capital,

- deductions for government intermediate goods and 'regrettable necessities', private intermediate product, disamenities of modern life, capital consumption and growth requirements to equip new workers, and to provide a growing standard of living to future workers.

The results, covering the period 1929/1965, present a positive growth of per capita income but at a lower rate than NNP (Table 6).

Daly and Cobb (1989) used a similar rationale to create the Index of Sustainable Economic Welfare (ISEW): the conventional measures from the national accounts are adjusted by imputations and subtractions in order to provide an improved measure of social income based on the notion of sustainability. The main differences from MEW are in the treatment of non-market activity (ISEW omits the value of leisure), 'defensive expenditures' (ISEW omits health expenditures and investment), long-term environmental damages (arbitrarily determined in ISEW but not present in MEW), adjustment for income inequality and other corrections: auto accidents, loss of wetlands and farmlands and national advertising (omitted only in ISEW). There is also an adjustment for depletion of non-renewable resources, subtracting the total value of mineral production, which is not present in MEW. The series covers the period 1950/1986, and it shows a negative per capita output growth for the period 1965/1986 (Table 6).

In a more recent paper Nordhaus (1992) provides a third estimate, called 'Hicks Income No.1'. It is an attempt to construct a sustainable income measure derived from Hicks' definition (Hicks 1939). The results from Daly and Cobb (1989) are used with several changes, excluding arbitrary or theoretically incorrect entries and replacing some estimates for better figures obtained from Eisner (1989). The results show that 'Hicks Income No.1' growth is always positive, slightly higher than GNP and NNP in the 1950/1965 period, and slower in 1965/1986 (Table 6).

Table 6:Comparison Of Growth Rates Of Different Income Concepts United States - 1950/1986

Income Growth	1950/1965	1965/1986	Growth Slowdown
Total Income Growth:			
ISEW	3.81	1.02	-2.79
MEW	2.07	na	na
Hicks Income No. 1	4.41	2.35	-2.06
GNP	3.75	3.05	-0.70
NNP	3.69	2.05	-1.14
Population Growth	1.63	1.05	-0.58
Per Capita Income Growth:			
ISEW	2.15	-0.03	-2.18
MEW	0.43	na	na
Hicks Income No. 1	2.74	1.29	-1.45
GNP	2.09	1.98	-0.11
NNP	2.03	1.85	-0.17

Source: Nordhaus (1992)

United States

Prince, R. and Gordon, P.L. (1994) Greening the National Accounts, Congressional Budget Office, Washington DC.

The empirical section of this study presents estimates of total rents from the depletion of oil in the US from 1981 to 1990. For the same period, the value of degradation of air and water quality is also estimated.

Total rents are calculated using a formula proposed by Hartwick and Hageman (1993). This differs from that originally proposed by Hartwick (1990) discussed in section 2. Rather than valuing discoveries at their full rental rate, Prince and Gordon net out from the usual 'rent times units of the resource depleted' calculation, the (marginal) cost of discovery multiplied by the units discovered. As such this has parallels with the adjustment for discoveries derived by Hamilton (1993). The results are not related to an estimate of 'green' NDP. If so then this figure would already contain the total value of discovery effort and so the estimates of total rent presented would be too 'low'. This aside, it appears that the value of oil depletion in the US varied from 2% of GDP during the first half of the 1980s to less than 1% of GDP in the remainder of the decade.

By relating changes in environmental indices to the costs of abatement the environmental degradation of air and water quality is valued - i.e. how much would it cost to maintain last years level of environmental quality. While it would appear that on average both air and water quality - as measured by the indices - improved from 1981 to 1990 significant values for degradation are obtained. The total value of environment degradation remains fairly constant at about 1% of GDP throughout the 1980s. Where the value of degradation decreases between years this is a reflection of actual abatement expenditures increasing the stock of environmental capital.

Zimbabwe

Adger, W.N. (1993) Sustainable National Income and Natural Resource Degradation: Initial Results for Zimbabwe, in Turner, R.K. (ed.) Sustainable Environmental Economics and Management: Principles and Practice, Belhaven Press, London.

This study estimates the rents from deforestation in Zimbabwe in 1987, soil erosion in 1990 and mineral extraction for the last quarter of 1990 and the first quarter of 1991. The relevance of national accounts adjusted for resource depletion is claimed to be of particular importance in developing economies where there is a high dependence on primary production.

Fuelwood is a major source of energy in Africa and the assessment is that Zimbabwe has a fuelwood deficit (Hosier, 1986). Demand outstrips supply and hence a rent might be expected to accrue to these dwindling forest resources. In 1987, the net stock reduction was 2.66 million tonnes. An estimate of the extraction costs was imputed from estimates of the minimum agricultural wage. This gives an estimate of average costs, where in the event of increasing effort required to search for fuelwood we would expect marginal costs (MC) to exceed average costs (AC). Subtracting AC from the market price of fuelwood in 1987, gives an estimate of depreciation (rent). The value of this depreciation was ZM$ 93.77 (9% of agricultural GDP).

The value of soil erosion has previously been estimated using either the measurement of lost productivity or replacement costs of lost nutrients. Adger estimates soil erosion using the former (for example see Bishop, 1989). Assuming that soil conservation measures reduce erosion below the level of natural replacement and contribute to observed incremental yield, then the difference in the estimated gross margins on the conserving and non-conserving farms gives a cost of erosion. Estimates of ZM$203.23 million for lost maize and cotton production were derived in 1987 prices. Combining this loss with the estimated forestry rent, depreciation of natural capital in 1987 was equivalent to nearly 30% of agricultural GDP (5% of aggregate GDP).[22]

Calculation of rents in the mineral sector highlighted the variability of these measurements. In the last quarter of 1990 rents were 20% of traditionally defined sectoral net product (gross profits less depreciation of man-made capital). In the

[22] The value of depreciation on man-made capital in the agricultural sector was about 6% of agricultural GDP.

first quarter of 1991 these amounted to 27% of sectoral net product. A production boom stimulated by the devaluation of the Zimbabwe dollar is given as the main reason for this increase - i.e. 1991(Q1) adjusted net product was over 7% greater than 1990(Q4) in contrast to traditional net product which grew over 18% over the period.

In terms of the uses of these adjustments, improved resource management is stressed, as are macroeconomic policy and sustainability issues in general. Data problems are emphasised, suggesting that the implementation of SEEA to a wider range of developing countries will prove complex.

5.International Organizations

International organizations have to varying degrees attempted to provide leadership and guidance to countries on their resource and environmental accounting efforts. The United Nations has a direct interest in the topic because the SNA is based on UN standards and guidelines. The World Bank has funded research, jointly with the UN Statistical Office, on the application of new satellite accounting techniques (these studies, for Mexico and Papua New Guinea, are reviewed in the section on empirical experience). The OECD group on the state of the environment has had natural resource accounting as part of its work programme at least since 1986. And the United Nations Environment Program (UNEP) has just started, in 1993, a research programme in this domain.

What follows is a brief description of these efforts by international organizations.

The United Nations

The United Nations, in conjunction with Eurostat, the IMF, OECD and the World Bank, is in the midst of the revision of the System of National Accounts, the first major one since 1968. Although the work to date has included major clarifications of concepts and classifications that impinge particularly on the treatment of commercial natural resources in the accounts, there is no intention to bring the environment and natural resources directly into the accounts, leading to the alteration of national accounts aggregates - in particular, only produced assets are explicitly accounted for in the measurement of net income and product.

As noted earlier, the provisional draft of Chapter XXI of the revised SNA (United Nations, 1992) includes a succinct description of the guidelines on a satellite System of Environmental and Economic Accounts (SEEA) (United Nations, 1990). However this draft chapter states explicitly that the description "... is included to guide countries in responding effectively to the current emphases in policy making and analysis on environmentally sound and sustainable economic growth and development and to help national accountants in elaborating environmental satellite studies which take the national accounts as a point of departure". The SEEA is not formally a part of the SNA, but rather an example satellite account under the heading "Satellite Analysis and Accounts".

Appendix 2 gives an outline of the structure of the SEEA, along with some basic definitions of terms. The salient characteristics of the system are: (i) economic

assets are split between produced and non-produced (natural) assets; (ii) the environment appears explicitly as a source of non-produced (but non-economic) natural assets; (iii) specific account is taken of the use of non-produced assets in arriving at a revised net product measure (see below); and (iv) the transfer of natural assets from environmental (non-economic) to economic non-produced assets is explicitly accounted for. The new net product measure is termed "environmentally adjusted net domestic product" (EDP) and is measured as follows:

EDP= consumption
+ gross capital formation (produced)
- consumption of fixed capital (produced)
- depletion of non-produced economic assets
- degradation of environmental assets
+ net exports.

An important point to note is that the SEEA does not provide definitive guidelines for valuation. For the depletion of commercial natural resources (i.e. economic non-produced assets) it suggests using either the El Serafy (1989) or Repetto *et al.* (1989) approaches; for the value of degradation of the environment it suggests using either a cost-based method (the cost of returning the environment to its state at the beginning of the accounting period) or contingent valuation of changes in the environment.

The inclusion of environment and resource accounting in Agenda 21 of the United Nations Conference on Environment and Development (as noted in the introduction to this study) has given new impetus to the development of the SEEA.

OECD

The Environment Directorate of the OECD has also been involved in environmental accounting, mainly through its State of the Environment Division. One of the principal tasks of this division is the development of environmental indicators, information and reporting. Within this area, one particular strand of work has been the development of environmental accounting with the aim of integrating environmental concerns into economic policies in general.

The OECD has concentrated on natural resource and environmental accounts in physical units as well as satellite accounts of expenditures on the environment. The

idea of modifying the System of National Accounts to arrive at an aggregate "green" GNP figure has been rejected for methodological as well as strategic reasons. On the methodological side, the risk of jeopardizing the consistency of the SNA system was considered to outweigh the benefits of (possibly) unreliable and dubious results. On the strategic side, it was considered that a "green" GNP figure would underestimate the welfare effects of environmental degradation and therefore would hinder rather than enhance the impact of the accounting exercise. This would result because of the small share that commercial natural resources play in OECD economies and the inability of the SNA to incorporate non-commercial resources directly. In contrast it was thought that physical resource and environmental accounts could provide useful information for policy makers as well as increase the awareness of environmental issues on the part of the general public and within policy making circles.

As a policy making tool, natural resource accounts are deemed to be directly useful in assessing the impacts of sectoral economic activities and policies. However, the indirect use of resource accounts as a source of information for constructing other indicators or as input to environment-economy models is judged to be even more important for the decision making process.

In 1988 the Group on the State of the Environment launched a pilot study on resource accounting with the aim of developing a common methodology that could be used by OECD member countries. This project consisted of the construction of forest and inland water accounts. Each resource account was led by a country (Norway and France respectively) and other countries were asked to supply the necessary information to construct equivalent accounts based on the leading country's methodology.

In the case of forests the countries that supplied the necessary information (apart from Norway) were Finland, France, Japan and the United Kingdom. The information requirements were even more difficult in the case of water accounts. Apart from France, only the Netherlands and Finland could provide the necessary information.

In spite of the low response rate of OECD member countries to the pilot study, the development of base tables for forest and water resources created the needed methodological homogeneity to guide the diverse efforts that countries are making in environmental accounting.[23]

[23] Although the pilot study was not successful in constructing full resource accounts for all countries, the data gathered was sufficient to construct resource sustainability indicators for most countries. For example, in the case of forests, an indicator for the intensity of forest use was

In the area of satellite accounts, the State of the Environment Division has been gathering and processing information from member countries for several years. The result has been the periodical publication of the statistics on pollution abatement and control expenditures based on surveys undertaken in most OECD countries.[24] These publications provide the needed information for making cross country comparisons and serve as an input to research on the economic impacts of environmental regulations.

The OECD has recognized that despite the fact that many countries have experimented with some type of environmental accounting[25]: "at present, the number of cases where NRAs (Natural Resource Accounts) were of *direct* use in the decision-making process appears to be still limited" (OECD Group on the State of the Environment, 1993). This may reflect the lack of a clear way to use the resource accounts in concrete decision-making situations -save the general references to their usefulness as an information base for policy makers.

UNEP

A 1982 special conference of UNEP mandated the Executive Director of UNEP to develop methodological guidelines for environmental accounting in the context of developing countries. Until 1993 UNEP's response was to sponsor, jointly with the World Bank, various expert seminars on national accounting. In 1993 UNEP launched its own environmental economics programme, a significant component of which is detailed case work on environmental accounting.

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constructed by the ratio of total annual harvest to annual growth of the forest resource. A similar indicator was constructed for water use by taking the ratio of total water withdrawal to the flow of resource availability.

[24] The newest publication containing figures for 1992 will be released soon.

[25] Appendix 3 contains a summary of the Natural Resource Accounting experiences in OECD member countries up to the beginning of this decade.

6.Conclusions

%Natural resource and environmental accounting is an ambitious undertaking, stretching the limits of both methodology and data. **The critical question in this study is the degree of linkage of these new accounts to the major policy concerns regarding the environment.** The conclusion of the OECD Group on State of the Environment, that there is little evidence for the *direct* use of natural resource accounts in the decision-making process, is significant in this respect, but it must be recalled that natural resource exploitation makes up a very small proportion of total economic activity in OECD countries.

Te study has reviewed the substantial academic literature on the methods on the environment and natural resources into the national accounts. **What is lacking in much of this literature, however, is any detailed discussion of the policy uses of the revised accounts - better measures of income or product are deemed to be sufficient justification for the proposed changes.** The empirical studies reviewed highlight the sheer difficulty of constructing these new accounts: data are inadequate or lacking, methods are still uncertain. The overview of activities by international organizations shows that they are essentially exploring this new area, with the United Nations taking the first steps towards standardizing definitions and methods.

The country case studies reveal that a wide variety of approaches to natural resource and environmental accounting is currently being developed. This variety reflects different endowments, environmental concerns and, to some extent, systems of political economy in the countries studied. Before drawing any general inferences with regard to green accounting, it is worth identifying some specific conclusions concerning the activities of these countries:

-The Brazilian work indicates the importance of sorting out the methodological issues in valuing resource depletion, since the range of estimates is so wide as to raise doubts about the usefulness of the work for policy purposes.

The efforts to estimate the value of water pollution and its treatment are unique among the countries studied, reflecting the importance of this issue for a developing country. Indeed, the whole area of the economic cost of environment-linked health damage is neglected. World Bank (1993) estimates that nearly 600 "disability adjusted life years" are lost per annum per 1000 population in Sub-Saharan Africa, for example. A significant proportion arises from environmental pollution. Since many

of these life years can be saved at modest cost, this suggests that national income adjusted for pollution-health damages would be significantly different to conventional national income.

-**The Canadian government is, along with the Netherlands, one of the few to embrace sustainability as an explicit goal in its environmental policy framework.** This gives the impetus to altering one of the standard National Accounts aggregates, national wealth, through resource accounts and valuation of resources in the ground. The satellite accounts are specifically designed to feed into policy modelling, enhancing the policy relevance of the accounts.

-**While the French patrimony accounts have existed as a framework for some years, the effort has been relatively small (about US $100,000) and lacks explicit links to policy concerns.** Relatively little data has been amassed, although this may change as the first steps towards institutionalizing this work are taken. The level of detail may be too high to be useful for national-level policy questions and too low for local or regional environmental problems.

-**The German accounting efforts are similarly weakly linked to specific policy concerns, but the work is to some extent politically driven: the Minister of the Environment, an economist, wants economic figures concerning the environment for use in policy discussions.** This is also a more diverse project, with an emphasis on building an environmental information system as well as on accounting. One of the strengths of the German effort is the firm support it receives from the scientific community, an important and influential player in the policy process in Germany.

-**The Netherlands is the other country in this study that has emphasized sustainability as a goal in its national environmental plan,** and this in turn has influenced its approach to resource and environmental accounting. Their unique methodology for valuing environmental damage, based on the costs of achieving sustainable use of the environment, will generate some interesting and useful data on carrying capacities and the costs of protection activities. However, this methodology is also subject to a lot of criticism on theoretical grounds. **The Netherlands is the only country studied that was specifically concerned with international linkages (e.g. the depleting or polluting characteristics of products imported) in their accounting work.**

-Norway has the longest history in the development of resource and environmental

accounting, and this shows up clearly in their work. Their accounting projects are carefully selected for their policy relevance, reflecting clearly the importance attached to natural resources and pollution emissions (particularly to air) in Norway. There is an explicit linkage between account development and policy modelling. With regard to the latter point, **another striking characteristic of the Norwegian work is the active role of the Central Bureau of Statistics in economic analysis, research and modelling, making the CBS a natural bridge between the Ministry of Finance and the Ministry of Environment in analysing environment-economy linkages.**

- While efforts in the UK are just beginning, the motivation for the work is notable for being politically driven, particularly with regard to international commitments to reporting on steps towards sustainability. In contrast to the Norwegian experience, the work of the Central Statistical Office and the Department of the Environment do not appear to be well co-ordinated.

The statisticians working on resource and environmental accounting are clearly responding to a political objective felt by many departments of the environment: how to raise environmental issues in ways that decision-makers will notice. Green accounting can be a worthwhile response. Raising these issues in terms of dollars and cents, and/or clearly linking environmental issues to economic phenomena, promises to be a useful step in meeting the needs of decision-makers. The country case studies lead to several general conclusions as well:

- **Resource and environmental accounting may be uniquely suited to the analysis of an issue on which only one country, the Netherlands, has placed any emphasis: the connection between domestic economic activity and the use of the environment in countries supplying the imports for the domestic market.** As questions of these international linkages rise in importance (tropical hardwood trade is the current example) this may provide a further impetus for accounting projects.

- While this study is explicitly not concerned with the best means of estimating green income or constructing satellite accounts, it is nevertheless striking that **sorting out methodological issues (through some combination of theoretical rigour and practical experience) appears to be extremely important.** The widespread disagreement over methods, and the wide variation in various empirical estimates (as noted in the chapter on empirical experience - see especially the study for Australia and, in the case studies chapter, Brazil) is discouraging the wider application of accounting methods.

- Whatever the methodological problems, there is a tendency apparent in the country case studies for the data providers to use accounting as a means to boil down the mass of environmental data into a form that is more useful for policy makers. This may be complementary to or a substitute for indicator development, but, like indicator projects, it is a response to an expressed need: **policy makers cannot make direct use of environmental data that are voluminous, difficult to aggregate and disconnected from other policy variables, especially economic ones. Fitting data into an accounting framework, with the discipline that this entails, may well be a useful response.**

- **There is some evidence that the statisticians involved in resource and environmental accounting are running ahead of the policy departments.** Viewed negatively, this may represent some misallocation of resources. Viewed positively, this may reflect statisticians who are anticipating the needs of the policy analysts. There is still a large element of research in much of this work, with inherently uncertain payoffs. More time and accumulated experience will be required to judge this question.

- It is notable that the country with the longest experience, Norway, is also clearly the country with the accounting programme that is most directly linked to policy concerns and specific applications.

- **The Norwegian experience also highlights the importance of institutional relationships in successfully creating links between data and policy uses.** The capacity of the Central Statistical Office in the domain of economic and environmental analysis, research and modelling, and the apparent willingness on the part of the Ministry of Finance and the Ministry of Environment to see this capacity developed, may well be unique. Unique or not, this non-adversarial relationship between data providers and policy analysts is a definite strength.

It was noted in the introduction that there are two broad approaches to natural resource and environmental accounting: construction of satellite accounts, linked to the standard national accounts but not integrated with them; and calculation of new or revised estimates of national accounts aggregates such as net income, net investment or national wealth. The analysis in this study for *developed* countries leads to the following conclusions with regard to these approaches:

- **The satellite accounting techniques, especially construction of pollution**

emissions accounts, but including as well resource flow and environmental protection expenditure accounts, appear to have the most direct policy relevance. These accounts can augment existing macro, general equilibrium and input/output models to yield useful results for policy makers.

- **The direct policy uses of adjusted national accounts aggregates appear to be limited.** It would be a mistake, however, to underestimate the political usefulness of the measures of sustainability that can be derived from these new aggregates. Indicators of sustainability could have a powerful influence on national and international public opinion, thereby indirectly influencing policy.

What broad conclusions should be drawn for *developing* countries? The much greater reliance of these countries on primary resources means that national accounting aggregates adjusted to reflect resource depletion (and discoveries, in the case of wealth measures) will have more direct policy relevance. In the light of rapidly growing populations, *per capita* estimates and the construction of time series are likely to be particularly important. Finally, the development of methods to measure resource rents as part of the process of producing revised national accounts aggregates will lead to several fundamental (and controversial) questions: (i) What is the magnitude of resource rents? (ii) What proportion of these rents is captured by the resource owner (i.e. the government)? and (iii) What is being done with these rents? Are they being used for current expenditures or invested for the future?

Finally, we reiterate that the practical use of "green" accounts has developed in response to different focal concerns. Combined with the methodological disputes, the end result is a set of differently based accounts. Removing or reducing the methodological dispute is a priority, not just as a matter of science, but because often starkly contrasting estimates of "green income" can only serve to undermine the credibility of the exercises. If the methodological differences can be resolved, this will leave differences due to varied objectives for green accounts. This we regard as healthy and desirable.

Appendix 1 - Persons Contacted

Canada

Penny Gotzamann, Acting Director General, Economics Directorate, Environment Canada, Ottawa.

Gordon Lenjosek, Senior Analyst, Fiscal Policy and Economic Analysis Branch, Department of Finance, Ottawa.

Philip Smith, Director, National Accounts and Environment Division, Statistics Canada, Ottawa.

France

Jean-Louis Weber, Director, International Affairs, Institute of the Environment.

Germany

Joachim Nick, Economist, Section G I 4, Economic Aspects of Environmental Policy, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Bonn.

Walter Radermacher, Head, Sub-division IV-E, Environmental-Economic Comprehensive Accounting, Federal Statistical Office, Wiesbaden.

The Netherlands

A. Adriaanse, Ministry of Housing, Physical Planning and Environment, The Hague.

Peter Bosch, Central Bureau of Statistics, Voorburg.

R. Fredriksz, Ministry of Housing, Physical Planning and Environment, The Hague.

Roefie Hueting, Central Bureau of Statistics, Voorburg.

Norway

Knut Alfsen, Director of Research, Central Bureau of Statistics, Oslo.

Oyvind Lone, Ministry of the Environment, Oslo.

Lorents Lorentsen, Director General, Dept. of Policy Analysis and Planning, Ministry of Finance, Oslo.

Hans Viggo Sæbo, Head, Division of Resource Accounts and Environment Statistics, Central Bureau of Statistics, Oslo.

United Kingdom

Hilary Hillier, Head, Environment Protection - Statistics, Department of the Environment.

Alan Brown, Environment Protection - Statistics, Department of the Environment.

Appendix 2 - Structure of the UN SEEA

The following table gives the basic structure of the UN satellite System of Environmental and Resource Accounts, as described in United Nations (1992). Definitions of symbols are given on page 94.

Table A2.1 Basic structure of SEEA

			Economic Activities			Environment
	Production	Rest of World	Final consumption	ECONOMIC ASSETS		Other non-produced natural assets
				Produced assets	Non-produced natural assets	
	(1)	(2)	(3)	(4)	(5)	(6)
Opening stock of assets (i)				$KO_{p.ec}$	$KO_{np.ec}$	
Supply (ii)	P Ci CCF	M X	C	Ig -CCF		
Economic uses (iii)						
Consumption of fixed capital (iv)						

Net Domestic Product (v)	NDP	X - M	C	I		

Use of non-produced natural assets (vi)	Use_{np}				$-Use_{np.ec}$ $I_{np.ec}$	$-Use_{np.env}$ $-I_{np.env}$
Other accumulation of non-produced natural assets (vii)						
Environmentally Adjusted Net Domestic Product (viii)	EDP	X - M	C	$A_{p.ec}$	$A_{np.ec}$	$-A_{np.env}$

Holding gains/losses (ix)		$Rev_{p.ec}$	$Rev_{np.ec}$	
Other changes in volume of assets (x)		$Vol_{p.ec}$	$Vol_{np.ec}$	

Closing stock of assets (xi)		$K1_{p.ec}$	$K1_{np.ec}$	

Key:

$K0_{p.ec}$, opening balance of produced economic assets
$K0_{np.ec}$, opening balance of non-produced economic assets
$K1_{p.ec}$, closing balance of produced economic assets
$K1_{np.ec}$, closing balance of non-produced economic assets
P, production (output)
Ci, intermediate consumption
CCF, consumption of fixed capital
NDP, Net Domestic Product
EDP, Ecological Domestic Product
M, imports
X, exports
C, consumption
Ig, gross investment
$A_{p.ec}$, net accumulation of produced economic assets
$A_{np.ec}$, net accumulation of non-produced economic assets
$-A_{np.env}$, net accumulation of non-produced environmental assets
Use_{np}, use of non-produced assets (i.e. depletion plus degradation)
$Use_{np.ec}$, use of non-produced economic assets (i.e. depletion)
$Use_{np.env}$, use of non-produced environmental assets (i.e. degradation)
$I_{np.ec}$, transfer of non-produced natural assets to economic assets
$-I_{np.env}$, corresponding reduction of non-produced environmental natural assets as a result of transfers
$Rev_{p.ec}$, holding gains/losses on produced economic assets
$Rev_{np.ec}$, holding gains/losses on non-produced economic assets
$Vol_{p.ec}$, changes in the volume of produced economic assets
$Vol_{np.ec}$, changes in the volume of non-produced economic assets

Appendix 3 - Natural Resource Accounting in OECD Countries

The following table summarizes the current activities in natural resource accounting by OECD countries, as described in OECD Group on State of the Environment (1993).

Table A3.1 Natural resource accounts in OECD Member countries

Country	Natural resource accounts (start of activity)	Institution	Main objectives	Environmental areas	Accounting framework	NRA used for	Planned activities	Related activities
Australia	Yes (1992)			Energy				Geographical information system (GIS)
Austria	Yes	Central Statistical Office		Forest			Satellite accounts	Material flow balances
Canada	Yes (1990)	Statistics Canada	Development of methodology; Physical description and monetary evaluation of stocks and flows of natural resources	Energy Forest	NRA will be integrated in SNA framework and will be published regularly	Integration of environmental aspects into SNA; Base for formulation of environmental policies; Input to economic models; Development of sustainability indicators		Environmental indicators
Denmark	No						A committee has been created to assess the possibilities of revising national accounts	Energy balances
Finland	Yes (1988) Preliminary study (1985-87)	Central Statistical Office	Combining environmental and economic data to support decision-making	Energy Pilot accounts: forest, land use		Develop environmental submodels (in particular for marine water		Continue NRA for forest, energy and land use. Develop accounts for air pollution.

						pollution) in macro-economic models		Develop forests modelling.

Country	Natural resource accounts (start of activity)	Institution	Main objectives	Environmental areas	Accounting framework	NRA used for	Planned activities	Related activities
France	Yes (1987)	Interministerial Commission for natural patrimony accounts/Ministry for the Environment	Description and evaluation (physical, monetary, aggregated) of stocks and flows of natural resources. Establish link between natural heritage and national accounts.	Methodology for all resources; Pilot implementation for water, forest, fauna and flora.	Integrated system of element accounts, ecozone accounts, accounts of economic agents and SNA.	Structuring information on natural resources in a coherent framework. Evaluate the different components of the natural heritage. Provide use for the decision-makers.		Statistics on environmental expenditures
Germany	No						Development of integrated environment-economy accounting (UGR)	Satellite accounts: pollution control and abatement expenditures
Italy	No						Methodological work. Development of environmental information system.	Satellite accounts
Japan	Yes (1992)						Centre for Global Environmental Research Japan Research Institute	Calculation of net national welfare. Environmental expenditure

								statistics.
Netherlands	Yes						Development of environment module in SNA. Linkage of SNA and physical data: energy and water.	Material balances. Environmental expenditure statistics. Adjustment of GDP.

Country	**Natural resource accounts (start of activity)**	**Institution**	**Main objectives**	**Environmental areas**	**Accounting framework**	**NRA used for**	**Planned activities**	**Related activities**
New Zealand	No						Methodological and theoretical work. Feasibility study on NRA.	
Norway	Yes (1974)	Central Bureau of Statistics	Establish a data base for environmental management. Establish link with economic data.	Energy Land use Mineral Fish Forest Air emissions	Accounting system similar to national accounts	Improve communication between different ministries responsible for natural resource management. Use NRA as input for environment-macroeconomic models.	Improve quality of existing accounts. Evaluate environmental services. Evaluation of damages. Evaluation of economic and environmental impacts of air policies.	
Portugal	Yes (1989)			Energy Forest	Experimental NRA			Environmental expenditure

				Minerals Waste				statistics
Sweden	No					Study on improved integration of natural resources into economic accounts.		

Country	Natural resource accounts (start of activity)	Institution	Main objectives	Environmental areas	Accounting framework	NRA used for	Planned activities	Related activities
Spain	Yes (1968-88)	Interministerial Commission on natural heritage accounts	Development of methodology. Provide integrated framework for environmental information.	Environment-economy model for Madrid region. Water Land use Flora and fauna Waste Marine resources				Satellite accounts. Environmental expenditure statistics.
United Kingdom	Pilot study completed (1992)	Department of Environment	Use for decision-makers on natural resources and environmental policies.	Pilot study: Water, forest, energy.				Environmental expenditure.
United States	Pilot project	Environmental Protection Agency		Chesapeake Bay Region			Methodological developments	Damage evaluation. Pollution abatement and control expenditures.

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