Journal of Official Statistics
Vol. 7. No. 4, 1991, pp. 499–513

Miscellanea

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Natural Resource and Environmental Accounting in the National Accounts[1]

Lindy H. Ingham[2]

Abstract: This article discusses the treatment of natural resources and environmental issues in the national accounts, and considers the criticisms of the existing treatment put forward by environmental economists and others. Some alternative approaches which have been proposed are examined. Possible future developments in accounting for environmental factors in the national accounts are also outlined. Where relevant, both a historical perspective and the Australian experience of accounting for natural resources and the environment have been included.

Key words: Natural resource and environmental accounting; national accounts; gross domestic product; sustainable income.

1. Introduction

In the literature, environmental concerns have been categorised as follows:

- depletion and extension of natural resources;
- conservation of the environment; and
- the effects of pollution and its control.

Although this categorisation in effect sets the conceptual scope of natural resource and environmental accounting, it should be noted that no country has as yet set up accounts, either within or outside the national accounting framework, to encompass all of these issues.

While this paper is primarily concerned with the treatment of natural resources and environmental issues within the national accounting framework, this need not be the only approach to the development of environmental statistics. For example, one would initially expect to see the development of an array of indicators of change in environmental conditions and in activities affecting the environment. These might be in aspects as diverse as agricultural practices, monitoring the use of funds, trends in recycling materials, and in the effect on the environment of various forms of transport. Indicators of this kind would be of interest

[1] The present article is a derivative of Australian Bureau of Statistics (1990).

[2] Research Officer, National Accounts Branch, Australian Bureau of Statistics, P.O. Box 10, Belconnen, ACT 2616, Australia.

in their own right but might also be used in compiling environmental accounts. This would be analogous to the relationship between indicators of economic activity and the set of conventional economic accounts.

2. Development of National Accounting

National accounts in their modern form evolved from the publication of Keynes's *General Theory* and the interest by governments during World War II and the early post-war period in production and allocation of resources to competing uses.

The major preoccupation of economists at the time was in building a statistical model of the workings of the economy, using the relationships postulated by Keynes, in order to develop prescriptions for a high and stable level of economic activity.

At their summary level the national income and expenditure accounts were designed to reflect the economic flows of the Keynesian system: production, consumption, investment and saving. The present national accounts still reflect this basic system of identities.

In recent years, a number of economists have come to the view that the conventional national accounts framework should be modified or extended to take into account such factors as the extent of renewability and the rate of depletion of natural resources, and of changes in the quality of the environment.

3. National Accounts Framework

3.1. Overview

The national accounts provide a systematic statistical framework for summarising and analysing the economic transactions taking place within a nation. A complete set of national accounts includes a number of flow accounts and a balance sheet. The flow accounts measure production, the incomes flowing from that production, both real and imputed, and capital transactions over a given time. The balance sheets record the levels of assets, liabilities and net worth at a particular point in time. The flow accounts and balance sheets are linked in that the stocks of assets and liabilities are equal to accumulated past capital transactions after allowing for revaluations and the creation and retirement of assets and liabilities. Australia has a full set of production and income accounts and is currently extending its capital transactions accounts to include flows of funds. As yet it has not compiled balance sheet accounts because of the significant estimation problems involved and the lack of data for some parts of the balance sheets. In addition, the overwhelming interest of economic policy makers in the past half-century has been in current income flows.

The international standard for national accounting is the United Nations' '*A System of National Accounts*' (the SNA). The Australian national accounts are based on this system. The SNA deals only briefly with balance sheets. An elaboration of the part of that system relating to balance sheets is contained in United Nations (1977) (known as M60), which was to provide provisional international guidelines.

3.2. Balance sheet accounts

Balance sheet accounts are defined as "statements of tangible assets and intangible non-financial assets derived by the various institutional sectors of the economy and of the outstanding financial claims between institutional units" (United Nations 1977, p.5).

Balance sheets measure national wealth, including the level of tangible assets which are made up of "human-made" assets and assets of the natural environment, or as

M60 defines them, reproducible and non-reproducible tangible assets. The former include the fixed assets and stocks of enterprises, financial institutions, government entities and private non-profit institutions. The latter include land, timber tracts and forests, subsoil deposits and historical monuments.

Within the SNA framework, balance sheet accounts are linked to the flow accounts by capital finance accounts, which portray a significant part of the changes between opening and closing levels of assets and liabilities. Those changes in assets and liabilities, such as net additions to the stock of natural assets, revaluations and unforeseen events, which are not included in the capital finance accounts of the SNA, are recorded in what are called the "reconciliation accounts." As those changes are also excluded from the production and income and outlay accounts, they do not affect the level of national income of the intervening period. They simply represent the changes in the value of net assets between successive measurement dates that are not attributable to transactions.

The principal exclusion from balance sheet accounts relates to resources in the public domain which are not subject to ownership rights and are thus generally not sold or purchased (e.g., rivers, lakes, parklands, unused wilderness and the atmosphere). This is consistent with the scope of the SNA which is generally limited to market activities (except for imputation for directly competitive non-market activities). Even if it were considered desirable to include these resources from the point of view of obtaining a more complete measure of the national estate, measurement problems would make their inclusion difficult in practice. Only those natural resources which are commercially traded or used in the production of goods and services that are priced in the market place can be readily valued. However, outlays on the permanent improvement and extension of natural resources in the public domain are considered within scope of the flow accounts of the SNA because their provision generates economic activity. They are covered in capital formation, thereby increasing the reproducible tangible assets (classified as "other construction works" or "land improvements") in the balance sheet accounts.

The initial expenditure to establish naturally growing but commercially traded assets, such as timber tracts, plantations and fisheries, is counted as capital formation in the flow accounts of the SNA. Further growth and depletion are not recorded as capital formation but are included in the reconciliation accounts. Both the creation of assets and subsequent increases or decreases affect the level of tangible assets recorded in the balance sheet accounts.

3.3. Reconciliation accounts

The reconciliation accounts are particularly relevant for natural resources. The items recorded in these accounts are categorised as follows:

- revaluations of assets due to price changes;
- net adjustments to the stock of assets due to unforeseen events (mainly premature retirements of assets because of early obsolescence as a result of technology changes);
- net increases in the value of tangible assets not accounted for in the capital finance accounts (such as changes in the existing stock of natural resources);
- net adjustments to the stock of assets due to changes in their structure and classification; and

- statistical discrepancies and discontinuities (representing the residual difference between opening and closing balance sheet positions).

The item "net increases in the value of tangible assets not accounted for in the capital finance accounts" is directly relevant to natural resources accounting. It includes natural growth less depletion of timber tracts, forests and fisheries; new finds less depletion of subsoil assets; and losses in land and timber tracts in catastrophes such as bushfires. It excludes, however, changes in land quality due to erosion, waterlogging, desertification, salinisation or upgrading; and increased availability of mineral resources due to technological advances. These latter changes are recorded as changes in the market value of land and subsoil assets – part of the revaluations item of the reconciliation accounts.

3.4. Deficiencies with M60

A number of problems exist within the UN's stated guidelines for balance sheets. First, it could be argued that resources in the public domain are part of the wealth of a country and should be included within scope. M60 appears to exclude them on the pragmatic grounds of "the conceptual and practical difficulties of valuing...[such] assets", i.e., they are excluded because they cannot be satisfactorily valued. Some examples of such exclusions are beaches, native flora and fauna, fish stocks within a nation's fishing zone and subsurface water.

Second, the UN balance sheet guidelines are deficient in that they do not provide for the separate identification of the extensions and depletions elements of a net change.

Third, implementation of the guidelines would pose further problems. Physical and monetary data for those non-reproducible assets within scope are poor and, in some cases, non-existent. Even where data for physical units exist, the problem of valuation remains. Given this constraint, there is an argument for data on the quantity of reserves to be presented separately within the balance sheets.

Guidelines are provided in M60 for the valuation of tangible non-reproducible assets. The two principal approaches are:

- the use of values derived from market transactions in assets; and
- when such values are not available, the use of the discounted present value of estimated future income flows derived from the assets to be valued. This method consists of valuing assets from which the returns are either delayed or spread over a lengthy period. The main problems with such an approach are choosing the appropriate rate of discount and estimating cash flows for future years.

Considerable valuation problems would have to be resolved before Australia could produce a full set of balance sheet and reconciliation accounts. At present, Australia does compile two important elements of balance sheets, namely stocks of fixed assets and the international investment position. However, the former refers to "human-made" rather than natural resource assets and the latter is restricted to financial claims between Australia and the rest of the world.

The framework for balance sheets as outlined in M60 has attracted less adverse comment from environmental economists than the exclusion of most environmental factors from the current measure of GDP. However, the fact that most countries have not yet fully implemented the balance sheet guidelines, particularly in respect of natural resources, has been noted as a major deficiency of national accounting systems. Given the emphasis on the national income accounts, the treatment of natural resources in these accounts is now discussed.

3.5. National income accounts

National income accounting measures economic production. Production is the process whereby labour, natural resources, accumulated capital assets and knowledge are applied to the provision of goods and services. Gross domestic product (GDP) is the most commonly used measure of aggregate income, or product.

The national income accounts concentrate on the role of capital and labour in the production process. Natural resources have a passive role in that they are regarded as gifts of nature with a zero supply price. Implicit is the notion that, as no costs in monetary units are incurred in their provision, nothing needs to be deducted from current income as resource stocks are depleted. Also, the conceptual approach adopted in the national accounts does not account for the costs imposed on the environment for the disposal of wastes from the production process.

However, any income-generating activity which flows from exploiting these assets does enter the national income and expenditure accounts. Sales of minerals are included on the expenditure side, explicitly in exports and implicitly in the final value of various goods and services sold (they are also shown explicitly within the "increase in stocks" item); on the income side, the value added from mineral extraction is included in wages, salaries and supplements, and in the gross operating surplus of enterprises.

4. Definitions of Income

4.1. Concept of income in current national income accounting

The origins of the existing national accounts concept of income lie in the history of the models of economic activity which have developed.

The classical economists regarded income as the return on three kinds of assets: natural resources, human resources (labour) and invested capital. However, the neoclassicists, from whom modern twentieth century economic theory is derived, dropped natural resources from their model to concentrate on capital and labour. The implied premise was that natural resources were in infinite supply or were capable of regeneration.

This premise has come under increasing challenge in recent times. Environmental economists have called for a reconsideration of the basic concepts of production and income. Specifically, they have taken issue with the concept of income used in national income accounting because it does not measure "sustainable income".

4.2. Concept of sustainable income

Sustainable or "true" income, as defined by Adam Smith and later clarified by Hicks, is the maximum value that a person can consume during a period and still expect to be as well off at the end of the period as at the beginning. In other words, sustainable income is the maximum amount that can be consumed in a given period without reducing the amount of possible income in the future. It is not really practicable to measure Hicks's concept of sustainable income in national income and expenditure accounts. Changes in net worth in balance sheet accounts will provide a measure of Hicks's "true income".

Conceptually, national accounting definitions of income at present do not approximate Hicks's idea of income. First, no deduction has been made from GDP for the capital that is consumed during a particular period. This is quite deliberate as the "gross" in GDP implies. National accountants have always recognised that a product

figure net of capital consumed (i.e., net domestic product) would be a purer measure of income and production but because of difficulties in measuring capital consumption, and because the major emphasis has been on actual income flows, GDP has remained the most commonly used summary measure of economic activity.

Second, the capital that is consumed to arrive at the measure of net domestic product (which better approximates Hicks's notion of income) is only the fixed capital component of the economy's productive assets. Natural resource assets, which also contribute to income in future periods, are ignored just as in the neoclassical model. The resulting aggregate, according to environmental economists, overstates the maximum net product available for consumption. (However, it is noteworthy that this is not the only area which is excluded in this way. Both advances in technology and the level of skills of the population are important productive assets which are not measured in the national accounts.) Some economists claim that the policy advice which results from ignoring natural resource assets encourages over-consumption of natural resources to the detriment of the long term sustainability of economic activity. It should be noted that net domestic product is not explicitly shown in the Australian national accounts. However, a similar concept, national income, is measured. It is defined as net domestic product (i.e., GDP less consumption of fixed assets) less net income paid overseas.

Third, a point sometimes overlooked in the literature is that Hicks's notion of income also implies that net extensions to the resources base should be added to income. New discoveries of oil, for example, would show up as a large increase in income in the period in which they were discovered. Substantial new finds would distort annual movements in income. Such a concept of income would have severe shortcomings for economic policy concerned with short term stabilisation. This leads to the further point that no single concept of income is suitable for all analytical and policy uses.

Two principal adjustments have been recommended in the literature to move the national accounts closer to a concept of sustainable income.

The first has been to extend the concept of depreciation to cover consumption of natural resources through degradation and depletion. The second is to subtract from GDP so-called "defensive expenditures" i.e., expenditures undertaken to protect the environment from damage incurred during economic activity.

5. Moving Towards a Concept of Sustainable Income

5.1. Degradation and depletion of natural resources

Many commentators argue that the central problem with the current SNA is that it treats the depreciation of human-made assets differently from that of natural resource assets. National income only accounts for the consumption of human-made assets, by writing them off against the value of production as they depreciate over their lifetime. The depletion of natural resource assets, however, produces no debit charge against current income to reflect the decrease in potential future production. Instead, in theory, the depletion is reflected in the balance sheets of the national accounting system. For example, in the words of Repetto, Magrath, Wells, Bear, and Rossini (1989, p.2) "a country could erode its soil, extract its minerals, cut down its trees but measured income would be unchanged as these resources disappeared." An example

of a country in such a situation is Nauru which has been heavily dependent on its phosphate deposits for its economic growth in the last few decades. However, growth from that source is not sustainable because the natural resource being exploited is rapidly being depleted. In national balance sheets, however, this situation would be identified by the decline shown in the country's net worth.

Two main conceptual approaches have been suggested to deal better with the depletion and degradation of natural resources and the environment in the national accounting framework: the depreciation approach and the user cost approach. The latter was developed by El Serafy (1989) to account for an apparent confusion between income and capital which, he argues, exists with the depreciation approach.

a. Depreciation approach

In the depreciation approach, the concept of depreciation of human-made capital is applied to the consumption of natural resource capital. The resultant estimate is deducted from GDP (as currently defined), along with the consumption of fixed capital to form NDP. (Using this procedure results in no change in the level of GDP but potentially significant reductions in NDP compared with present estimates.) Although the broad principle seems clear, a number of details at both the theoretical and practical level have to be resolved. For example, should the deduction to derive NDP include only depletions or should it relate to net depletions, i.e., additions to resource stocks less depletions? Should revaluations due to price changes be included? If additions are included, growth in NDP may actually be greater than that in GDP in some years. For resources that are sold, the depreciation factor (i.e., the economic rent attributable to the ownership of that resource) can be estimated as the value of sales less costs of extraction (i.e., intermediate expenses and labour and capital costs including a normal return to capital).

Ideally, reserves of mineral resources should be valued at the market prices at which the natural resource asset would currently change hands if sold in its entirety. However, because most resource stocks are unlikely to be the subject of a current market transaction, an alternative means of valuation is required. Two methods have been proposed:

- the net present value of future net returns; or
- the net price, or unit rent, of the resource multiplied by the relevant quantity of the reserves.

The *net present value* method, recommended by the United Nations Statistical Office, requires that future prices, operating costs, production levels, and interest rates be forecast over the life of the reserves (for example, a given oil field) at the time of their discovery. The present value of the stream of net revenue is then calculated, representing the total revenue from the resource less all extraction costs.

The *net price* method, adopted by the private accounting bodies in the USA for oil and gas stocks, applies the prevailing average net price per unit of the resource (calculated as current revenues less current production costs per unit) to the physical quantities of proven reserves in order to derive changes in the levels of proven reserves. It is a much simpler method than the former.

Despite the existence of estimation and data problems, environmental economists argue that it is better to make some allowance for the use of natural resources than to

make none at all. They acknowledge that some estimates may be rather arbitrary, but note that a degree of approximation is already required in the estimation of depreciation of human-made capital and in other national accounting aggregates, such as the imputed rent of owner-occupied dwellings.

It should be noted that, because reserves of some natural resources such as coal, iron ore and bauxite are so extensive, their present economic rents are quite low even though the level of extraction is reasonably high. In these circumstances, it would make little difference whether or not net changes in stocks are recorded as a deduction from (or an increase in) NDP.

El Serafy (1989, p. 13) rejects the depreciation approach on conceptual grounds. He writes: "If we deduct from the gross receipts from mineral sales in any one year an amount equal to the depletion along the lines described above, the value of *net income* from this activity becomes zero. Where a country derives 100 percent of its receipts from, say, petroleum extraction – an extreme case of a Saudi Arabia – the depreciation approach (ignoring the multiplier effect of ancillary activities related to extraction as well as the contribution of other sectors to value-added) would give us a GDP of 100 and an NDP of zero – a measurement that is not particularly edifying." He suggests that the depreciation approach is flawed because it deducts the whole of gross product from the gross receipts. However, his views seem to rest on an extreme interpretation of the depletion factor. They do not accord with those of most environmental economists who consider that economic rent (as defined above) should be adopted as the depletion factor. He therefore recommends the user-cost approach to overcome problems with the depreciation approach.

b. User cost approach

The user cost approach modifies the measurement of the depletion factor which, in the depreciation approach, potentially wipes out all the growth in activity from the net product or causes large swings in the growth rate when new reserves are discovered. It attempts to split, net of extraction cost, the revenue from the sales of a depletable resource into a capital element, or user cost, and a value added element representing true income. The capital element represents asset erosion, which could be reinvested (if the owner wanted) to generate sufficient future income, to maintain the present level of true income as the resource is being depleted and long after the original resource has been exhausted. This part (asset erosion) should be excluded from both GDP and NDP. The value added element on the other hand should be included in GDP and NDP. Therefore the user-cost approach, unlike the simpler depreciation approach, alters the level of GDP itself.

The concept behind the user cost approach is to calculate that part of total receipts attributable to true income. In practice, a discount rate is applied to the total receipts over the whole life of the resource. It involves calculating the amount of income which would have to be invested in each period to maintain the same income in each period while the resource is being used and after it is entirely used up. Assumptions have to be made about the reserves-to-extraction ratio (i.e., the life expectancy of the resource measured in years) and the discount rate. For example, a country which liquidates its reserves of a particular resource over fifty years needs to set aside for reinvestment a smaller portion of its receipts than another which liquidates its reserves over twenty years and can thus count a larger portion of its receipts

as current income. Similarly, the higher the discount rate, the higher is the proportion of receipts allocated to current income.

5.2. *Defensive expenditure*

The national accounts treatment of expenditures incurred to defend the environment against damage by economic activity has also attracted attention from environmental economists. These expenditures are undertaken to mitigate the unwanted side effects of production and consumption. They are made to compensate for, redress or guard against losses of environmental functions relating to land, air and water. They include expenditures on pollution abatement, soil conservation, air and water quality monitoring, water and sewerage treatment, waste disposal, and cleaning up pollutants from the environment. Expenditures on the prevention of, and compensation for, environmental losses do not contribute to the quantity of goods available for consumption; they simply protect or replace scarce environmental goods that were already available. They can be viewed as a cost of economic activity and it has therefore been suggested that they should not contribute to the level of sustainable income or production.

Environmental economists regard the treatment of defensive expenditure in the national accounts as unsatisfactory because this expenditure actually adds to the level of measured income in many cases. Defensive expenditures are treated differently in the national accounts depending on the economic agents undertaking the expenditure. Government sector output is calculated as the sum of wages paid and material inputs used. Therefore, government expenditures on the environment are measured as purchases of final goods and services (of either a current or capital nature). As a result, measured income and expenditures will rise if there is an increase in government expenditure on protecting the environment. For example, if the government is involved in an extensive clean up of the environment after, say, a major oil spill, measured income will be seen to rise at the same time as there has been a deterioration in (or at best a partial reinstatement of) the natural environment.

The effect on measured income of defensive expenditures by industry is a little less certain. Current expenditures are treated as intermediate consumption and therefore, at least initially, do not directly add to income. They are reflected instead as a cost, resulting in a lower gross operating surplus of the industry concerned. However, in practice it is reasonable to assume that the cost of ongoing defensive expenditures, such as for pollution abatement, will be reflected to some extent in the price of goods sold. The effect on measured income in current price terms will depend on the elasticity of demand for the particular good or service in question and therefore expenditure may not detract significantly from measured income. On the other hand, in the case of irregular expenditures, say for environmental clean-up after the release of pollutants, it would be reasonable to assume that such costs are not passed on, unless the business is in a monopoly position. Defensive expenditures of a capital nature, such as the purchase by industry of equipment to inhibit the release of pollutants, are treated as final expenditure.

One problem with changing the treatment of defensive expenditure is where to draw the line. There are many other final expenditures not directly related to the natural environment but which are not associated with an increase in goods available for consumption, (e.g., expenditures on national

defence). Given that the purpose of defence is to maintain the status quo, any such expenditure does not result in an increased availability of goods for consumption, yet measured income rises if defence expenditure increases.

It should also be noted that the exclusion of defensive expenditure from GDP would have consequences for the accounts that go beyond the reclassification of these expenses from final expenditure to intermediate expenditure. The wages and salaries and gross operating surplus flowing from these expenditures would also have to be identified in some way so that they could be deducted to preserve the identity that GDP can be measured by summing either incomes, gross output less intermediate expenditures, or final expenditures plus exports less imports.

A further practical problem is that pollution abatement expenditure can be notoriously hard to define from a statistical collection point of view. While businesses may know how much they have spent to comply with recent government regulations, they will probably not be able to identify (or even be aware of) their total expenditures on pollution abatement. Also there is the difficulty of separating out the cost of new plant purchases into the components which relate to pollution abatement and those which relate to production of goods and services.

6. Future Developments in Environmental and Resource Accounting

6.1. Review of SNA

The SNA is currently undergoing an intensive revision in the light of the experience of countries and international agencies in its use over the twenty years or so since the release of the 1968 version. The revision of the SNA is being managed by a group consisting of members of the United Nations Statistical Office, the International Monetary Fund, the World Bank, the Statistical Office of the European Communities and the Organisation for Economic Co-operation and Development. A number of expert group meetings have been held, which will culminate in the production of a redrafted SNA. It has already been decided by the experts involved in the revision process that no major conceptual changes should be introduced into the SNA.

The experts acknowledge that the current system has many shortcomings with respect to environmental and natural resource accounting but consider that it is not yet feasible to replace existing concepts of income with the concept of sustainable income. The existing system is a well-established system of data collection and accounting that serves many different short, medium, and long term socioeconomic analyses. Before specific recommmendations can be made for changes to the core of the SNA to better incorporate the environment, it is the view of the national accounts experts that some outstanding conceptual issues need to be resolved, and a lot more empirical work has to be undertaken.

However, a consensus has emerged in recent expert group meetings that enough progress has been made to link the environmental accounting to the core of the SNA by means of "satellite accounts." Such a system would allow specific areas of social concern to be analysed, without overburdening or disrupting the "core" system. The satellite accounts would provide measures of defensive expenditures and of the use, depletion and degradation of natural resources. This would enable aggregate indicators of environmentally adjusted or sustainable income and product to be produced. The satellite accounts would also link physical resources with monetary

environmental measures and balance sheets. The view of the national accounts experts is that further consideration could be given to adjusting the core of the SNA once adequate experience has been gained with these types of accounts and when various conceptual and valuation issues have been resolved.

6.2. *A Draft Framework for satellite accounts*

A "Draft Framework" for a proposed set of environmental satellite accounts was presented at the Twenty-First General Conference of the International Association for Research in Income and Wealth by Bartelmus, Stahmer, and van Tongeren (1989). It drew heavily on earlier work on this topic by Bartelmus and van Tongeren and took into account suggestions made at meetings held in November 1988 and January 1989. This topic was also discussed at a meeting of national accounts experts in Paris in July 1990 where strong support for the continued development of satellite accounts was registered, with further discussion scheduled for subsequent meetings in 1991. The Framework follows as closely as possible the concepts established in the SNA. It segregates all flows and stocks of assets in the national accounts related to environmental issues, while maintaining the production boundary of the SNA. This facilitates direct comparison of original (unadjusted) SNA data with environmentally adjusted indicators and better integrates environmental variables into established economic analysis.

Specifically the Framework focuses on:

"– the use of natural resources in production and final demand, adjusting the concepts of intermediate and final consumption, value added, capital consumption and formation and introducing a broader concept of wealth accumulation;

– the degradation of environmental quality (from pollution and other impacts of production, consumption and natural events); and

– the treatment of expenditures of environmental protection" (Bartelmus, Stahmer, and van Tongeren 1989).

Two groups of tables are included in the Framework. The first group shows the supply and use of goods and services, by industry, with the separate identification of environmental protection services from other production activites. The second group comprises the opening and closing balance sheets and two tables linking them – a table on volume changes in tangible wealth and a table on revaluation of assets.

The Framework outlines the calculation of various environmentally adjusted indicators. The first, "environmentally adjusted GDP", is obtained by subtracting the environmental protection services (defensive expenditures) of governments and households from GDP. This reflects the fact that the Framework treats the environmental protection services of households and governments as the intermediate consumption of these sectors whereas the SNA currently includes them as final consumption by those sectors. The defensive expenditures of industry are already included in intermediate consumption when deriving unadjusted GDP.

Another indicator is "sustainable gross domestic product" (SGDP), which is the difference between environmentally adjusted GDP and environmental costs. (Environmental costs result from the quantitative depletion of natural resources and the degradation of environmental quality by economic activities and from "natural or multiple causes".) It should be noted that additions and extensions to the natural resource base are not included in income

but are only taken account of as they are exploited. Sustainable net domestic product is obtained by deducting the depreciation of fixed human-made capital from SGDP.

It is envisaged that the Framework will be developed into a draft manual and applied to several developing countries and perhaps one or two industrial countries in the form of pilot studies of in-depth case studies. This process will highlight potential problems at the conceptual, practical and policy-making levels. Some of these problems have already been discussed in Peskin and Lutz (1990). Subsequent reviews of the proposed manual by expert national accountants can be expected to lead to the publication of a handbook in the handbook series of the SNA. As part of this process, in October 1990 a preliminary draft of part one of the handbook dealing with general concepts (United Nations 1990) has been prepared. It follows the lines of the Framework outlined above. It reflects "work in progress" and was distributed to expert national accountants to obtain comments and to provide a basis for discussion. Its contents were discussed at the Special Conference of the International Association for Research in Income and Wealth (IARIW) on Environmental Accounting in May 1991. A number of issues arose which were further discussed at the July 1991 OECD meeting of national account experts and will assist in the refinement of the draft handbook. Specifically, general agreement amongst participants was reached on the following topics:

- in agreement with the 1991 version of the SNA boundary of production, accounting for environmental aspects and natural resources should not be integrated into the national accounting system. Natural resource assets should be included in the balance sheets but not the flow accounts.
- the adjective "sustainable" preceding economic concepts such as development, growth and income was not appropriate because it is difficult to define its actual meaning.
- the core of the SNA is not to be compromised.
- there are significant theoretical and practical problems in moving from physical quantities to monetary terms.
- it would not be appropriate to incorporate an allowance for degradation of the environment in GDP estimates.
- some issues, still subject to considerable debate, include the treatment and valuation of defensive expenditures, and resource stock depletion and appreciation.

Developmental work on physical resource accounting already begun by the United Nations Environment Programme (UNEP) will be continued, with emphasis on assessing the environment and natural resource base, the changes in quantity and quality of this base, and its linkage to monetary accounting.

6.3. *Further development work*

Developmental work on other aspects of natural resource accounting is also planned by a number of international agencies. This work is to be undertaken co-operatively by the World Bank, United Nations Statistical Organisation (UNSO), the United Nations Development Programme (UNDP) and UNEP, along with non-governmental organisations and developing-country governments.

Several industrial countries are currently developing natural resource accounting systems. Repetto, Magrath, Wells, Bear, and Rossini (1989) have reviewed international activity in natural resource accounting and an extensive survey of official resource and

environmental accounting in eight industrialised countries has more recently been carried out by Peskin and Lutz (1990). Norway and France have developed extensive systems of natural resource accounts as a supplement to the system of national accounts. Norway has compiled accounts in physical units for "material resources" such as fossil fuels and other minerals, and for "biotic resources" such as land, water and air. The French system of Natural Patrimony Accounts is the most comprehensive system and aims to cover economic, ecological and social environments. These accounts are sub-divided into physical, geographical and "agent" accounts, with "agent" referring to all accounting for those activities that link human activity to the natural environment. The accounts are in physical units, with provision for monetary valuation for stocks and flows that are marketed. West Germany is considering the development of satellite environmental accounts, following the Bartelmus et al. (1989) approach, with initial work reviewing the effect on GDP or defensive expenditures, in particular pollution abatement expenditures. As with most systems collection of data is in physical units. The Netherlands, active in research in resource and environmental accounting for a relatively long time, has just begun attempts to adjust national income accounts for environmental losses and resource depletion. Japan and the US have, in the past, given priority to the development of estimates of pollution and environmental quality over development of estimates of natural resource stocks. In 1973, Japan attempted to adjust GDP in a number of ways including accounting for environmental degradation to better reflect changes in national welfare. There are currently no plans at an official level to continue this work. In the United States, however, investigations are proceeding as to the feasibility of developing more extensive resource and environmental accounts, in addition to the data on pollution – abatement expenditure already assembled. Canada has begun a program on resource and environmental accounting, with a full set of balance sheets to be produced in 1993 and satellite accounts scheduled for 1994. Sweden will be publishing balance sheet estimates for forest and minerals late in 1991. Australia will continue to investigate the emerging statistical requirements in these areas and will allocate further resources to improving the statistical measures available on its natural resources and environment. This is discussed in more detail below. In conclusion it should be noted that no country actually adjusts its national income accounts for the depletion of (or additions to) its natural resources.

6.4. *Australian developmental work*

The recent growing emphasis on the setting of environmental policies has resulted in intensive interest in resource and environmental accounting by several government and non-government agencies in Australia, all of which have some responsibilities associated with, or interest in, the environment. The central statistical agency, the Australian Bureau of Statistics (ABS), supports the development of satellite accounts as part of the revised SNA and the development of environmental indicators. It is attempting to coordinate the environmental data from the other agencies in order to build a coherent statistical framework as the basis for the setting and implementation of environmental policies.

Two sections in the ABS are following developments in this area. The National Income and Expenditure Section has begun investigating the compilation of balance sheet accounts relating to forestry, land and sub-soil assets. The section is also contributing to the international debate on

the development of guidelines. Within the Agriculture and Mining Section, an Environmental and Natural Resource Statistics Unit has been set up to provide physical data for use in compiling balance sheet accounts and possibly for publication in their own right or to form the basis of environmental indicators. The Agriculture and Mining Section is also:

- compiling a compendium of Australian environmental statistics,
- collecting information from households on environmental behaviour and attitudes, and
- collecting data on environmental protection expenditure, pollution abatement and other environmentally related activities by including questions in several existing industry and activity specific ABS surveys and censuses.

The ABS is working closely with the New Zealand Department of Statistics on joint development of aspects of environment statistics to utilise the available resources of the two organisations as efficiently as possible. Contact has also been established with a number of overseas statistical agencies working in the field from the Netherlands, United Kingdom, United States, Canada and the World Resources Institute.

Interestingly Australia is the only developed country to have had some accounts compiled along the lines of Repetto's work. Young (1990) of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has attempted to adjust GDP for resource degradation and appreciation for Australia for the years 1980–89. Although acknowledged by Young to be "back of the envelope" estimates, they suggest that corrections for land and forest degradation are relatively consistent from year to year and far less volatile than changes in stocks of minerals and other subsoil assets which have large positive or negative changes depending on price movements. The results were discussed at the May 1991 IARIW conference where delegates agreed that such conclusions would apply to most developed countries.

7. Conclusion

While recognising the interest in adjusting major aggregates in the national accounts so that the sustainability of economic growth can be assessed, it also needs to be said that there is no single indicator which can describe all aspects of the well-being of a country's citizens. National accounting measures such as national income or GDP are major indicators of economic activity but there are significant aspects of the "quality of life" which cannot be comprehended in a system of economic accounts, just as there are significant aspects of an individual's well-being which are not measured in the conventional concept (or any other concept) of that individual's income.

Notwithstanding their limitations, especially in relation to uses for which they were never designed, the national accounts provide vital information for a range of important purposes. The conventions followed in compiling them are fully articulated. They have been developed and refined over the course of the past half-century, by experts who understand that there are many questions which cannot be answered by any system which relies solely on the measuring rod of money (even though techniques are available for removing the effects of changes in the value of money). The system of national accounts provides a framework or structure which can be, and has been, adapted and extended to facilitate the examination of various economic and social policy issues. Environmental and natural resource

issues can also be accommodated within this framework.

The most promising developments in accounting for natural resources and the environment would appear to be those related to satellite accounts, which would provide an important supplement to the national accounts. The advantages of setting up satellite accounts are that:

- they would be compiled within the internationally recognised (and used) SNA framework;
- as a result, they could be interpreted in conjunction with the best available measure of overall economic activity – the national income accounts; and
- the lack of consistent data over time would not directly affect the quality of the existing accounts, which are important tools for economic policy makers.

It must be recognised however, that there are a number of difficulties still to be resolved within this framework, namely, debates about conceptual and valuation problems and problems involved in obtaining accurate and reliable data on levels of stocks of natural resources and the magnitude of the factors which impact upon these stock levels from year to year.

8. Acknowledgement

I also want to acknowledge the contribution of my colleagues at the ABS, in particular, Ross-Harvey and Tony Johnson, to my early drafts.

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Received January 1991
Revised November 1991