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EXECUTIVE SUMMARY

At present, national accounts provide a framework whereby the level of economic activity can be measured in any given year (an accounting period). The most widely used summary indicator to emerge from these accounts is a measure of 'income' known as Gross Domestic Product (GDP). If we look at GDP in different years then we can obtain some idea about what is happening to economic activity over time. For example, in the UK in the years 1990, 1991, 1993 and 1993 annual GDP growth was respectively, 0.4%, -2.2%, -0.5% and 2.0%. This simple illustration provides an indication of one of the uses of the conventional national accounts. That is, in providing a guide to the economic performance of a country over time: in this case the mixed fortunes of the UK economy in recent years. Furthermore, where some internationally agreed means to measure economic activity exists we can also measure economic performance between countries. Although subject to revisions such an agreed framework is in principle supplied by the United Nations: the System of National Accounts (SNA).

However, these measures of economic activity are limited as indicators of development. Hence, if we are to rely solely on say, GDP per capita to tell us about the standard of living of a nation then we are likely to obtain a misleading picture. Nor will we learn much about the sustainability of present development. While it might legitimately be questioned as to how pervasive concepts such as GDP (and hence the national accounts) are in many aspects of policy making, these limitations are increasingly becoming cited as a cause of concern. One aspect of this concern is articulated in the possibility that a rising level of GDP is perfectly consistent with environmental degradation. This has given rise to calls for '*green accounting*'.

For the most part, the GDP of a particular nation is made up of those transactions that are made in private markets: i.e. purchases of goods for which there exists a market price such as apples and oranges. Thus, adverse environmental change will be indicated by measures such as GDP only insofar as it results in *less* apples and oranges being produced. Yet, many of the services that the environment provides have no observable market and hence no market price. The direct consideration of these services and, in addition consideration of possible decline over time due to environmental degradation is beyond the scope of the accounts as they currently stand. In effect, the possibility that increases in the goods and services for which markets exist can occur *at the expense* of items affecting the standard of living for which there are no markets is ignored. Therefore, our current national accounts yield incomplete measures of welfare because they do not reflect this possible offsetting effect on human well-being.

The aim of this report is to explore the possibility of integrating nature conservation values into national accounting exercises. This can be seen as part of the wider area of environmental accounting. This term can evoke many interpretations and as such there is no single set of activities indicative of this area. Nor is there a unique taxonomy. Yet, at its simplest it could involve two broad activities. The first is to leave the existing national accounts alone but to develop a coherent set of physical indicators and/or physical information in accounting form. Of course, concepts such as GDP would still give their

misleading messages but this could be judged along-side the recorded changes in summary environmental indicators.

Yet this approach falls short of giving us a measure in units that are comparable to GDP. If we are to achieve this we need to find some way to link conventional measures of income with physical indicators of the state of the environment. The requirement is to express any new measure in monetary terms. However, the two approaches - physical and monetary - are clearly linked. For example, an index of air quality is a physical indicator of environmental quality which can tell us, among other things, average ambient air quality between various years. If this physical information can be weighted by some price then we can obtain a monetised value of air quality over time. This means that we have moved to a position where this information can be integrated into our conventional measures of income. Hence, if environmental quality is deteriorating then, other things being equal, this will be reflected in a reduced rate of growth of any adjusted measure.

In making these adjustments, we will have moved away from conventional measures of income (such as GDP) towards what might be better described as *measures of welfare*. We suggest that this more ambitious path is worthy of considerably more exploration. Before we move on, it is necessary to reflect on the status of such measures. Measures of welfare in environmental accounting are still in their infancy. It would be over-ambitious to propose a measure of welfare as a replacement to conventional measures. There are a variety of reasons for this but primarily, there are dangers in replacing a proven system with an indicator with poorly defined uses. It would be far better to see these exercises as complements to (*but consistent with*) the existing set of accounts.

In addition, answering questions concerning sustainable development necessitates that we shift away from the focus on gross measurements (e.g. GDP) to *net* measurements. One such measure emerges from the accounts as they presently stand: that of Net Domestic Product (NDP). NDP is a measure of net income that takes account of the fact that wealth can be liquidated (or 'run-down') in addition to being created. We need to continue this mode of thinking in the move toward environmental accounting. In fact, such reasoning is already in place in the development of resource accounts, defined as accounting for 'commercial' natural resources (e.g. oil, natural gas, timber, fisheries). For the purposes of environmental accounting with its focus on non-marketed environmental sources of welfare, we need to obtain a *net measure of welfare*. The importance of net concepts of both income and welfare is in informing questions regarding *sustainable development*. These questions are inextricably linked to the use of wealth over time.

While sometimes subject to private ownership, many environmental resources are publicly held and are not exchanged in private markets. Nevertheless, environmental resources such as forestry and landscape form part of the total wealth of a country such as the United Kingdom. In the sustainability literature terms such as 'natural capital' are now commonplace. An emphasis on wealth is along these lines, although we can denote natural wealth as '*natural assets*' (as opposed to 'manufactured capital or assets' in the form of machines and buildings and 'human capital or assets' as embodied in knowledge and skills). It is from the use of assets that we can obtain the goods and services from which in turn we derive our income or as we argue more broadly, welfare or well-being. We should also note

that environmental resources are often assets from which are derived *multiple services* over time. As we show, many of these insights can be handled in accounting terms and, as an application, we provide three empirical examples drawn from the literature.

Progress towards environmental accounting has already begun, although much work remains to be done. Much of the theoretical work is relatively abstract while the more practical literature has often restricted its attention to identifying the *costs of environmental protection* (so-called 'defensive expenditures') and/or estimating the *costs of restoring environmental quality* (so-called 'restoration costs'). While we conclude that these adjustments have their place in an environmental accounting framework, this work should aim to go much further. This parallels much of the research within environmental economics where the analysis of environmental change draws on an array of *non-market valuation techniques*. In effect, these techniques can yield the prices with which we need to weight physical data regarding the environment and environmental change. The three case studies that we high-light all provide useful illustrations of the use of these techniques in the context of environmental accounting.

Some green accounting exercises appear to have as their motivation the desire to show that our aggregate welfare is far smaller than that described by GDP. Hence, these exercises proceed to 'lop' off as many costs as possible (e.g. pollution damages etc.). However, using the above framework and drawing from the literature we show that this response is probably not appropriate and sits uneasily with existing accounting conventions. A convincing strand of the literature suggests that a measure of welfare may actually be higher than conventional measures such as GDP. However, this is largely irrelevant as we are not interested in the absolute size of any measure as such. It is the evolution of the chosen aggregate indicator over time that is of crucial importance as an indicator of welfare: e.g. its level relative to those levels prevailing in previous years.

The progress that we identify does not necessarily mean that we are in a position where robust periodic estimates of welfare that adequately capture environmental services could be calculated tomorrow. Many issues concerning both methodology and the systematic valuation of multiple services of the environment are yet to be satisfactorily resolved. Yet, the general direction of some research (including official work) is that progress can be made and it would be extremely interesting to see a reliable measure at least attempted for the United Kingdom. In terms of policy, it is apparent that in the interim, decision-makers will need to rely on a range of environmental indicators.

In summary, it is clear that a promising line of inquiry can be traced out whereby broader aspects of environmental change and nature conservation values could be gradually introduced into either official green accounting or independent research efforts. This draws on economic models of environmental ('green') accounting issues and ultimately the applied valuation techniques in environmental economics. Allied to a physical database, adjustments that are broadly consistent with existing accounting concepts can be derived. This at least provides a general framework whereby the many proposed modifications can be evaluated.

1. Introduction

National accounts record both the value of the flows of *economic* goods and services produced in an economy in an accounting period and the opening and closing balances of the value of stocks of assets. It follows that the same national accounting framework provides the means whereby information with respect to (a) flows of services derived from *environmental* resources and (b) changes in these flows over time, can be arranged and analysed. Furthermore, if this information can be expressed in monetary values it can be linked to the conventional economic magnitudes measured in the accounts. Such measures would serve to increase our understanding of the linkages between environment and economic development and crucially the sustainability of this development. However, the most conspicuous successes in the practical application of modified national accounting have been confined to those resources that pass through markets: i.e. so-called commercial resources. There remains an array of questions relating to the integration of non-marketed environmental resources in national accounts that have been only partially explored. Yet, for national and the global economy it is these questions that characterise much of the environment debate. Clearly, an increasing emphasis on these broader aspects of accounting for environmental resources is desirable. Fortunately, there is a growing theoretical literature that has began to address such concerns. In addition, there are also empirical extensions of these developments.

This paper provides an overview of the state of the art in modified national accounting as it affects the flow of 'nature conservation'. We will define 'nature conservation' widely to encompass non-marketed environmental resources. Obviously, this covers a wide range of resources but some general characteristics can be discerned. These are that the resources are assets in the sense that they provide services that we value over time. If these assets are degraded either through direct or indirect overuse then these services will decline. Hence, our preliminary treatment is general in scope. Specific examples will be illustrated after the main unifying concepts have been introduced. In the main we will concentrate our efforts on the work that has been undertaken towards monetised extensions to conventional accounts. Another view is that monetised environmental accounts are not needed at all. On this argument, the purpose of environmental accounting is to produce environmental indicators and/or *physical* accounts: i.e. physical measures of resource flows and environmental change.

The choice will depend on the inevitable limitations imposed by data. Perhaps more importantly much depends on the *purpose* of modified national accounting. These might be categorised as:

(a) measuring sustainable development.

(b) showing the links between the macroeconomy, the environment and environmental policy.

(c) measuring 'true' economic wellbeing, or welfare, or the 'quality of life'.

(d) measuring the *stock* of capital assets (wealth) and changes in these stocks over time. Capital assets include environmental resources.

It should be noted that objectives (a) to (d) could in principle be met without monetisation. However, they can also be met *with* monetised accounts.

2. What are National Accounts?

The National Income and Product Accounts of individual nations were developed primarily to record economic activity. However, much of the interest in these accounts is the extent to which aggregates such as Gross Domestic Product (GDP) can shed light on the 'standard of living' of a nation's population.[1] It is well established that these records of economic activity are inadequate measures of human welfare or well-being. The degree of error is especially influenced by the extent of non-marketed activity in economies. By and large, the aforementioned emphasis on economic activity has restricted measurement of economic activity to marketed transactions. One significant exception is government provision of goods and services measured in terms of the costs of provision.[2]

It is on this basis of marketed transactions plus such imputations that the standard national accounting identity Gross Domestic Product (GDP) is calculated.[3] GDP is based on the identity that *total income* equals *expenditure*. Total income refers to the income paid to factors of production. Broadly speaking corresponds to labour and owners of manufactured capital, land etc. Expenditure refers to consumption (government and private), gross investment (government and private) and imports and exports. Although different countries maintain different accounting conventions, international comparison is intended to be facilitated within the set of accounting procedures recommended by the United Nations: the System of National Accounts (SNA). These procedures set international standards for the compilation of national accounts and have been subject to continual augmentation and change since the SNA were conceived (Ruggles, 1993). The last such revision being in 1994 (United Nations, 1994a).

It has been argued that the practical requirement for *international* and *temporal* comparison justifies the narrow emphasis of the SNA on marketed transactions. Yet, it can equally be argued that by leaving out important sources of welfare these 'streamlined' comparisons may not be very meaningful (Eisner, 1988). Environmental resources and the benefits that these resources provide constitute one important source of welfare in this sense. We are also interested in the changes in these resources over time. From this we could infer future service flows and the *sustainability* of welfare. At present national accounting aggregates provide some indication of sustainable development in a very narrow sense. Yet, sustainability concerns urge us to look for broader interpretations of welfare and it's future

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[1] Gross Domestic Product (GDP) per capita, for example, is a widely used measure on its own, or as part of a wider 'development index' such as the Human Development Index (UNDP, 1993).

[2] This cost probably represented a lower bound to the true social value of provision. Even here the costs of provision is defined in terms of market prices.

[3] We choose to use GDP in our terms of reference here. Gross National Product (GNP) is defined as GDP plus net factor income earned abroad. The distinction is not crucial.

path. Furthermore, we would envisage environmental feedbacks to have implications for the sustainability of economic activity. Neither the own effect on welfare or this feedback would be indicated by present efforts to infer sustainability of national economies from national accounts.

The desire to inform the sustainability debate is not the only reason to modify national accounts. The established accounts and their associated aggregates are used to guide short to medium term macroeconomic policy. Altering these aggregates to include environmental change risks losing the insights provided by conventional accounts regarding cyclical economic trends. Thus, a criterion for any revision of national accounting guidelines regarding the treatment of the environment is that of consistency with this framework. It can be argued that some of the monetary valuation techniques required to implement a comprehensive environmental accounting process do not satisfy this criterion of integration with the SNA. This possible inconsistency is lessened insofar as the aim of empirical studies is not to alter the core SNA at present but to develop 'satellite accounts'. These accounts are linked to the SNA typically through the Income and Product Accounts or the Input/Output Accounts. An example of a 'satellite account' is the System of Integrated Environmental and Economic Accounting (SEEA) in which physical and monetary environmental data are typically combined. The SEEA is the current United Nations revision of accounting procedures to evaluate environmental aspects of the economy (United Nations, 1994b). The term 'satellite accounts' indicates that the core SNA structure is not changed. The new income aggregates that emerge from the SEEA are *complementary* to the traditional income aggregates. They are not at this stage considered as an *alternative*. Many countries have committed themselves to the goal of 'green' accounting. Indeed this commitment is enshrined in Agenda 21 (UNCED, 1992). It is intended that the SEEA will eventually provide a framework for the international comparison of these national efforts.

3. Resource and Environmental Accounts: Conceptual Differences

While it is important to recognise that the national accounting framework is far more than a means to estimate aggregate measures of income and output, this focus is a useful first step in order to examine the perceived limitations of the national accounts. In theory, what is required is the development of altered national accounting aggregates, or, in the spirit of satellite accounting, the development of additional aggregates. Monetary values could be assigned to environmental variables so that new measures of income, product and wealth are produced. National accounting aggregates expressed in monetary form consist of two components: a quantity weighted by a price. We need to have satisfactory information on both if we are to move on to make *actual* adjustments. Before, this can be undertaken we need to know what it is that we need to adjust. This will be determined by the range of questions that we wish our modified accounts to answer. One obvious question would be how do the services that environmental resources provide affect measures of welfare. A second might then relate to sustainability and ask how is welfare affected when changes in stocks of environmental resources occur.

Many of these questions can be analysed by using economic models which use accounting relationships to derive altered aggregates. This is useful for two reasons. Firstly, these

models show that there is a basis in economic theory for national accounts. Secondly, these models can be extended to consider, in a tractable way, precisely the sort of environmental problems that are of interest here. The concept of *net product* - i.e. gross product less depreciation of assets - is identified by Hamilton *et al.* (1994) as the key linkage between the existing accounts and many of the suggested resource and environmental extensions in the much of the literature. 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. Capital consumption represents the depreciation of assets.

Earlier, we said that conventional GDP is equal to the sum of consumption (C), investment (I) and net trade (exports minus imports). Ignoring the latter this is simply written,

$$GDP = C + I$$

Conventional Net Domestic Product (NDP) is then

$$NDP = C + (I - \delta K)$$

or, $$NDP = C + \dot{K}$$

i.e. $$K = (I - \delta K)$$

where δK is the value of depreciation of the manufactured capital stock. $\dot{K}$ is therefore net investment. The extension of this Hicksian notion to include changes in environmental assets would seem quite logical. Now, of course these insights do not necessarily imply that we are a short step away from making actual adjustments to accounts. There are significant methodological problems in moving from idealised theoretical models to actual measurement. It may be that the ability to answer our questions is eroded when we move to actual measurement. Critics would argue that the economic models from which such insights are derived stand or fall on their assumptions. *Resource and environmental accounts* are potentially extremely diverse, reflecting as they do wide ranging motivations. However, Hamilton *et al.* (1994) use the following definitions.

Resource Accounts: in a sense resource accounting consists of a process of identifying items that are already in the accounts, and reclassifying them under a different heading. For example, this is found in the proposed treatment of nonrenewable resources (such as oil, natural gas, coal and minerals) in the SEEA. Generally, these resources are bought and sold in markets and so the revenues from these transactions are recorded in the national accounts. However, none of this revenue is identified as the value of depletion that reflects the loss of an asset. For example, total rents from resource extraction - i.e the excess of revenue over costs of production - are currently recorded as a combination of excess returns to the owners of manufactured capital and royalties and indirect taxes paid to government (Hamilton, 1993). The reclassification identifies these total rents as resource depletion and subtracts them from GDP as a type of asset depreciation. The new aggregate that emerges is a form of Net Domestic Product.

Environmental accounting deals with a subset of non-marketed transactions, the value of which may not even enter the current national accounts under any heading. Hence, we are

concerned with environmental resources and environmental services that provide sources of welfare that are beyond the scope of the present SNA. It is likely however that the SNA will reflect changes in some environmental assets, and their causes and consequences, indirectly. These indirect effects are numerous (Hamilton *et al.* 1994). For example, they would include: (a) environmental protection and rehabilitation expenditures by businesses, governments and individuals; (b) changing values of economic assets (both positive and negative) resulting from environmental change; (c) costs incurred treating polluted environmental inputs to production; (d) health treatment costs resulting from environmental deterioration; (e) use value of the environment in the form of recreational expenditures (access fees, travel provisions etc.).

One of the main emphases of this paper is that the concept of NDP is still important in environmental accounting. Examining an extended NDP for environmental resources gives us a starting point for thinking in terms of ways forward in environmental accounting both in terms of physical and monetary data requirements. Again, these new measures can be seen as complementary (i.e. satellites) to or substitutes for conventional aggregates. However, measurement difficulties are far more complex relative to the resource accounting approach. This may mean that environmental accounting needs to be given a more flexible definition. This could entail a greater role for environmental indicators and physical accounts. Some of these suggestions are considered in more detail later. For now, we will concentrate on environmental accounting insofar as it relates to monetary valuation. Three broad approaches to environmental accounting can be identified in the literature (Hamilton *et al.* 1994). We briefly summarise these approaches before going on to deal with each in more detail. It should be clear that each imposes different data requirements in ascending order of difficulty:

A[1] those approaches that assume that environmental damages (i.e. the loss of environmental services) can be proxied by expenditures on environmental protection, or, more widely, 'defensive expenditures'. Hence, this approach attempts to identify some of the indirect effects of environmental change listed in (a) to (e) above;

A[2] those approaches that assume that environmental damages can be proxied by cost-based approaches such as the cost of returning an asset to some prespecified state. This state may correspond to either an environmental standard or the environmental state prevailing at the beginning of the accounting period;

A[3] those approaches that attempt to provide extended measures of economic welfare based on a full evaluation of the extent of environmental services and the loss of these services due to adverse environmental change. The array of environmental resources to be appraised is potentially vast and would include for example, biodiversity and carbon cycling. Many of these resources will be global with respect to the nature of the services that they provide.

Approach A[3] is the most complete of the three. Empirical examples of environmental accounts have also included A[1] and A[2]. The first two approaches, particularly A[1], are often used due to the lack of adequate data on the monetary values. Moreover, A[1] does not require physical data, for it merely entails identifying and netting out expenditures contained in the accounts. In principle, all that is required is detailed data on expenditures and an agreed classification of what exactly constitutes 'environmental expenditure'. Hence A[1] is

described here as the least demanding in terms of data. Practical first steps may include establishing ways to measure explicitly the effects of environmental change that currently are only measured indirectly in the SNA (Hamilton *et al.* 1994). Identifying defensive expenditures is one aspect of this.

4. Approaches to Environmental Accounting

4.1 Environmental Defensive Expenditures

Modern economies commit substantial resources to environmental protection expenditures. How are these respective expenditures made by firms, governments and households reflected in current national accounting practices?

(i) when firms make defensive outlays, these expenditures are treated as part of the costs of the firm and hence counted as intermediate demand. As such these expenditures do not enter the firm's final demand and therefore they are not reflected in measures of domestic product;

(ii) governmental defensive outlays are included in final demand, measured at the cost of provision;

(iii) household defensive expenditures are also included in final demand.

Hence, the national accounts indirectly reflect a change in environmental quality (Herfindal and Kneese, 1973) where a portion of output is made up of goods consumed in order to defend against environmental damage (Peskin, 1981). While, these expenditures are relatively easy to identify it is less clear how they might inform environmentally adjusted measures of aggregate product. Two strands can be identified which argue that these expenditures should not form part of measures of domestic product. On one hand it is argued that defensive expenditures by governments and households are part of intermediate production. For example, the treatment of *government* environmental protection expenditure in this way is intended to bring the accounts in line with the treatment of firm's environmental protection outlays (Herfindal and Kneese, 1973)[4]. Intermediate production is made up of those products that are used in the course of producing other products. Another aspect of this argument was introduced by Juster (1973). Juster argued that household defensive outlays do not alter the flow of environmental benefits but merely prevents further deterioration. In other words, environmental expenditures by households do not increase welfare but merely preserve the status quo (e.g. not becoming ill from environmental pollution). If defensive expenditures do not contribute to welfare, then this provides a rationale for excluding such expenditures from measures of a nation's product that are supposed to reflect welfare. Again this can be couched in terms of intermediate product. Household environmental expenditures are not valued in themselves, but are used to defend against a deterioration in final services that are

[4] Herfindal and Kneese suggest that consumer defensive expenditures be deducted as intermediate product but they speculate that these expenditures are likely to be small.

valued. Intermediate production does not contribute to final product and thus is not included in measures of GDP (and therefore NDP).

Treating defensive expenditures along these lines is not without controversy. The most common criticisms are levelled against the rationale for the deduction of household defensive expenditures. Hence, Hamilton (1992) argues that it is a misnomer to suggest that household defensive expenditures do not increase welfare. If this were the case then presumably such expenditures would not be made. Hence, defensive expenditures confer benefits (Proops, 1991). The general direction that this critiques moves towards is that, while Juster's original premise can be accepted, it is the value of the pollution itself that must be deducted from measures of final product (Maler, 1991; Hamilton, 1992). Similar arguments can be used in the presence of government environmental protection expenditure. A slightly different critique is offered by Hamilton (1992) who argues that the value of GDP cannot vary simply as a result of reallocating expenditure items to different sectoral accounts. His example is that if a government waste management activity were privatised and its services sold to producers, then after adjustments to taxes (that finance the expenditure) and prices GDP should be unchanged.

It would appear that what we should be attempting to measure is the social value of pollution. This can be thought of as the value of the change in stocks of environmental resources such as clean air. As such this represents a depreciation charge. In order to make this adjustment we need to know both the physical reduction in the relevant resource stock and the marginal value of pollution. Neither are easily measurable and so it might be argued that defensive expenditures could represent the value of this stock change. Defensive expenditures become a proxy for environmental degradation in this case and should be subtracted from conventional GDP to arrive at an 'environmental version' of NDP. Note that the value of defensive expenditures remains in the definition of final product in contrast to when the expenditure was considered to be intermediate product.

Again, the advantage of this approach is that these outlays are relatively easy to identify and measure. For example, ECOTEC (1993) found that total defensive expenditures in the UK were approximately 2.5% of GDP in 1990. Over half of this total was made up by pollution abatement expenditure. If it is known that *all* damages due to pollution are offset by appropriate defensive expenditures then the sum of these expenditures might be interpreted as a good estimate of pollution damage (Peskin and Peskin, 1978). But it is not clear that defensive expenditures are perfect substitutes for environmental damage. Therefore, the value of environmental damage cannot be assumed to be equal to the value of defensive expenditures. Olson (1977) proposed that the value of defensive expenditures be deducted from GDP along with an amount corresponding to how much consumers are willing to pay to eliminate any remaining disamenities. This approach has also been suggested by Pearce *et al.* (1989). Yet, the critique by Hamilton (1992) that defensive expenditures are welfare augmenting still applies. Defensive expenditures such as pollution abatement might be better thought of as representing investment in environmental resources (Solow, 1993). That is, these expenditures enhance the provision of future environmental services. Yet, deducting defensive expenditures leads to perverse policy signals, where any country could raise its measured welfare level by spending *less* on the environment. It is this kind of message that has led many to advocate the modification of existing accounts and would be a shame if this shortcoming were carried over into environmental accounts. Hence, we still seek some other

way to measure the value of environmental damage.
More importantly, an emphasis on defensive expenditures can only give a partial view of environmental change. It cannot be used to speak of changes in environmental quality in a broad sense (Herfindal and Kneese, 1973). An extreme but obvious example is the changes in environmental benefits when resources such as biodiversity are lost. In fact much of the concern over the need to deduct defensive expenditures can be viewed as a response to a lack of accepted methodology and empirical experience regarding the analysis of environmental damage. It is no accident then that the demand for environmental adjustments to measures of aggregate product based on defensive expenditure occurred most forcefully during the early 1970s. Contemporary views are summed up by Lorentsen (1993) who concludes that while the identification of defensive expenditures is interesting for other analysis, it is not an accounting issue. The United Nations Statistical Office or UNSTAT - the organisation responsible for the both the SNA and SEEA - has reacted in a similar vein recommending that environmental protection expenditure should be identified but not deducted from either GDP and NDP.

4.2 Cost-based Approaches

An alternative approach has been taken up by UNSTAT among others (see Bartelmus *et al.* 1991). This approach assumes that a value of environmental damage can be arrived at by the use of cost-based measures. The basis of valuation is the cost of returning the environmental asset to its state prevailing at the beginning of the accounting period. Note that this assumes that the value of environmental degradation can be approximated by the amount of expenditure that would be necessary to restore environmental quality. This contrasts with the amount *actually* spent during the accounting period: i.e. the defensive expenditure approach described above.

Bartelmus *et al.* (1991) suggest deducting negative changes in, for example, air quality from net product as a type of asset consumption. The monetary value damage of air pollution is therefore the value of the change in the stock of clean air.[5] The Dutch Central Bureau of Statistics (CBS) 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 prevailing at the beginning of a particular accounting period (see Hueting, Bosch and de Boer, 1991). For example, such "sustainability standards" would be consistent with sustainable yields, critical loads, or zero damage, concepts. It has also been proposed that UNSTAT cost-based adjustments could work on the basis of acceptable standards for some assets (Bartelmus *et al.* 1991). However, these are not necessarily equivalent to the sustainability standards advocated by the Dutch CBS.

The actual basis of valuation that UNSTAT takes is that of replacement or 'restoration' cost.

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[5] Others have defined changes in environmental quality in terms of a flow only. Environmental damage in terms of air pollution only has a negative effect on output in the current period - i.e. it has no implications for future air quality and therefore future output of environmental services. Environmental damage is a pure disamenity rather than a depreciation charge.

In the case of soil erosion this involves calculating the amount of fertiliser that is required to offset the decrease in soil fertility that has occurred. The advantage that UNSTAT sees in this approach is that it is consistent with current SNA measurement of manufactured capital depreciation.[6] Yet, such analogies are not always useful. Where there is irreversible loss in running down environmental assets, replacement cost could well be infinite (Grambsch, Michaels and Peskin, 1993; Lange and Duchin, 1993). One additional suggestion has been to value losses in terms of avoidance cost. This would provide an estimate of the costs to polluters from foregoing the activities that would inflict an irreversible loss on society. These notions of 'restoration' cost and 'avoidance' cost have often been confused with rules for strong sustainability as in the 'constant natural capital' rule of Pearce, Markandya and Barbier (1989) and the idea of non-increasing 'environmental debt' (Jernelov, 1992). This interpretation is incorrect as section 7 attempts to show.

The more general concern in the economics literature is the degree to which abatement cost is a good estimate of environmental damage. As with the analysis of defensive expenditures the question is whether the adjustment has any basis in economic theory. Whilst it is well documented that such approaches may not be particularly meaningful in cost-benefit analysis, it would appear that there is some support for the use of abatement costs as a measure of the marginal valuation of pollution damage in national accounting studies. One example proceeds by way of an analogy. Natural assimilative capacity constitutes a valuable economic service, the existence of which means one less unit of pollution to abate at a social cost (Faber and Proops, 1991). If it can be argued that the costs of abatement is an appropriate measure of this service, then similarly, environmental damage might also be measured in this way. This represents the opportunity costs of pollution in terms of the resources that must be forgone in order to restore environmental quality: i.e. the resources that must be substituted for the 'free' services of the environment (Peskin and Peskin, 1978). If the abatement technology does not exist the cost would be measured in terms of the reduction in output consistent with restoration. The former is akin to restoration costs, the latter is akin to avoidance costs.

Hartwick (1990) arrives at a similar conclusion with a more formal model. Pollution is an input into production implying less output for a given level of other production inputs.[7] Production leads to additional pollution, so on and so forth. There is a natural rate of assimilation which can be augmented by pollution abatement control - i.e. the rate of reduction of the stock of pollution is greater the greater the level of control is. One interpretation that can be applied to the expression of the marginal valuation (or 'shadow price') of pollution that 'drops' out of the analysis is that it corresponds to the marginal cost of abatement. In Hartwick (1992, 1993) a specific application of this is given in the shape of a soil erosion problem as a result of agricultural production. Interpreting this adjustment in the same vein as in the general approach, means that the correct value is the marginal cost of restoring the fertility of a unit of land. This gives rise to a new expression for NDP namely,

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[6] Depreciation of manufactured capital is measured at current replacement costs. This total is known as the Capital Consumption Allowance (CCA). This is the same as δK above.

[7] i.e. pollution is a 'bad'.

$$gNDP = C + K - mc_x.\dot{X}$$

where, mc_x is the marginal cost of abating an additional unit of pollution; $\dot{X}$ is change in the stock of the environmental resource ($\dot{X} < 0$ in the case of an increase in pollution). We call this new measure gNDP ('green' NDP).

As Hartwick points out, such results give an economic rationale to the approach of UNSTAT. This conclusion is also arrived at by Hamilton (1994). However, interpreting the restoration cost method on the basis of these conclusions does not appear to be adequate. Hartwick argued that one of the effects of pollution was to depress the level of production. But these effects on marketed output are already reflected in the accounts. For example, a portion of the effects of say, soil degradation will be reflected in lower agricultural output in the current period. To then count the costs of restoration as the value of environmental degradation is double-counting (Harrison, 1993). Environmental degradation is the difference between the value of unobserved output prevailing when there is no degradation and the value of observed output with degradation.

Harrison (1993) argues that a more valid interpretation of restoration cost adjustments is the value of free 'waste disposal services' to polluters. By using this service by disposing a unit of waste today, firms use up the ability to dispose of a unit of waste tomorrow (net of assimilative capacity). Hence, our interpretation of the term $mc_x.\dot{X}$ alters. However, it may be the case that our reinterpretation urges us to think more closely about our concepts of GDP. GDP is intended to include the gross value of output. Hence, it includes the value of deterioration of manufactured capital and the value of the change in nonrenewable resources. Harrison (1989) recognised that this logic extends to the value of changes in environmental resources. Yet, because this value is not actually included in measures of GDP as currently defined then the value of these services should be added to GDP. This gives us the following expression for green GDP (gGDP).

$$gGDP = C + I + mc_x.\dot{X} \quad = \quad GDP + mc_x.\dot{X}$$

Yet, the use of this service implies erosion of the environmental resource. Waste disposal 'uses up' the asset of clean air for example. Therefore, restoration costs have no part in gNDP as the second expression indicates.

and,

$$gNDP = gGDP - \delta K + mc_x.\dot{X} \quad = C + \dot{K} + mc_x.\dot{X} \quad = NDP + mc_x.\dot{X}$$

Note that in this example gNDP = GDP. Most empirical studies such as van Tongeren *et al.* (1993) have subtracted out restoration costs from conventional GDP. Hence, there is no consideration of the non-marketed services that are provided by the environment.
The notion of 'green' GDP is perhaps not the easiest concept to grasp. This is especially the case where its calculation entails adding components to obtain a new gross measure of product *then* immediately subtracting the item to arrive at a new net measure of product. Nevertheless, the concept of gGDP does follow from the logic of national accounting and the two key definitions of product: net and gross (see section 7).

A key valuation issue is identified by Faber and Proops (1991), based on the public good characteristics of many environmental resources. These characteristics mean that consumption of a unit of the good by an individual does not reduce its availability to others. In addition, individuals cannot be excluded from consumption of the good.[8] It is likely that waste disposal services in the case of air and water will be used up faster than in a situation where property rights existed. The level of pollution abatement is unlikely to be *socially* optimal and therefore, we would expect that the observed price of abatement ('restoration') will be *too low*. This creates a problem for analysis because it is the shadow price of abatement that we need in order to make welfare interpretations of measures of NDP. Two responses could be invoked although neither is wholly satisfactory. A heroic stance might be that these actual prices do not differ too much from unobserved true values (Hartwick, 1990). A more practical response could be that short of estimating true 'shadow values' these are the only prices we have (Faber and Proops, 1991). These issues are not easily resolved and go to the heart of the debate over the meaning of adjusted measures of welfare. These issues cannot be ignored and are returned to in section 6.

Waste disposal services are only one aspect of environmental service flows the value of which does not enter the accounts in any way commensurate with their contribution to welfare. For example, the service flow of amenity is not recorded in the conventional accounts. Neither are changes in these service flows which would be considered to be depreciation. A more *thorough and systematic* approach to accounting for environmental resources would have to go beyond restoration cost.

4.3 Measures of Welfare and Environmental Change

If the effects of environmental change are to be fully included into accounting systems then this will require the expansion of concepts such as NDP into a welfare measure (Hamilton *et al.* 1994). Unfortunately, expanding traditional national income measures into welfare measures is not straightforward. While it is certainly not inconceivable to begin to move in this direction, it is far easier to state what it is that we require *in theory* than to actually move to reliable empirical applications. The basic starting point of this approach is the recognition that environmental resources provide a stream of services over time. These are environmental service flows and therefore constitute 'output' akin to the goods and services measured in the SNA. The crucial distinction is of course that environmental service flows are, for the most part, non-marketed. To maintain broad consistency with conventional accounts we require a monetary valuation of the stream of benefits that society derives from the environment. This could then be added to traditional measures of income. Measures of changes in this stream (amenity loss, life support functions), could then be combined with *explicit* measurements of how traditional income alters as a result of environmental change (effects on marketed goods and services). This would provide the linkage that is sought between human welfare and the environment, with monetary values as the numeraire

[8] These criteria are respectively known as non-rivalness in consumption and non-excludability in consumption. In reality, there are many example of goods that are partially non-rival or partially non-excludable.

(Hamilton *et al.* 1994).

Working towards this goal requires the gradual linkage of non-marketed valuation techniques with the traditional market price times quantity imputations that form the core of present national accounting conventions. If we wish to obtain a better picture of welfare based on nature conservation values we must broaden our accounting concepts and hence there appears little other way in which a monetised welfare measure can be obtained. While, it would be a mistaken claim that this is the only route (empirical difficulties are just one reason as to why this is so) seeking expanded measures of welfare is a legitimate pursuit.

It was noted above that there is a long standing recognition that measures of economic welfare such as GDP are poor indicators of total welfare. There are numerous sources of non-marketed welfare of equal (or greater) standing with marketed welfare and for this reason a wide range of social indicators is compiled.[9] In addition, increasing attention is given to indicators regarding the 'state of the environment'. These data are compiled because the environment is perceived to be a source of welfare. This does not mean that we understand precisely what this contribution to welfare is. In this respect it is not 'welfare itself' that we attempt to measure, it is in Eisner's (1988) words 'the penultimate ingredients of welfare'. We are interested in measuring the value of the provision of marketed and non-marketed output to individuals in society and net additions to the capital stock relevant to future output.

Economic Theory and the Treatment of Environmental Services

In section 3, we discussed an adjustment to NDP where pollution was an input to production. By adding an additional argument into the production function - describing the way in which inputs are transformed in outputs in production - and resolving the problem the adjustment is obtained. The same principle applies for analysing the effects of changes in environmental services on individuals or households. An additional argument is introduced into the utility function of individuals. Previously, welfare or utility has been assumed to depend only on consumption of produced goods and services so that, $U = U(C)$, where U is utility and C is consumption. The expression then says that utility depends on the level of consumption. Environmental services affect utility directly, so that the utility function can be written, $U = U(C, X)$, where X are environmental services. Hence, services such as environmental amenity increase utility. Conversely, losing these services because of pollution will decrease utility or welfare.

The exact nature of the adjustment that is derived from this depends on the particular stance taken on a number of issues. One of the foremost of these is that we have to decide whether or not it is the level of environmental services that affects welfare or changes in environmental services. Hartwick (1990) argues that it is changes in the level of pollution - i.e. increases or decreases in the pollution stock - that impinges on welfare. This is justified by Hartwick on the basis that it does not make sense to include an environmental variable in the utility function if it is unchanging. On this basis, it is the *change in the pollution flow*

[9] Examples are indicators of literacy, schooling, infant mortality, life expectancy. The UNDP has experimented with several others such as political freedom and gender equality (UNDP 1992, 1993).

that occurs in the accounting period that enters the utility function in which case U = U(C, $\dot{X}$). The shadow price is the value of pollution increments to individuals (or households). In turn this could be related to the willingness-to-pay of individuals for a reduction in pollution by one unit. To reiterate, a new NDP expression proposed by Hartwick involves the estimation of the value of the rate of change in environmental quality along side conventional NDP. Here we have,

$$gNDP = C + \dot{K} + (p_X + mc_X).\dot{X}$$

where p_X is willingness-to-pay of individuals for a reduction in pollution by one unit. We also include the effect of the loss of waste disposal services discussed section 4.2. Note that the two effects are additive. Obviously, NDP > gNDP indicates that there have been decreases in environmental quality in the accounting period (and vice versa for improvements in the environment). It also indicates that conventional NDP can tend to overstate 'true' income. The question is how best to approximate changes in the flow of environmental benefits. Such values will approximate changes in stocks of environmental resources.

In contrast, Hamilton (1994) considers both the level of environmental services as well as their rates of change over the accounting period. The flow of environmental services enters the utility function: U = U(C, X). (This is slightly different to Hartwick's function which is for the change in the flow of environmental services.) Solving the problem yields a measure of gNDP (although Hamilton calls it a measure of economic welfare (MEW)) that includes two new terms. One denotes the change in the level of environmental services ($\dot{X}$), the second denotes the level of environmental services.

$$gNDP = C + K + p_X.X + (p_X + mc_X).\dot{X}$$

The shadow price is again the unit price that utility maximising consumers are willing-to-pay for a marginal unit of environmental service (p_X). Multiplication gives the sum of monetised sum of environmental services and the change in environmental services which is then added to conventionally measured welfare (C + $\dot{K}$). The term (X + $\dot{X}$) is the net level of environmental services.

5. Towards Actual Environmental Accounts

Economic models offer insights into the adjustments required to national accounting systems in order to consider environmental resources. We wish to consider environmental resources as assets and to consider the service flows that these assets provide. In accounting terms, these findings can be analysed in terms of the implications for the definitions of *asset boundaries* and *production boundaries*.

Asset Boundaries

An asset boundary contains 'real' assets that are given a value in the balance sheets of an economy (Prince and Gordon, 1994). In the SNA these assets would consist of manufactured

(or 'fixed') capital and financial assets. Harrison (1993) defines an asset as "a stock of wealth over which ownership can be established and that may be the subject of an SNA transaction in the future". In the UN SEEA non-renewable resources would also be within the asset boundary. Hence, the value of stocks of non-renewable resources at the beginning and at the end of the accounting period are imputed. The value of the change in the stock of non-renewable resources corresponds to the depreciation of the resource. These natural assets are a subset of the commercial resources previously discussed.

The asset boundary could be extended to environmental resources. However, special conventions may need to be adopted before environmental assets can be defined in this way. Thus, Harrison offers a second more general definition that keeps the emphasis on ownership rights but where these rights can be enforced institutionally, individually or collectively and confers *economic benefits* to 'owners' over time. However, assigning a value to stocks of environmental resources is often not feasible. Typically, we would not think to measure a stock of clean air or clean water. It is the physical dimension of the problem that is the obstacle here. This could also apply to other environmental resources suggested for included as assets such as 'non-commercial' biological resources. However, this is not an obstacle that need preoccupy us because another important aspect to extending the asset boundary is to recognise that some assets can depreciate. Assets that can depreciate either through use or accidental loss are termed 'fixed capital' in the accounts (Prince and Gordon, 1994). Clearly, it is possible to measure changes in air quality, as opposed to actual "stocks".

Production Boundaries

The production boundary on the other hand, contains information on the flows of those goods and services that are considered as either intermediate or final product. Intermediate products are those goods that are used in the production of other goods and services whereas final products are produced for their own sake. Only those goods that are considered to constitute final product contribute toward GDP. This distinction was discussed in the context of defensive expenditures. The goods and services derived from nature which are provided as final services should be included in definitions of final product and hence contribute to a new definition of GDP. Along similar lines, it might argued that nature is a productive sector. The nature sector provides final output to households.

The UN SEEA can be viewed as an attempt to change the asset boundary rather than the production boundary. Hence, measures of GDP remain unchanged while measures of NDP are usually adjusted downwards due to the depreciation of natural assets. For an organisation such as English Nature, two main adjustments to the accounts might be focused on that have an emphasis on nature conservation values. We firstly need to define an asset. Secondly, we need to think about the flows of final services that are derived from this asset. We consider two such examples. The first, where forests are the asset and the second where land is the asset.

An example: the forestry sector

A national economy is made up of many sectors. One of these is the forestry sector. How would the activities of this sector be reflected in national accounts as they presently stand if forests are defined as an asset? These activities can be defined as contributing to a gross

product for the sector. Conventionally defined sector product will in part be made up of timber income (rents). Measures of net product in this sector would also contain these rents. But we have defined the forest as an asset and so running down this asset is akin to depreciation. More specifically it is the trees that are the asset. The 'standard approach' to estimating the value this depreciation of forestry or trees is to estimate the rental component of timber revenue and treat this as depreciation (for example Repetto *et al.* 1989; Soloranza *et al.* 1991; Cruz and Repetto, 1992; van Tongeren *et al.* 1993). The asset is valued in the balance sheets in terms of its ability to generate future timber rents.

But forestry provides non-marketed benefits that are ignored under this approach. It is useful to briefly list some of these benefits. This list is not intended to be exhaustive. It does however, provide an indication of the additional breadth of services that would need to be considered in an environmental account for the 'timber' sector. Forestry provides recreation, habitat for flora and fauna (biodiversity), carbon fixing and storage and flood protection. In order to assess the nature conservation values of forests we need to expand the production boundary to consider the aforementioned non-marketed services. This in turn changes the set of services by which the asset is valued. Thus, the forest asset should now also be valued in terms of its ability to generate future recreational services. Clearly, 'mining' the forest for timber or for other reasons might mean a reduction in these non-marketed services. Hence, the forest asset as a generate future recreational services can depreciate. This also holds for the forest as a generator of habitat services, carbon fixing etc.

An example: the land-using sector

The above example would clearly build on the approaches taken by, say, the World Resources Institute and UNSTAT whereby the asset boundary is extended to consider 'trees'. In contrast, Hartwick (1993) has suggest that the asset that we should be valuing is land and not trees as such. We might then refer to forested land rather than the forest itself. This is appealing as it gives us the opportunity to talk in terms of one overarching asset but also an asset that is connected with many different uses. Different land uses will be associated with different asset values: i.e. different land uses will be associated with different levels of marketed and non-marketed environmental services. For example, we might expect a unit of forested land to provide a greater level of carbon fixing services than a unit of agricultural land (Brown, 1992). Hence, shifting land-uses will be associated with depreciation or appreciation of land assets. In principle, this depreciation could be calculated by estimating the capitalised value of the environmental services lost when land use is switched. This must be balanced by the additional marketed output that is gained when say, land is switched to agricultural use. These marketed values will of course be captured in the conventional accounts. Hartwick also notes that land prices will change when land uses are switched. This represents either a capital gain or a capital loss. Capital gains are not normally included in the flow accounts although the inclusion of these price changes in measures of income has been proposed by Eisner (1989). Whether it is appropriate to include price changes in measures of *sustainable* income is disputed (Scott, 1990).

5.1 Empirical Examples of Environmental Accounts

To date few empirical studies relating to 'nature conservation' values in environmental accounts have been undertaken. Most studies that have emerged can be more appropriately

be classified under the heading of 'resource accounting' or, represent environmental accounting insofar as it relates to the concept of restoration cost. The existence of non-marketed environmental services from land in forestry is usually recognised, yet no calculations are undertaken and then integrated into the new measures of final product. Hence, it is not possible for example to evaluate adequately Anielski's (1992) conclusion that the value of forests as a standing stock of timber are small in comparison to the present value of non-marketed benefits of forests.

However, several empirical studies do exist. Understandably, to make the studies possible, the unit of analysis has been confined to the specific sectors: e.g. land-using and forestry sectors. However, as these sectors are of strategic importance in the provision of environmental services they do illustrate the magnitude of these services relative to those marketed goods and services provided by these sectors that are included in the conventional accounts. We highlight three studies here. The first two are of interest in that they provide respective examples of the two approaches discussed above, namely whether our relevant asset is 'trees' or 'land' (Hartwick, 1993). The third study is emphasised because it attempts to relate changes in environmental services over time to changes in the value of an environmental asset in the balance sheet of the accounts. All three studies are of interest in their use of non-marketed valuation techniques in order to arrive at environmentally revised measures of income.

(a) Re-evaluating Measures of Product when Forests are an Asset

Forest Resources in Sweden

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

(a) an imputation for the value of the net change in the growing stock of timber which are referred to as direct forest values. This is a stock adjustment - i.e. the value of the change in the forest stock measured by timber rents. This was referred to above as the standard approach to accounting for forests. Hultkrantz finds that the stock of trees in Sweden is growing and hence augments the accounts with the value of this growing stock. The conventional accounts make no corresponding imputation in the measures of product for rates of growth over rates of cutting.

(b) additional stock adjustments for the value of the change in stocks of environmental resources. These stocks are biodiversity, carbon sinks, exchangeable cations in soil (i.e. acidification) and lichen stocks (providing the service of reindeer forage):

(c) the value of (sustainable) activities such as berry and mushroom picking, meat from hunting game.[10] These are service flows from the forest.

Table 1 indicates that there has been 'depreciation' in the stock of diversity of flora and

[10] Hultkrantz does not make it clear whether such values are already included in Swedish measures of national income or whether harvesting is non-marketed.

fauna living in Sweden's forest habitats.[11] There is no one accepted methodology to value this change and Hultkrantz proposes two possibilities. The value of depreciation in parentheses is based on a CVM study by Johansson (1989). That study derived a WTP for the protection of 300 endangered species in Sweden that when aggregated over the Swedish population gives a value of some of 3.6 million SEK per year. In a sense, what is being defined is a non-use value. The entire Swedish population is implied to hold a value for the existence of biodiversity as defined by the current number of species. Hultkrantz argues that a more appropriate measure of depreciation is the opportunity cost of biodiversity preservation. This is defined as the timber rents that must be foregone in order to ensure a 'reasonable' level of protection for biodiversity. These rents will be foregone because preservation entails the setting aside of additional protected land. It is estimated that maintaining adequate habitat requires the 10% protection of total forested area as a *minimum* target. Currently, an estimated 5% of forested land in Sweden is protected and so to meet the 10% target, an additional 5% of forested area is in need of protection. Hultkrantz translates this into an increase in annual protection costs of 5% of annual timber income. Annual timber income (rents) are 12.15 billion SEK so the opportunity cost of biodiversity preservation is 600 million SEK is arrived at (i.e. 12.15 billion SEK multiplied by 0.05). This is somewhat higher than the estimate shown in parenthesis based on CVM. As Hultkrantz notes, this is interesting for it tentatively indicates that the 10% target is not supported by the total WTP of the Swedish population.

Forests provide a valuable service by sequestering CO_2 in the atmosphere. Variations in the carbon inventory can be related to changes in the stock of trees. If the stock of forests is decreasing then the value of this service is decreasing. This would represent depreciation. Conversely, an increase in the forest stock represents an appreciation of this service. The latter is relevant to the Swedish case due to the growing stock of trees. The corresponding increase in the carbon inventory is estimated to be 7.3 million tons. The next step is to find an unit price to weight this quantity by. As for Hultkrantz's biodiversity imputation, two alternative valuations are proposed. The first interprets Swedish effluent fees on carbon dioxide emissions - (0.92 SEK per kg of carbon) - as the (politically determined) shadow price of emissions. The value of the change in the carbon stock increment is shown in parentheses to be 6.7 billion SEK. Hultkrantz again opts for valuation in terms of the opportunity cost of carbon storage and so again this is driven by the value the timber income foregone. In practice this amounts to counting the value of the growing stock of timber twice: i.e. 3.8 billion SEK.

Depreciation of soils due to acidification is estimated on the basis of replacement cost - i.e. the cost of liming one hectare of forest land from the air (e.g. from an aircraft) with three tons of lime and magnesium multiplied across all soils acidified. This is similar to the type of adjustment proposed by UNSTAT. For the value of lichen stock changes the opportunity cost approach is advocated. This is the cost of foddering reindeer with hay. The physical data required for this are the growth of lichen stocks and the required forage per reindeer. Of course, the forest asset provides many other services not considered in this study due to data problems. For example, the valuable function of flood protection is not included although Hultkrantz feels that this value is intertwined with biodiversity and soil quality elsewhere in

[11] According to Hultkrantz, biodiversity in Sweden has a relatively low base due to periodical ice covers.

the accounts. Furthermore, this study only looks at changes in stocks rather than the level of service flows. Our next highlighted study contains a mixture of both calculations.

(b) Land-use Accounts in the United Kingdom

Adger and Whitby (1993) estimate the value of environmental services in the land-using sector in the UK. The land-using sector is made up of agricultural land, Forestry Commission land and land under conservation designations (Sites of Special Scientific Interest etc.). The stated aim of the exercise is to provide an indication of the relative contribution of this sector to welfare insofar as it relates to environmental services. This includes the value of marketed output such as agricultural production.[12] The concept of sector output is enlarged by the consideration of non-marketed services of the land-using sector.

Table 2 indicates that Adger and Whitby's adjusted Net Product is about 25% *greater* than conventional Net Product. This is mainly due to a large positive value for environmental service flows. The largest single adjustment is amenity value associated with landscape, wildlife and recreational benefits on public designated areas. These are positive externalities the value of which will only partially be recorded in conventional accounts.
Existing valuation studies are used to infer a total amenity value of £888 million in 1988. (Hultkrantz found that imputing a similar value was not possible in the Swedish context.) The adjusted accounts are augmented by this amount. This provides some indication of the potential losses where assets in the form of public designated areas are run down. In other words, policies that degrade the countryside are likely to have larger welfare impacts than will be apparent by looking at the conventional accounts. That is, by looking at the magnitude of the level of service flows this can be inferred. There is no corresponding measure of depreciation based on whether or not this asset value had been depreciating. Government defensive expenditures are treated as intermediate production and hence deducted from the income measure for reasons discussed in section 4.1.[13]

Other changes to the accounts are for changes in environmental resources. The use of nitrogen in UK agriculture has led to pollution of water resources. Hanley (1989) used a CVM study to estimate the benefits of the abatement of agricultural nitrate pollution in terms of cleaner drinking water in the Anglian Water Authority. Using Hanley's estimated WTP per household of £13 for improved water quality, the *aggregate* annual benefit of the improvement of water quality of £10.8 million. This sum is imputed as a depreciation charge to represent the deterioration of drinking water quality.

As also emphasised in Hultkrantz (1992) carbon fixing services are provided by forestry

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[12] In this respect the interpretation of welfare is important. Prices of agricultural output will be distorted by the effects of the Common Agricultural Policy. Price support drives a wedge between the marginal value of output and observed output prices. It is the former that should command our interest in any assessment of welfare provided by the sector.

[13] 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 expenditures 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.

resources but also emphasised here by commercial plants in the agricultural sector. Anderson (1989) estimates the social cost of carbon to be £31 per tonne. This price can be combined with an estimate of net carbon emissions of -4.75 million tonnes in the sector (Adger *et al.* 1991). The total value of this carbon *credit* is £146.2 million. This is classified as an increase in the value of assets (i.e. akin to an investment). Hartwick (1993) points out that a more appropriate classification of this item would be that it is a service flow of the environment. The adjustment would then appear along side the amenity value of designated public areas. Hultkrantz also presented his adjustment in terms of a stock change. The difference is that there, the forest asset as a source of carbon fixing services was increasing due to the growing stock of trees. The carbon inventory reported by Adger and Whitby presents the carbon balance for one year only. It does not indicate whether the carbon balance has been increasing over the accounting period. Hartwick notes that the positive carbon balance does tell us that this service (however classified) led to less polluted air by reducing atmospheric CO_2 concentrations. If the asset in question is 'air', rather than land, and the value of this asset is changing over the accounting period then this imputation might be thought of as a type of stock change.

(c) Environmental Accounting for Chesapeake Bay in the United States

Grambsch, Michaels and Peskin (henceforth GMP) (1993) have undertaken an environmental account case study for the Chesapeake Bay region in the United States. This is the most comprehensive of the case studies we examine in this paper for the reason that the project was supported by the US Environmental Protection Agency (EPA). The concept of final product is applied to the region under consideration. Adjustments to this product are in terms of the services derived from a previously undefined nature sector. The methodology used is that of Peskin (1976; 1981; 1989). The adjustments emphasised in this framework are the benefits of the current flow of environmental services rather than the rate of change in these flows. However, in contrast to the two previous case studies, GMP (1993) present asset values based on the present value of these services. This allows a judgment to be made as to whether the asset in question has depreciated or appreciated in value between the years 1982 and 1985.

The asset is Chesapeake Bay itself: i.e. land. The values are therefore in terms of the Bay as a generator of different services. Final services (non-marketed service flows) were valued using contingent valuation and travel cost surveys. Waste disposal services were valued at the costs of pollution control and the costs of environmental damages were valued using estimates of EPA policy benefits. Grambsch, Michaels and Peskin have urged that their results be treated with some caution. The bay is a generator of final services. These services are extremely varied and relate to direct use values such as recreational activities which include beach use, fishing, hunting, and wildlife observation etc. This asset value shows an appreciation of $112.3 million. Waste disposal generator asset values decreased by 37.8 million due to pollution control regulations. Due to the appreciation of final demand services, the value of total asset services still increased. However, the final asset value is the Bay as a generator of Net Environmental Benefit (NEB). This declined by $235.7 million due to increases in environmental damage over the period. How does this tally with the observation of increasing final services. GMP (1993) suggest that more people received the services of the bay and unit values for recreation were held constant in the analysis, even though environmental quality was declining.

6. Non-marketed Valuation in the National Accounts

It seems clear that if either, the services of environmental resources ('outputs' of the environment) or, changes in these services (depreciation) are to be included in the accounts then the use of non-marketed valuation techniques will be a crucial link between physical data and extended measures of welfare. At present, valuation in the national accounts consists simply of the quantity transacted times a market price. There are of course precedents for the inclusion of other imputations. We have drawn attention to the long-standing imputation based on the cost of providing government services times the quantity of services provided. Imputations also exist for estimating the deterioration of manufactured capital based on current replacement costs. In this case, we do not 'observe' the units of capital that are used up, and hence this has to be inferred in some other way. The estimation of rents for commercial resources can also be seen as an imputation of sorts, namely the market price of the resource minus the costs of extraction (see, for example, Hartwick 1990 and Repetto *et al.* 1989). The valuation of environmental degradation is also imputed on the basis of restoration costs or avoidance costs. Hence, imputations in the accounts are not new. The important but perhaps obvious point is that these imputations must approximate what it is that we want to measure. In particular, if we want to infer the welfare implications of economic activity then the prices imputed must reflect marginal valuations of the services involved. The same must be true of imputations based on non-marketed valuation techniques for environmental services. (Table 4 compares the various valuation techniques drawn on in Adger and Whitby, 1993 and Hultkrantz, 1992.)

As Hamilton *et al.* (1994) and others have pointed out, some comfort can be drawn from the progress made with respect to valuation in environmental economics. Cropper and Oates (1992) provide a detailed assessment of this progress both in indirect market valuation (e.g. travel cost and hedonic price methods) and direct market valuation methods (e.g contingent valuation and stated preference methods). It has been argued that the values that are derived using these techniques are incompatible to the market price based valuations of the national accounts and that this precludes the integration of the two (Hueting, 1989; Bryant and Cook, 1992). This argument is hard to sustain. Both are supposed to be marginal valuations of goods and services.[14] Moreover, if the argument were true this would eliminate any analysis that attempted to compare non-market and market valuations. In contrast, cost-benefit analysis has a long tradition within environmental economics based precisely on this premise. There seems little reason to suppose that national accounts are any different.

A slightly different critique is offered by Harrison (1993) who also argues that the non-existence of markets for environmental assets precludes their integration in national accounts. For example, recreational value is equal to the price paid for it. If this is zero, the argument goes, then the value entered in the accounts should be zero. Insofar, as access fees are paid then this represents the value of the recreational activity. Such fees are currently entered in the SNAs but we might also argue that the costs of travel to the recreational site are not identified. Indirect valuation techniques such as the hedonic price method are based on the

[14] In reality, market prices would be expected to diverge from true marginal valuations due to market imperfections etc.

premise that the value of environmental services is indirectly related to a market transaction. Hence, these techniques might be used to assess the extent of environmental values that are indirectly reflected in the accounts. More importantly, the Harrison critique ignores much of the developments made in environmental valuation. It would appear that Harrison is not arguing that environmental assets are worthless but "that there is no frame of reference available that is consistent with the rest of the accounts and would allow a monetary figure to be devised". But within environmental economics we would argue that this frame of reference is provided by non-market valuation techniques and in particular, the contingent valuation method (CVM).

The contingent valuation method offers a way to evaluate environmental services in terms that we can readily understand and compare to other monetary values. This method is often employed where there is no market for a particular good or service and in addition where there is little interaction with marketed transactions. Hence, respondents to CVM questionnaires are asked to value goods and services *as if* there was a market in which transactions could be facilitated. In fact, the suggestion of the possible use of these sample surveys in national accounts is not new (Usher, 1980). Furthermore this suggestion is tacitly accepted in The UN Handbook (1994) which states that CVM could be used in an extension of the SEEA. Thus, it can be argued that the broad principle of including non-market valuation methods beyond those associated with avoidance or restoration costs is established. However, at this stage UNSTAT advocates the use of CVM surveys for "ad hoc modelling and research than for routine data collection" (Bartelmus, 1993). The chief problem relates to actual application where data is at present very limited and to the methodological and empirical problems present in these studies.

On the latter point, many critiques of CVM have been offered (see, for example, Bateman and Turner, 1992). For example, considerable attention has been directed towards the existence of repeated large discrepancies between willingness-to-pay and willingness-to-accept measures of welfare (Knetsch, 1989). Individuals appear to value losses significantly more than they value gains of similar magnitudes. This could present difficulties for interpretation in national accounting aggregates relying as they do on an assumption of linearity. The empirical examples discussed in section 5.1 illustrate the use of CVM results in environmental accounting. However, a word of caution is required regarding the interpretation of the depreciation charge. In Adger and Whitby the value of water pollution was estimated using a household WTP estimate derived from a CVM study. This is then multiplied across all households affected by poor drinking water quality. But we are used to thinking about depreciation in terms of a reduction in water quality. Nowhere is it suggested that water quality actually declined over the accounting period (although this may have been the case). The adjustments suggested in section 5.1 indicate that the relevant depreciation charge is the rate of change in water quality ('units' of water degraded such as represented in an index of water quality) multiplied by the willingness-to-pay for a 'unit' of improved water quality. Alternatively, Adger and Whitby's adjustment can be seen as defining an environmental standard in terms of acceptable drinking water quality. The same comments apply to Hultkrantz's use of Johansson's CVM study on biodiversity preservation.

The existence of limited data with which to evaluate the integration of CVM estimates in environmental accounting exercises is also problematic. Hamilton (1994) noted that the level of non-marketed environmental services be included in extended measures of welfare.

However, it would appear in practice that this data requirement will be hard to satisfy. For example, the UN Handbook envisages that CVM techniques could be used to evaluate changes in environmental services rather than the level of the services themselves. It is the former that is the least demanding. Hartwick (1990) offers some theoretical support for this approach. As noted above, Adger and Whitby (1993) do provide a measure of the level of service flows in the estimation of an imputation for amenity benefits. However, no corresponding imputation was offered for changes in these flows over the accounting period.

Furthermore, while numerous CVM studies do exist, it is important to recognise the variable reliability of each. It is clear that a credible application of this technique to yield reliable results for national accounting purposes will be a huge task, demanding many resources. Section 4.3 showed a general framework for aggregate product when there are environmental resources. This was seen to be a workable concept in terms of the definitions of asset and production boundaries in the national accounts themselves and empirical examples of sectoral accounts. There are less grounds for optimism if what we are discussing is non-market valuation applied to the *environment as a whole*. There are also important theoretical concerns with a measure of income produced on this basis. Hultkrantz (1992) notes that adding estimates of willingness-to-pay for non-priced environmental services does not give a correct measure of national product if these services *were* correctly priced. These prices would change the allocations within the non-environmental sector, within the environmental sector and between the two sectors. Hence 'true' national product might look very different to an expanded national product figure. While estimates of a comprehensive 'green' measure of welfare are absent, there is a long tradition of expanded measures of welfare based on additions of imputed values of other non-marketed services, particularly in the US (Nordhaus and Tobin, 1973; Eisner, 1989). If we can get over these theoretical conumdrums then we need to ask at what intervals a measure of welfare could be determined. We are interested not in the level of a new accounting aggregate in any one year but its changes over time. This in itself generates large data requirements. Hence, it is fairly clear that this measure could not be calculated on a monthly, quarterly basis or even annual basis as can most key economic and national accounts data. As Juster (1973) notes, this shortfall is probably overstated. Environmentally adjusted measures are usually relevant to questions regarding the long-term evolution of welfare and sustainable development. Assessing these changes does not need to occur on anything less than a yearly basis. It may be that even longer intervals could be conceived of.

Preliminary environmental accounting studies might, given finite resources, profitably use the concept of '*benefits transfer*'. Limited available data makes an appraisal of this concept a key issue in the possible extension of environmental accounting. 'Benefits transfer' refers to the extent to which a benefits estimate at one site can be transferred to another site. Alternatively, information could be obtained from several studies and suitably summarised and transferred to a new site and differing conditions at the new site could be taken into account (OECD, 1994). While it may at first appear that this process has a key role in environmental accounting, its actual application is not without difficulties. In particular, problems are potentially serious with respect to the process of aggregation of transferred benefit estimates (Adger and Whitby, 1993). This exercise may contain biases, the magnitude of which will depend on the degree of substitutability or complementarity between, say, different designated areas providing service flows such as recreation. For example, if these areas are *substitutes*, then estimated aggregate marginal valuations will be too high relative

to its 'true' levels. There is in addition a real danger of double-counting when arises the value of recreation has already been attributed to another sector (say, tourism) (Clough, 1991). The extent of this problem will be determined by how *externalised* the environmental service is. In other words, the degree to which demand for the non-marketed service is reflected in marketed transactions.

It is apparent the search for a monetised estimate of welfare is not a small undertaking and requires much development, refinement and data collection and collation. A general alternative approach is to go for 'quick and dirty' monetised measures of welfare that have little basis in economic theory. This might be interpreted as a practical response to limited data and the need to answer pressing concerns. One such exercise is by Jackson and Marks (1994). Theirs is an 'index of sustainable economic welfare' (ISEW) for the United Kingdom from 1950 to 1990. The ISEW takes personal consumption expenditures and adds or subtracts various components as it is felt appropriate. The ISEW has some twenty components of which nearly half could come under the heading 'environmental adjustments'. For example, the value of the loss of wetlands services is estimated at an arbitrary price of £1000 per acre of wetland times acres lost.[15] An imputation for the social cost of long-term environmental damage relies on an assumption drawn from Daly and Cobb (1989): $0.50 to each barrel of oil equivalent of non-renewable resources consumed. Similarly, an estimate of the globalised costs of ozone depletion is based on an estimate drawn from Cobb and Cobb (1994) yet no explanation is given for this figure (of £26 per kilogram of CFC-11 and CFC-12). The latter two adjustments alone largely contribute to Jackson and Marks' finding that their per capita index of welfare was only 3.2% higher in 1990 than in 1950. This gives a per annum growth rate of 0.1% (compared to a per annum growth rate of 2.1% for GNP over the same period). A full discussion of Jackson and Marks' study is not possible here. But some preliminary comments are needed because some of their monetised adjustments do come under the heading of environmental change and nature conservation values. The authors argue that the need to make to adjustments now should run ahead of the ability to make such changes. However, while it can be argued that there is a rationale for each suggested adjustment, one is left with the distinct impression that some of the numbers have simply been 'plucked from the air'. What is more, it is these numbers that drive the more strong conclusions of the work. Clearly, a better balance must be struck between the desire to provide adjusted monetised indicators and the ability to provide reliable estimates on something other than arbitrary guesstimates. A measure which is lacking in a sensible interpretation provides few insights. The use of short-cut methods whilst providing preliminary insights into the estimation of environmental changes needs particular scrutiny and treated with some caution. This is apparent when we recognise that the presentation of a single number and its development over time attracts much publicity.[16]

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[15] This is a 'conservative' estimate based on a range of estimates summarised in Pearce (1993).

[16] See for example, "Quality of Life 'has fallen since 70s'", *The Guardian*, Monday 16th May 1994.

7. Sustainability Indicators Using Environmental Accounting

It is evident that extending measures of national income might give us estimates of gNDP or gGDP *in excess* of those associated with conventional measures of product. This may seem strange for much of the impetus for resource and environmental accounting has drawn on the idea that current measures of domestic product overstate 'true' domestic product. The object of some studies was to address this disparity by making suitable downward revisions to conventional measures to reflect the use of non-renewable resources and environmental degradation. It will be true that if an economy is relying heavily on the (domestic) extraction non-renewable resources then its NDP adjusted for the resource depletion will be lower than conventional NDP which is unadjusted for this depletion. However, this will not necessarily be the case for environmental resources if we are including goods and services in measures of NDP - namely environmental services - that were not previously measured in the national accounts. This new measure of product will by definition be higher than its conventionally measured counterpart. The size of this difference is obviously determined by the importance of environmental services that are considered.

We can indicate these differences with a simple numerical example. We begin by defining five different expressions of domestic product. The first two expressions are the familiar GDP and NDP measures. The third expression - 'green' GDP - is conventionally defined GDP plus some measure of the value of environmental services (ES).[17] ES is a sum of non-marketed environmental services estimated by CVM. The inclusion of ES in gGDP means that we have extended the production boundary. The corresponding gNDP nets out both the depreciation of manufactured capital and the change in the level of environmental services. Lastly, UNSTAT gNDP simply subtracts this change from conventional NDP (i.e. does not augment conventional GDP).

$$GDP = C + I$$

$$NDP = GDP - \delta K$$

$$gGDP = GDP + ES$$

$$gNDP = GDP - \delta K + ES + \dot{ES} = NDP + ES + \dot{ES}$$

$$UNSTAT\ gNDP = NDP + \dot{ES}$$

Assume that $C = 75$; $I = 25$; $\delta K = 10$; $ES = 15$; $\dot{ES} = -3$

[17] Such that it can be thought of as $p_X.X$, where p_X and X are respectively vector of shadow prices and environmental services.

Figure 1.

	Conv. NDP	UNSTAT gNDP	gGDP	gNDP
100	90	87	115	102

A range of values are obtained in figure 1 and we can legitimately ask what is their respective interpretation and in what sense do they relate to each other. Firstly, these values are generated in the same accounting period so it would be incorrect to suggest that domestic product has 'grown' because of the difference between GDP and gGDP. The discrepancy is due to the expansion of the production boundary. This means that we are measuring in our concept of domestic product, sources of welfare that were previously excluded from this quantification. As it is well known that GDP is a narrow measure of welfare, it is hardly surprising that this measure expands when we consider additional sources of welfare such as the environment. In effect, GDP and gGDP are measuring very different things. GDP those items that are counted as income in the traditional sense, while gGDP includes those items that contribute to a wider definition of welfare.

gGDP gives us a new base measure from which we make our adjustments for the depreciation of assets. Hence, a comparison between gGDP and gNDP is a valid one. The fact that both gGDP and gNDP are larger than GDP and hence NDP is not a measure of sustainability, it is only an indication of the effects of the inclusion or exclusion of non-marketed sources of welfare. Furthermore only if all environmental services were lost in the accounting period would we find that gNDP = NDP. These are similar findings to the empirical application by Adger and Whitby (1993). The difference is that there no consideration of a new base measure of green GDP is made. If this were the case then the results would be those shown in Table 5 Finally, the UNSTAT version of gNDP as derived from the SEEA does not consider gGDP and in addition, only changes in ES are accounted for. What we should be more interested in is changes in gGDP and changes in gNDP over time rather the differences between say GDP and gGDP. If an accepted means to undertake environmental accounting can be found then we could also make comparisons of gNDP between countries. If we are interested in sustainable development then whether or not gNDP is either increasing or decreasing can be viewed as a measure of sustainability of an economy. Measures of Net Product can be interpreted as the interest on the stock of assets (Solow, 1986). If this return is declining over time then this is an indication that assets are being run-down.

In fact, these inferences can be obtained somewhat differently. Pearce and Atkinson (1993, 1994) have presented a savings rule whereby sustainability is defined by a positive level of net savings: savings net of the value of changes in assets. These measures could be expanded to include changes in environmental resources (the loss of environmental services occurring due to degradation for example). Two related sustainability indicators can be defined for resource depletion (Proops and Atkinson, 1994).

The first measure relates to the quantity of sustainability (defined as the quantity of net

savings).

$$\sigma = s - \delta K - p_R R + \dot{ES}$$

where, σ is the quantity of sustainability; p_R is the non-renewable resource rent where R is the units of the non-renewable resource extracted.

The second indicator relates to the proportion of sustainability. Here, magnitudes on the left hand side of the expression for σ are expressed as a proportion of national income (y) which in this case might refer to gGDP.

$$\rho = (s/y) - (\delta K/y) - (p_R R/y) + (\dot{ES}/y)$$

For sustainability we require that,

$$\sigma > 0 \text{ and } \rho > 0$$

The important point is that an economy that is using up environmental services, will look less sustainable on this rule because other things being equal, $\dot{ES} < 0$ will lower net savings and hence decrease either σ or ρ.[18] Only, considering the value of depreciation of manufactured capital or non-renewable resources is likely to give us a misleading picture of sustainability.

There is however an important problem with this approach in that it implicitly assumes a world characterised by *weak sustainability*. Weak sustainability assumes that it is a generalised productive capacity that needs to be passed on to each generation, or, each successive accounting period. No particular asset is considered to unique in the sense that it must not be allowed to deteriorate. Hence, weak sustainability does not necessarily require that we maintain a particular environmental resource. The only requirement is that if this resource is 'used up' then it must be replaced by an alternative asset with an equivalent or greater return. This means that a sustainability criterion can be expressed in the form of a savings rule rather then a constraint that a particular level of environmental resources be maintained. Of course, the same problem occurs in monetised resource and environmental accounts by assuming that a single aggregate level of welfare can be derived. While we would expect that the services of an asset that has few or no substitutes will have a correspondingly high marginal value, the valuation exercise still assumes that an assessment of trade-offs can be made (Proops, 1991). Uncertainty surrounds the substitutability debate and for this and for other reasons many different perspectives on sustainability have been proposed encompassing the notion of *strong sustainability* where the retention of current environmental resources has been advocated. In this case, the meaning of a single monetised measure of welfare can be questioned. If it is argued that there exist some environmental assets that are not substitutable for other assets then a practical response might be physical measures of these assets which can then be analysed separately or along side measures contained in the national accounts.

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[18] Note that σ and ρ are related by $\sigma = \rho Y$

8. What are the Alternatives to Monetised Measures of Welfare?

Much of the theoretical literature has been concerned with the development of models that give rise to new expressions of NDP. Empirical applications have attempted to infer the non-marketed valuation techniques that would have to be employed in order to put such results into practice. These techniques such as CVM are discussed in the UN Handbook (United Nations, 1994). However, while some scepticism has been expressed regarding these developments others have rejected this route. The opposition is diverse reflecting on one hand, those who advocate notions of strong sustainability based on physical constraints on the use of the environment to those who feel that the explanatory power of the national accounting framework will be jeopardised if radical changes are made to it. Hence, we might expect significant opposition to these extensions from official statistical offices. Principle among the official dissenting voices is the Environment Directorate of the OECD which has as one of its main tasks the development of environmental indicators, information and reporting. In terms of actual accounting, the emphasis of this work is on natural resource and environmental accounts in physical units (see, for example, OECD, 1992).[19] The concept that has been the primary focus of this report, namely modifying the SNA to arrive at an aggregate "green" measure of national income figure is rejected.

One reason for this rejection is the perceived risk of jeopardizing the consistency of the existing SNA system and is considered to outweigh the benefits of (possibly) unreliable and dubious results. Yet, the direction that green accounting efforts have taken so far has been at pains to live within the framework of the SNA. In any case, the stress on the satellite accounts leaves the core SNA framework intact. More important is the claim that the benefits of monetised accounts are both unreliable and dubious. It is argued that it is not within the art of the possible to incorporate valuations of environmental resources *directly* into national accounts. In particular, it is considered that a monetised "green" measure will tend to underestimate the welfare effects of environmental degradation. This could be interpreted as an articulation of the strong sustainability issues briefly discussed above. We have already noted the problems concerning the limits encountered to valuing the environment as a whole. Concentrating our monetary measures on commercial natural resources for which valuation methods are relatively straightforward is also ruled out by the OECD. This is because of the small part that *domestically extracted* commercial natural resources play in OECD economies. However, this ignores the fact that many of these commercial resources are imported. As Proops and Atkinson (1994) have demonstrated, it may be possible for countries or regions to 'import' sustainability.[20]

In contrast, many believe that *physical* resource and environmental accounts could provide useful information for researchers, policy makers as well as increasing public awareness of environmental issues (Hamilton *et al.* 1994). Physical measures of environmental quality and 'extent' are the main feature of 'state of the environment' reporting. Hence, the UK Department of Environment (1992) publishes summaries of numerous environmental

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[19] In addition, there is a focus on satellite accounts of expenditures on the environment.

[20] Asheim (1986, 1994) considers this idea rooted in a neoclassical optimal growth model.

indicators. These data relate to emissions, deposition, climate change, land-use and flora and fauna habitats etc. However, we are interested in gaining an understanding of economy-environment linkages (Pearce *et al.* 1990).

An Environmental Index

It is possible to by-pass resource and environmental accounting altogether and opt for a index made up of a number of chosen environmental indicators. Hope, Parker and Peake (1992) present a pilot index that has nine components. These are split into three headings: air pollution (nitrogen oxide and carbon dioxide emissions, sulphur dioxide urban concentrations, low level ozone concentrations); water pollution (oil spills, water quality); and landscape (fertiliser use, resident populations, new dwellings started). These are mostly indicators of sources of pressure on the environment rather than indicators of the responses of receptors (e.g. emissions of sulphur dioxide rather than ambient concentrations of sulphur dioxide in the air). In contrast environmental accounts couch their adjustments in terms of the degradation of receptors which often constitute assets.

In order to turn this vector of indicators into a single index Hope, Parker and Peake (1992) use the results from various public opinion polls on the environment and weight each indicator accordingly. The result of using these surveys is that greater weight is given to global and national environmental issues. In addition, water and air pollution variables receive more weight in the overall index than do the landscape variables. The preliminary results indicate that, taking a value of for the year 1980 = 100, environmental quality has not deteriorated significantly over the decade. Some years are characterised by declines in environmental quality, other years associated with an increase.

Physical Accounting

Translating environmental data into an accounting framework is also seen as an important step in organising and making sense of diverse statistics. This role of physical accounting is emphasised by the Dutch Central Bureau of Statistics (CBS).[21] Hence, a long term aim of the Dutch CBS is to link environmental data to a more integrated scheme of environmental accounts and national accounts in physical terms (CBS Netherlands, 1993). Again it is the economy-environmental linkages that are of primary interest. We therefore need some way to relate these physical accounts to conventional economic variables.

One approach is suggested by the Norwegian Central Bureau of Statistics (CBS). It is argued that concepts such as green NDP give misleading information, particularly because they refer to hypothetical costs rather than the macroeconomic effects actually incurred by effecting pollution abatement or conservation measures (Aaheim and Nyborg, 1994). The Norwegian CBS's favoured approach employs a macroeconomic model in order to examine these scenarios where environmental protection strategies compete for resources with other economic activities. Using a simple numerical example Aaheim and Nyborg (1994) demonstrate that adjustments understate the changes that occur in the presence of

[21] The Dutch CBS is the organisation responsible for the compilation of environmental and land-use statistics in the Netherlands

environmental protection activities lowering aggregate investment, consumption and hence conventional NDP.[22] This type of analysis is concerned with the macroeconomic effects of exogenously (politically) determined environmental goals. It does not require an indicator of, say, sustainability because this criterion and the means to satisfy it have already been determined. Hence, there is no reference to the measurement of the benefits of environmental protection in terms of improvements in welfare from increased environmental quality. The Norwegian CBS appear to have found this approach very useful in answering the questions that they see as the most compelling: namely, the macroeconomic effects of environmental policy.

Integrating Physical Data into Monetised National Accounts

A different approach that shows how physical environmental statistics can be linked to an national accounts based upon social accounting matrices (SAMs) is offered by de Boo *et al.* (1991)[23]. Depending on data availability the components of the matrix can be disaggregated to yield more information as is required. Weale (1992) has also suggested that physical environmental data and monetary values of conventional accounting entries can be placed in a table that conforms to an accounting system (although row totals and column totals and hence accounting identities do not balance). So, it may not be an implacable obstacle that monetary values cannot be attached to many aspects of the environment. Yet, if prices could be found for the data then aggregation of the matrix suggested by de Boo *et al.* (1991) would result in a measure of green NDP. The emphasis on the matrix is a useful one as it serves to remind us that national accounts and resource and environmental accounts are not just the means to obtain a single aggregate measure of economic activity and welfare. The disaggregated approach could be the basis of an analysis of the interaction between, for example, the 'environmental sector' and production and household sectors. It is also important to recognise that physical information on the environment is a prerequisite to any attempts to provide monetary accounts and new aggregates.

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[22] Contrary to the usual assumption invoked in these models that economies are fully employed, many economies are characterised by unemployed resources. In such cases, environmental protection programmes may not lead to significant macroeconomic repercussions and may actually stimulate economic activity (for a summary of these issues see Atkinson and Dubourg, 1994).

[23] For a discussion of the concept and use of SAMs see Pyatt (1991).

9. Conclusions

Much of the empirical research effort devoted to 'green' national accounting has focused on resource accounting, defined as accounting for 'commercial' natural resources (e.g. oil, natural gas, timber, fisheries). Accounting for other environmental concerns has largely been restricted to identifying the costs of environmental protection and/or estimating the costs of restoring environmental quality. Within much of environmental economics however the analysis of environmental change and environmental problems has gone beyond this level of debate, drawing on an array of non-market valuation techniques. It is not far-fetched to say that we will see this same shift of priorities in attempts to 'green' the national accounts. As we have defined it here, this will entail a move towards environmental accounting.

To a large extent, this process has already begun and the various approaches outlined in section 4 provide several starting points. Clearly, there is no shortage of possible modified measures of NDP to choose from, such that each choice demands careful interpretation. While remaining relatively abstract, the frameworks discussed in section 4.3 show that these expressions for 'green' domestic product have at their core the premise that environmental resources are assets from which are derived multiple services over time. These services contribute to welfare. In accounting terms, section 5 showed that these insights can be handled by redrawing asset boundaries and production boundaries. The latter modification provides the basis for which environmental assets should be valued. Many complicating questions arise from this. One is the degree to which we are interested in calculating either a green NDP or GDP. In principle, it is both concepts that should have our attention. The usual distinction between the two measures remains the same: GDP is the sum of all final goods and services, including those resources (i.e. assets) that were used up in the process of generating it. NDP is the sum of final goods and services, net of the resources used up in the process. This implies that green GDP should be gross of all asset depreciation including the loss of non-marketed environmental resources. A more demanding modification is that a value of the level of non-marketed environmental (final) services should be included in a measure of green GDP. This may seem surprising for the modifications seem to be moving our adjusted measures in an upwards direction. Others such as Jackson and Marks (1994) have concluded the opposite because they have included, in their welfare measures, the imputed value of negative environmental change rather than consider this in the context of the level of services that prevail both before and after this change.

In any case, we need not be overly concerned regarding whether 'green' GDP or NDP appear to be in excess of their conventional counterparts. As argued in section 7, it is the evolution of the chosen aggregate over time that is of crucial importance as an indicator. For this, we are interested in changes in assets that constitute the wealth of any economy and so it is the path of measures of net product that demand our attention. Table 6 summarises the four main approaches to 'accounting' for the environment emphasised in this paper. Each has its own rationale and suggested adjustment. The Table also includes a brief assessment of the merits and drawbacks associated with each approach. On a concluding note, we require some assessment on the relative merits which will provide some guide for future priorities.

- Monetised welfare measures would appear to offer the most scope for future

development.

The main reason for this claim is that there are clear policy advantages to data that can be relatively easily compared to conventional measurements. The valuation of environmental effects in cost-benefit analysis is a good example of this. In addition this approach is firmly rooted in economic theory. This is not to say that we could estimate a robust measure of welfare that adequately captures environmental services tomorrow. Yet the general direction of some research (including official work) is that progress can be made.

- Further investigation is required concerning particular environmental assets and their associated service flows.

The concept of 'natural capital' is now widely used in the analysis of sustainability issues. For national accounting purposes a more precise definition needs to be sought for the various components of this aggregate stock. Harrison (1993) provides one example of this but is less sanguine concerning the prospects for valuation of assets and service flows. But, methodologies for valuation do exist and it is these methods that would provide the link between an assessment of environmental assets and extended measures of welfare.

The empirical examples described in section 5.1 show that it is possible to estimate environmental accounts that are broadly consistent with accepted frameworks. However, measures of welfare that have attempted to provide a more complete assessment of environmental change have tended to take a far more *ad hoc* approach to measurement. The question is, to what extent can more robust measures of welfare be built on non-marketed valuation techniques. Problem areas can be located with the chosen valuation method itself and the appropriateness of the method within the national accounts.

There does remain a legitimate issue concerning the status of a more ambitious adjusted measures of welfare. The following comment by Peskin would appear to be highly relevant.

> "Since the new account entries in no way destroy the existing accounting system, they could be either accepted or ignored, depending on how one felt about the worthiness of imperfect estimates" (Peskin, 1981 p535).

Another reason often given to ignore these estimates is that it is argued that the attempt to aggregate the values of heterogenous services is in itself a meaningless exercise which loses more information than is gained. The strength of this claim will depend on the perceived value of the new information and new aggregate concepts that emerge relative to the perceived value of current aggregates and national accounting efforts (Peskin and Peskin, 1978). Yet, the policy implications, that determine the perceived value, of resource accounting are all too often poorly defined and this is probably even more true of environmental accounting. This does not downgrade the status of adjustments but clearly, more thought needs to be given to why precisely modifications are sought.

Suspicion of the aggregation process implicit in these modifications is often evoked by those who advocate physical indicators of the environment. It was noted above that national accounts are probably not suited to dealing with strong sustainability issues but that the conventional accounts form a useful input into analysis along side physical indicators. Yet

even here the aggregation tendency can dominate as the various attempts to derive physical environmental indices show. There will remain the dilemma concerning the appropriate weight to assign to each component of any index. Of course, environmental accounting based on an expanded monetised measure of welfare uses imputed prices as these weights.

In summary, advocating the development of an approach based on a monetised welfare measure by no means excludes other approaches. Hence,

- The approaches outlined in Table 6 are not entirely mutually exclusive.

Physical data is essential before any values can be assigned. Properly measured restoration costs do have an economic rationale for inclusion in a measure of welfare. Defensive expenditures represent the indirect effects of the environment on the magnitudes that are currently measured in the SNA. Thus, as Hamilton *et al.* (1994) suggest, the identification of these
expenditures could be viewed as a practical first step in accounting for the effects of environmental change on welfare. In the interim, we will need to rely on a range of environmental indicators. What is clear is that a promising line of inquiry can be traced out whereby broader aspects of environmental change and nature conservation values could be gradually introduced into either official green accounting or independent research efforts. This draws on economic models of green accounting issues and ultimately the applied valuation techniques in environmental economics. Allied to a physical database, adjustments that are broadly consistent with existing accounting concepts can be derived. This at least provides a general framework whereby the many proposed modifications can be evaluated.

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Table 1. Environmental Account for Forest Resources in Sweden 1987 Billions SEK

Timber products	**Value**		
Market value (roadside)	18.63		
Inputs from other sectors	3.14		
Increase in growing stock	3.80		
Silviculture	-1.55		
Subtotal 1	20.89		
Other products			
Berries	0.50		
Mushrooms	0.55		
Meat from game	0.47		
Subtotal 2	1.52		
Changes in environmental stocks			
Biodiversity	-0.60	or	(-0.36)
Carbon sinks	3.80	or	(6.70)
Exchangeable cations in soil	-0.60		
Lichen stocks	-0.02		
Subtotal 3	2.58	or	(5.72)
TOTAL NET INCOME	24.99		

Source: Hultkrantz (1992)

Table 2. UK Land-use Sector Environmental Accounts

Sustainable Net Product	**£ million 1988**
GROSS PRODUCT	5498
minus Depreciation on human-made capital	-1470
equals NET PRODUCT	4028
minus Degradation of natural capital:	135
(of which: carbon-fixing + 146 water pollution - 11)	
minus Defensive expenditures:	- 58
(government expenditure to maintain landscape and conserved areas and to clean up pollution)	
equals ENVIRONMENTAL DAMAGE	+ 77
plus Biodiversity	+ 94
plus Amenity:	+ 794
(of which green belt + 642 national parks + 152)	
equals ENVIRONMENTAL BENEFITS	+ 888
equals SUSTAINABLE NET PRODUCT	4993

Source: Adger, N. and Whitby, M. (1993)

Table 3. Non-market Asset Values and Depreciation, 1982 and 1985 (millions of 1987 U.S. dollars)

Asset value	**1982**	**1985**
Final demand services	15,632.0	15,744.3
Disposal services	2,807.8	2,770.0
Total services	18,439.8	18,514.3
Net environmental benefit	12,231.4	11,995.7

Annual Depreciation (appreciation)	**1982**	**1985**
Final demand services	(37.4)	(37.6)
Disposal services	12.7	12.5
Total services	(24.8)	(24.9)
Net environmental benefit	79.1	77.5

Source: EPA (1992) cited in Grambsch, Michaels and Peskin (1993)

Table 4. Valuation Techniques Used in Adger and Whitby (1993) and Hultkrantz (1992)

SERVICE VALUED	Adger and Whitby (1993)	Hultkrantz (1992)
	ASSET VALUED	
	Land	Forest
Recreation	Yes (contingent valuation)	No
Government Defensive expenditure	Yes	No
Carbon storage/ fixing	Yes	Yes (political shadow price, opportunity cost)
Biodiversity	No	Yes (contingent valuation, opportunity costs of conservation)
Pollution	Yes (contingent valuation)	Yes (restoration cost)

Table 5. Adger and Whitby's Land-Use Account for a 'Green' GDP

CONVENTIONAL	ALTERNATIVE
GROSS PRODUCT = 5 498	GREEN GROSS PRODUCT = + CONV. GP + environmental service flows + use of environmental assets - defensive expenditures[1] = 5 498 + 888 + 157 - 58 = 6 485
NET PRODUCT = + CONV. GP - depreciation[2] = 5 498 - 1470 = 4 028	GREEN NET PRODUCT = + GREEN GP - depreciation - loss of environmental assets = 6 485 - 1 470 - 11 = 5 004

Notes

1. debatable deduction
2. refers to deterioration of manufactured capital

Table 6. A Summary of Possible Approaches

Defensive Expenditures	Restoration Cost	Welfare Measures	Physical Indicators
1. Rationale The amount actually spent on environmental protection is a first approximation of the value of a decrease in environmental quality.	**1. Rationale** the value of environmental degradation can be approximated by the amount of expenditure that would be necessary to restore environmental quality. i. represents marketed production lost due to pollution ii. represents value of waste disposal services to producers	**1. Rationale** Obtain a measure of welfare based on a full evaluation of the services of environmental resources. Large emphasis on non-marketed values and how these values can be related to environmental change, particularly changes in amenity, ecological functions etc.	**1. Rationale** Often starts from a scepticism of 'economic' approaches particularly those to derive monetised welfare measures. Also those who believe national accounts should not be adjusted for environmental imputations
2. Adjustment i. Deduct household and government def. exp. as intermediate product. Changes both GDP and NDP by this amount. ii. Deduct def. exp. as proxy for depreciation of environmental resources. Changes NDP by this amount.	**2. Adjustment** The cost of returning the environmental asset to its state prevailing at the beginning of the accounting period. Type of asset consumption (i.e. depreciation) so deduct from NDP If rationale ii. is chosen then another option is to calculate a green GDP by adding the value of depreciation to conventional GDP. Estimate green NDP as before	**2. Adjustment** i. obtain a measure of the value of the change in environmental services. calc. green GDP by adding the value of change to conventional GDP. Estimate green NDP as before ii. still requires i. but also a corresponding evaluation of the level of environmental services. Add to green GDP. Green NDP must be net of changes	**2. Adjustment** No adjustment to conventional measures of GDP or NDP is proposed. Instead stops the data collection process at physical measures of the state of the environment i. Environmental indices from environmental data ii. Physical accounts of stocks and flows of environmental resources iii. Some link to conventional economic variables e.g. via modelling approaches/ pressure state response indicators

Table 6. A Summary of Possible Approaches (continued)

Defensive Expenditures	Restoration Cost	Welfare Measures	Physical Indicators
3. Assessment	**3. Assessment**	**3. Assessment**	**3. Assessment**
i. Relatively easy to identify. No physical data required	i. Relatively easy to work out if have adequate physical data base and data on costs of environmental protection.	i. Builds on economic theory and advances in environmental economics.	i. By-passes valuation problems.
ii. No guarantee that these outlays are an accurate approximation	ii. Has some basis in economic theory	ii. Extensive physical data requirements. It may be that the change in environmental services is less complex to calculate than the level.	ii. Difficult to evaluate changes in environmental quality relative to economic variables. Need some other way to do this.
iii. Some def. exp. are an investment in environment. Anomalous policy signals.	iii. Actual cost data likely to be, on one hand too low due to public good aspect of environment, and on the other too high due if not referring to least-cost method of control.	iii. Extensive monetary data required. Need to harness non-marketed valuation techniques. Possibility of using 'benefits transfer'.	iii. Require some way to reduce mass of environmental data to a manageable state.
iv. Only a narrow subset of issues related to nature conservation can be addressed.	iv. May need to use avoidance costs when restoration costs are infinite (e.g. irreversibility).	iv. Could answer larger array of questions than many other approaches on e.g. sustainability but full evaluation of environment not yet possible	iv. May not give environmental issues as high a profile as measures based on readily understood monetary values.
	v. Limited coverage of values affected by loss of environmental assets.		