ENVIRONMENTAL ACCOUNTING:
WILL IT MEET THE GOALS OF ECOLOGICAL ECONOMICS?

DR. JOY E. HECHT
CONSULTANT ON ENVIRONMENT AND INFORMATION SYSTEMS

Tel: 1-202-494-1162
Email: jhecht@alum.mit.edu
URL: users.rcn.com/jhecht/professional

Abstract

The modification of the national income accounts to incorporate environmental considerations has been endorsed by ecological economists in the hope that it will help move countries toward sustainable use of natural resources and environmental services. This paper considers whether or to what extent this goal is likely to be achieved in the foreseeable future. It does so based on two factors. The first is the results of a survey of environmental accounting activity in a group of developed and developing countries, conducted in 1999 and 2000. The second is the draft revised manual on economic and environmental accounting, the SEEA 2000, now being developed under the auspices of the UN Statistics Division by the "London Group." While these accounts can provide very useful data for environmental and economic policymaking and analysis, they will not fully meet the hopes of ecological economists, because they shy away both from the estimation of alternate macroeconomic indicators and from the valuation of non-marketed environmental services.

A. WHAT MIGHT WE WANT FROM ENVIRONMENTAL ACCOUNTS?

Great claims have been made for environmental accounts. They are supposed to keep our economies on a sustainable development path, replace conventional macroeconomic indicators with measures of welfare, and guarantee that a wide range of environmental and social impacts will be taken into accounts as we make decisions about economic growth or development. Unfortunately, these claims are made not by the accountants and statisticians who are building the accounts, but by people who hope that "green" macroeconomic indicators will shift public decision-making away from maximizing consumption and income towards consideration of other forms of well being. They often know little about how environmental accounts are actually being built or their potential to achieve the goals set for them. Meanwhile, people on the supply side of the environmental accounting arena often work with insufficient input from the demand side, and are designing the environmental accounts based on the tools they already work with rather than what the demand side wants.

This paper compares the demand for environmental accounts, particularly from environmentalists and ecological economists, with the actual accounts as they are being designed and constructed. The update of the 1993 System of Integrated Economic and Environmental Accounting (United Nations, 1993, known as the SEEA) is being carried out by the London Group, an international task force comprised of national accountants and statisticians from OECD countries who are building environmental accounts in their own countries. The most recent draft of their work, known as the SEEA 2000, is now being finalized, and should be published in 2002. Since 1999, when the UN Statistical Commission charged it with developing international guidance on environmental accounting, the London Group has opened its meetings to national accountants and statisticians from developing countries and to a group of international experts on the subject. The group's perspective is very much that of the accounting practitioner rather than of the economist, theoretician, or environmentalist.

Environmental accounts are seen as a way to meet a number of objectives. While they are interrelated, it is possible to distinguish two threads running through them. One goal is to establish new macroeconomic indicators that will replace - or at least supplement - conventional GNP and GDP. How such indicators might be constructed depends on which criticisms of the conventional measures they are intended to satisfy. Some people seek marginal changes primarily to incorporate the depletion of natural assets in a form comparable to how we depreciate human-made assets in the conventional accounts. Others feel that indicators should capture the harm to humans that results from environmental degradation, and seek a range of adjustments to move them in that direction. Still others would like the accounts to tell us whether our current income is sustainable, and if not, what our income would be if we behaved sustainably. The goal of new macroeconomic indicators is discussed in section B below.

The second goal concerns our desire to track whether we are using resources sustainably. While the issue of sustainable income arises when we discuss adjusted macroeconomic indicators in section B, maintenance of assets such as forests and fisheries is a fundamental component of sustainability aside from income levels. Section C of this paper considers how the accounts contribute to tracking whether assets are being managed sustainably.

B. ADJUSTED MACROECONOMIC MEASURES

For decades, critics of the System of National Accounts (SNA) have pointed out that its major macroeconomic indicators - gross national product, gross domestic product, and national income (GNP, GDP, and NI) - are used as if they were measures of welfare, whereas in fact they measure only economic

activity. Such criticisms come in particular from environmentalists, ecological economists, and others concerned with understanding the economy within the context of the natural environment. Their focus is on the distortion in public decision-making that occurs when resources are allocated so as to maximize income growth without factoring in the role of the environment in generating that income or the impacts of income generation on the environment. Frequently they call instead for the development of green macroeconomic measures - green GDP or NI - whose use to steer public actions they believe would lead to more sound use of natural resources.

B.1 "Correcting" the SNA measures of income

Some objections to the conventional indicators originate with the concept of income. As defined by Hicks (1946, p. 172), and regularly cited in discussions of sustainability, income is the amount that a person can consume this week, and still be as well off at the end of the week as at the beginning. Conceptually, this is what we mean by sustainable income - the level of consumption that can be maintained while ensuring that well being will not decline. In terms of the national accounts, since consumption (or depreciation) of capital this week will reduce our ability to consume next week, net national product - GNP less depreciation - is frequently understood to be a measure of income as Hicks defines it.

However, as many economists have pointed out (see, for example, Daly, 1989, p. 8) have pointed out, consumption at the level of net national product depends on being able to consume non-renewable natural resources and degrade the environment, and is therefore higher than sustainable income should really be. They therefore recommend that the depletion of natural capital should be subtracted from GNP to correct for this. In addition, economists such as Daly consider defensive expenditures - those expenditures made in order to protect ourselves against the harm that we cause to the environment - to be a form of intermediate expenditure rather than final consumption. Consequently, they argue that these should be subtracted from GNP as well. The resulting figure, they claim, would correctly measure Hicksian or sustainable income.

Mainstream thought in environmental accounting (e.g. United Nations, 1993, SEEA 2000) agrees on the need to subtract the depletion of natural capital from GNP to get a more "correct" value of NNP. However there has been considerable debate about whether defensive expenditures should be subtracted out as well. The arguments for subtracting them essentially are based on an effort to convert GNP (or NNP) into a measure of welfare rather than a measure of economic activity. If GNP simply measures economic activity, then defensive expenditures by consumers are treated as final consumption, like other expenditures by consumers. (Defensive expenditures by enterprises, of course, are treated as intermediate rather than final consumption in the conventional accounts.) However, if GNP is really to be considered a measure of well being, then it is appropriate to regard defensive expenditures as an intermediate expense rather than as something contributing directly to welfare.

The SEEA 2000 does not even consider the idea of subtracting defensive expenditures to obtain adjusted macroeconomic indicators. Two factors play into this deliberate omission. First, while at first glance it might be clear what we mean by environmental defensive expenditures - for example, triple-glazing to keep out street noise, or more refined drinking water treatment systems to compensate for contaminated intake water - in fact, the more we think about it, the less clear this category is. We make defensive expenditures in all arenas, not simply to protect against environmental harm; should we subtract all of them? Must we also subtract medical expenditures (defense against illness), the costs of earthquake-proof building techniques (defense against nature), locks on our homes or cars (defense against human actions),

commuting costs (defense against whatever we might not like about living near our work), and so on? If we deduct any defensive expenditures, it is difficult to know where to draw the line.

The second concern about defensive expenditures is more fundamental. Conventional accountants and statisticians who work regularly with the conventional SNA are concerned that environmental accounts be consistent with the conventional system insofar as possible. Conventional GNP and NNP are measures of economic activity, not measures of welfare. While some defensive expenditures may not contribute to welfare, they are nevertheless economic activity. Macroeconomic indicators that did not include them would not be a "more correct" calculation of what the SNA already aims to calculate, in the way that deducting depletion of natural resources is a better way to estimate what is already intended by NNP. Instead, deducting defensive expenditures would be one step in the direction of converting GNP or NNP to measures of welfare rather than economic activity.

B.2 Creating a measure of welfare

A measure of welfare would differ fundamentally from GNP or NNP in many ways. For our environmental accounts to be meaningful, we don't want to go "half way." Either we calculate a measure of economic activity or we calculate a measure of welfare, but something half way between them would be even harder to interpret than the indicators we already have.

A measure of welfare would differ fundamentally from a measure of economic activity in the way we value transactions. In the conventional accounts, consumption and other economic transactions are valued in terms of market prices. Such prices do not include consumer surplus - i.e. the amount that consumers would have been willing to pay for goods above and beyond the market price. However any measure of the welfare derived even from consumption of marketed goods would have to include consumer surplus. If consumer surplus were calculated for everything in the accounts (were that even possible, which is unlikely), the resulting measures would obviously be completely different from GNP and NNP. If only the satellite environmental accounts included measures of welfare- for example, the welfare derived from consuming non-marketed environmental goods and services - the accounting data on the environment would be incompatible with the rest of the data in the SNA. While such environmental data would not therefore threaten the integrity of the conventional SNA, this incompatibility would make it difficult to integrate the conventional data with the environmental satellite accounts for analytical purposes.

A related concern arises when it is argued that the accounts should capture the loss of non-marketed environmental goods and services due to other economic activity; for example, the loss of recreation on a lake which becomes polluted. The argument is that that loss of that "free" recreation opportunity should be subtracted out of the macroeconomic indicators. However, it would be incorrect to subtract out the loss if its value had not been included in the accounts in the first place. To ensure consistency, the value of all non-marketed environmental goods and services, like swimming in the lake, would have to be estimated in monetary terms and included in the accounts. Then when a new factory on the lake increased marketed output, that increase would automatically be counter-balanced in the accounts by the loss of non-marketed recreation due to its pollution.

While this might make sense if we were building a welfare accounting system, it is not consistent with the SNA, and the London Group (SEEA 2000) has rejected it. Moreover, if we were building a welfare accounting system rather than a transactions accounting system, we could not justify including welfare derived from the nature environment but no other sources of welfare. Obviously many other non-marketed factors also contribute both to economic well being and to welfare; measures such as the

Nordhaus and Tobin Measure of Economic Welfare include leisure time and unpaid household labor, for example. (Nordhaus and Tobin, 1973) A GDP figure adjusted for the environmental concerns but not for any of the others will be incomplete as a measure of welfare. However adjusting GDP to include all non-marketed components of welfare would go far beyond the focus of environmental accountants, and they have chosen not to attempt it.

B.3 Environmentally adjusted indicators in SEEA 1993: maintenance cost

Having rejected the idea of calculating a measure of welfare and the deduction of defensive expenditures, the 1993 SEEA (United Nations 1993) and the subsequent handbook on its implementation (United Nations and UNEP 2000) recommended calculation of two environmentally adjusted GDP figures, referred to as "EDP-I" and "EDP-II." EDP-I would be calculated by subtracting the depletion of natural capital from conventional GDP, so that natural and human-made capital would be treated in the same way in the accounts. This is the same adjustment recommended by Daly and discussed above. EDP-II was calculated by subtracting so-called "maintenance cost" from EDP-I.

Maintenance cost was defined as costs that "would have been incurred if the environment had been used in such a way as not to have affected its future use." (United Nations, 1993, para. 50) Conceptually, this should measure the direct expenditures that would have been required if at the end of the year the environment was to be at the same level of quality as it was at the start of the year. In theory, EDP-II could be a reasonable measure of sustainable income; it should tell us what our income would be if we had made all the expenditures needed to ensure that our natural assets did not degrade at all over the year.

In practice, maintenance cost has more often been estimated as the expenditure that would have been required to reduce all pollution to the level considered safe, or to national emissions standards. (See, for example, Korea Environmental Institute, 1998; National Statistical Coordination Board, 1998; Jao and Chen, 2000) The estimates of the cost of reducing pollution are typically based on technological information on pollution control techniques and engineering estimates of the cost of implementing them. In some cases, where domestic data are not available, U.S. data on pollution control costs per unit of output have been applied to other countries.

This approach to estimating maintenance cost and thus to deriving environmentally adjusted GDP has the advantage of being relatively easy to implement. It has the disadvantage of being meaningless, however. If firms were really required to make the expenditures in question, the economy as a whole would adjust to the new cost structures for production. Prices would go up, consumption would shift, and the overall structure of the economy would adjust accordingly. The actual new level of output would be higher than EDP-II, because price changes would cause demand to shift to those industries and products for which pollution reduction was the cheapest. While technology-based estimation of pollution control costs is appropriate at the margin, where all else may be held equal, summing those estimates across the entire economy is not a correct way to determine what GDP would be if there were to be no environmental decline over the time period.

For this reason, while the SEEA 2000 discusses the maintenance cost approach at some length, it drops the recommendation that countries calculate EDP-II. It discusses why measures like EDP-II (renamed environmentally adjusted GDP or eaGDP) could be interesting, but acknowledges that as implemented they do not measure what they could measure in theory, and are therefore misleading rather than helpful.

B.4 Environmentally-adjusted indicators in SEEA 2000: modeling sustainable income

The alternative to the maintenance cost approach is to build a model of the economy that actually predicts the structural adjustments that would occur if more stringent environmental controls were to be implemented. Such work has been undertaken in many countries. For many years Hueting has encouraged the Dutch Central Bureau of Statistics to estimate the income that would result if economies actually achieved the physical sustainability targets that appear to underlie their commitment to international treaties like the Convention on Biodiversity. His approach involves defining standards for pollutant emissions and resource use based on scientific assessments of what would be physically sustainable, and developing abatement cost curves based on currently available technology and technology that can reasonably be anticipated in the foreseeable future. Those curves are then used to estimate the cost of meeting emissions and resource use targets. Where technical measures would not suffice, he assumes that the public will accept policies to encourage use of more environmentally benign products or activities; where even that won't suffice, production is expected to decline in order to attain the standards. The Netherlands has estimated so-called "sustainable national income" on an experimental basis using this approach, but no other country has followed their lead. (Hueting and de Boer, 1999)

A number of countries have linked environmental accounting data to national macroeconomic models in order to predict economic structure and income under different assumptions about how they might achieve specific environmental targets. Scandinavian countries have focused on what it would take to meet their targets under the Kyoto Protocol, using the models to identify least-cost strategies for accomplishing their environmental goals. (Hecht 2000) For example, the Swedish Ministry of Finance has integrated an environmental module into the general equilibrium model that it uses for medium-term economic forecasts. The module uses environmental accounting data to link emissions to productive sectors and to assess the economic impacts of different environmental goals. It also is linked to transportation models, since transport is a major source of pollutant emissions and a key input into production. They have used this to assess the implications of Kyoto Protocol targets for economic activity.

Norway has used environmental accounts in macroeconomic modeling in several ways. First, they use them to project the role of the energy sector in their economy. Second, they project the impacts of energy price changes on their economy, through changes in industrial and household demand. Third, they too are using their accounts data to analyze the economic impacts of complying with the Kyoto Protocol and the efficiency and effectiveness of different policies to reduce carbon emissions. They have also linked transportation to this analysis, since it is both a major source of greenhouse gas emissions and an important input into economic activity and household consumption. The focus of this work is not to develop "green" macroeconomic indicators, however; it is to assess proposed economic or environmental policies according to their estimated impacts on the economy.

The SEEA 2000 discusses such modeling as a way to estimate an environmentally adjusted income, which they term greened-economy GDP, or geGDP. Its authors recognize that it is the only correct way to estimate what EDP-II hoped to calculate in a much simpler way. However, while such analytical work relies on data compiled in the environmental accounts, the models are perceived as research that relies on the accounting data, rather than as a part of the accounts themselves. Thus while environmental accounts can contribute to analysis of the economic consequences of specific policies, they will not allow us routinely to generate sustainable income figures that will influence economic policy decisions as the conventional macroeconomic indicators do now.

B.5 Physical macroeconomic indicators

The SEEA 2000 incorporates both physical and monetary flow accounts. The SEEA physical accounts parallel the monetary accounts of the SNA, tracking flows of different materials by sector, quantified by weight. They may be linked to so-called "material flow accounts," an approach to accounting that has been developed by several research institutes working largely independently of the national income accounts. (Adriaanse et al, 1997, Matthews et al, 2000) Unlike the SEEA physical flow accounts, the material flow accounts (MFA) place a significant emphasis on macroeconomic indicators rather than on the detailed sectoral flows. The MFA also pick up flows not captured by the SEEA, such as mining overburden and other materials that are displaced in the course of production but are never directly used.

Material flow accounts are used to produce a measure of the total flows that occur in the course of production, total material requirement, or TMR. TMR is taken as a rough indicator of the environmental burden of the economy. Some practitioners of material flow accounting call for a reduction of the ratio of TMR to GDP by a factor of four or even ten to achieve sustainability.

Time series trends in TMR/GDP can give some sense of the direction of the economy in terms of its use of the environment. They would, of course, supplement rather than replacing conventional macroeconomic indicators, since they do not incorporate any of the economic measurements that are a basic part of the accounts. Moreover, TMR and other MFA indicators are calculated by summing the weights of all materials; thus heavy but harmless materials like soil and rock are added to light but dangerous ones like mercury. The resulting indicators are subject to the obvious criticism that the resulting measure masks the differential impact on the environment of different materials and makes TMR less than meaningful. However this is an interesting first cut at a macroeconomic indicator of links between the environment on the economy; refinements on this approach may be more useful in the future.

C. MEASURING SUSTAINABILITY

A second aim sought from the environmental accounts is that they will tell us whether our economy is sustainable, or how far we are from a sustainable development path. To assess whether, or how, the accounts can shed light on the sustainability of the economy we need to consider what we mean by a sustainable economy or a sustainable development path.

The definitions of sustainability and sustainable development are myriad, and this paper is not the place for a thorough consideration of the issue. However a simplification of the options is feasible. To begin, a distinction is typically made between weak and strong sustainability. Weak sustainability essentially assumes that all forms of capital are substitutable for each other, and aims to ensure that the value of capital does not drop over time. Strong sustainability, in contrast, assumes that natural capital can not be replaced by human-made capital, and must be retained in its current form. Between these extremes is a variant of weak sustainability that recognizes that some natural capital, termed "critical natural capital," is indeed irreplaceable, while other natural capital can be replaced.

In addition, we must consider the scale at which we want our economy to be sustainable. We could call for the national economy as a whole to be sustainable (either strongly or weakly). Alternately, we could call for more detailed components within it to be sustainable. For example, many people are concerned about ensuring the sustainability of individual communities. This might mean ensuring that residents of a city or town can continue making a living without having to move elsewhere. Often that in turn depends on a specific industry remaining in the community, such as a factory threatened with closure. Other people are concerned about the sustainability of specific industries; for example, firms operating within

the U.S. mining industry seek to ensure that sectoral operations will not be completely shifted overseas in search of lower costs and less regulation. Sectoral sustainability could also mean that such renewable resources as fisheries or forests are harvested at their maximum sustainable yield and no faster. In contrast, national sustainability (especially weak sustainability) would mean that national income is maintained without regard for whether individual communities or industries decline.

Just as sustainability could be defined at more detailed levels, such as the community or the industry sector, so it could be defined at more aggregate levels. Many people focus on global rather than national sustainability, since there is only one environment and many threats to it are global rather than national or local. From this perspective, our measures of sustainability should be global rather than national. Clearly national accounts as currently formulated will not shed much light on global sustainability, since they very carefully include only the data for a single economy.

A less ambitious aim regarding the rest of the world might be that in shedding light on the sustainability of a single economy, the environmental accounts take into account the impacts of the consumption and production of that economy on the rest of the world. Thus, for example, the U.S. accounts might take incorporate the impacts on south east Asian countries of their production for export to the U.S. (Of course if such damages were tracked in U.S. accounts, then the countries to which the U.S. exports would have to include in their accounts the environmental impacts in the U.S. of its exports, in order to maintain balance.) This approach would capture the impact of wealthy countries that concentrate their economic activity in the service sector and import manufactured goods from poorer countries, thereby shifting outside their borders the environmental harm caused by their consumption.

The national income accounts, and by extension the environmental accounts, are constructed at the national level. Data underlying the accounts are organized by industry sector. To the extent that establishments are clearly defined and their locations known within sub-national administrative boundaries, it may be possible to disaggregate data somewhat along administrative boundaries, although for companies that have integrated activities across the country this will not be meaningful. Without knowing the exact geographic coordinates of each enterprise, the accounts cannot be disaggregated according to ecological units such as watersheds or ecosystems. Consequently, they can provide information at the national and sectoral levels, or on sustainability of individual assets, but provide less insight into community sustainability and none into the sustainability of activities within an ecosystem. They can be used to shed some light on global issues, but their applicability for that purpose is limited. Consequently, the discussion below considers how the accounts answer questions about strong and weak sustainability at the national level, and then consider global issues, but does not consider community sustainability.

C.1 Strong sustainability

C.1.a Concepts

While economists and accountants describe strong sustainability as if it were a simple concept, for natural scientists is it, of course, much more complicated. (See, for example, Munasinghe and Shearer 1995) To determine what this concept could mean in practice, we must first determine what exactly we seek to sustain. For example, we might begin by breaking down natural resources into a few broad categories; forests, fisheries, water, sub-soil assets, and so on. Then we might define sustainability as the maintenance of stocks of each asset type, and the harvesting of renewables at maximum sustainable yield.

Considering a specific asset, such as forests, does sustainability mean maintaining the stock of each species or of each forest ecosystem type. Must each occurrence of a particular type of forest ecosystem be maintained? Or is it considered sustainable if the total area of that ecosystem type is constant, even if some forests are completely cut down while others expand? Has an ecosystem type been maintained if some species within it change, or must it maintain the exact species composition over time? Is an ecosystem type defined by a specific species composition, or by some more abstract interaction patterns among types of species, within which individual species may change? And so on. From a scientific perspective, defining sustainable management of the forest and determining which concepts of sustainability are useful for which policy and management purposes are clearly complex tasks. The same would go for any other type of natural asset.

From an economic perspective, forest asset sustainability is also complex. Forests provide a variety of services of value to humans, including timber, non-timber forest products, habitat for wildlife, carbon sequestration, watershed protection, recreation, and so on. Does "sustainable forest management" necessarily sustain all of these, or might it only sustain some subset of them? Can we consider the capacity to provide each service a distinct asset and consider whether the value of that asset is being conserved?

Non-renewable resources also pose an array of questions from a physical sustainability perspective, albeit rather different ones. At first glance it would appear that non-renewables cannot be used sustainably, by definition. Two ways to understand non-renewables make at least partial inroads into that problem, however. Through ongoing mineral exploration, we might be able to identify new resources as fast as we consume the ones we have, thus ensuring that the physical stock of known, economically exploitable subsoil resources remains constant. However, this won't actually maintain the supply available in the natural environment; it only maintains the supply that we know about. Another approach is to think of recycling - or "mining the landfills" - as a way to "renew" at least some non-renewables rather than delving further into the sources remaining in the natural environment.

The physical accounts proposed in the SEEA 2000 will make it possible to track some of these kinds of sustainability. There are several components to the physical accounts, paralleling the structure of the monetary accounts of the 1993 SNA. The asset accounts present the stock of assets at the start of each year, determinants of changes in stock, and the stock at the end of the year. The flow accounts track the movement of materials through the economy, including inputs into production, outputs for sale, and residuals discharged into the environment, organizing them into supply and use accounts that parallel those of the conventional SNA.

C.1.b Implementation of forest asset accounts

Work is relatively advanced on the implementation of physical asset accounts, especially for forests and sub-soil assets. Canada and a group of European Union countries have gone the furthest in the area of forest accounting. (Statistics Canada 1997, European Union 2000) However, it is difficult to develop detailed information on strong sustainability from their accounts. The European accounts divide forests initially into two categories, those available for wood supply and those not available for wood supply. Forests available for wood supply are further classified according to how intensely they are managed and by broad species type, while those not available are divided between protected areas and areas where the wood would not be commercially viable. The Canadian accounts are similar. They cover only those forests where timber production is economically viable, and distinguish between broad-leaved and coniferous forests. Their data come from provincial forest inventories, so they do have sub-national information. Of course a single Canadian province is larger than many European countries, so in practice the level of spatial detail is no greater for Canada than for Europe!

Both account systems follow the asset definitions of the SNA (and its European equivalent, the European System of Accounts), only including those assets that bring economic return to their owners. Consequently, protected forests are excluded from the accounts, as are non-marketed forest services such as wildlife habitat, watershed protection, and (barring full implementation of the Kyoto Protocol) carbon sequestration. Recreation is assumed to occur only in protected forests, so the consumer surplus derived from free recreational use of private forests is also omitted. The accounts include forest area, timber volume, and density, tracking opening stocks, changes over the year, and closing stocks. Developers of both forest account systems recognize the existence of other forest services aside from timber, of course. There are plans to extend the Canadian system beyond its focus on timber, but that will require significant additional data that are not yet available.

Whether the current level of detail in the forest accounts is sufficient really depends on the forest services with which the users of the accounts are concerned. From the perspective of the ecologist interested in ecosystem structure, biodiversity conservation, or habitat maintenance, the accounts won't be very helpful because they don't provide any information about ecosystem quality. Because there is little spatial detail in the accounts, they cannot be used to assess whether forests protect downstream ecosystems from erosion. On other hand, with data on trends in forest area, timber volume and, in the Canadian case, age structure, it should be possible to estimate trends in carbon sequestration and assess whether that service of the forests is likely to be sustained. Thus these accounts let us analyze some, but by no means all aspects of forest sustainability.

C.1.c Physical accounts and recycling

Physical asset and flow accounts can shed some light on the use of non-renewables. They will provide basic data about trends in stocks for the resources they cover, and thus whether, at least as far as we know, we are finding new stocks at the rate that we are using up the ones we had at the beginning of the time period. The physical accounts also track the flows of "residuals," the accounting term for waste products or pollution.

These data should combine to give us some understanding of the extent of recycling and reuse of materials. Ideally, we would like to be able to track individual products through the economy, seeing

- how much is produced from raw materials,
- which sectors use it,
- what wastes they generate, and
- whether those wastes end up being recycled or disposed of.

To do that, we would want to know the output of the producing sectors, the intermediate inputs of the consuming sectors, and the wastes of the consuming sectors. These would all have to be classified according to the same system, so that we could relate trends in recycling to trends in new production from raw materials and see whether recycling is influencing the extraction of raw materials. The accounts do not let us do that, however. Products are classified using the Central Product Classification system (CPC). Classification systems for residuals are still being developed, but they are not the same as the product classifications. While products manufactured out of residuals are classified according to the CPC, we have no way to determine what share of those products used recycled material as input.

A less ambitious aim would be to track the share of residuals that are recycled, without linking them directly to extraction of new raw materials. This is more practical, and to some extent the physical supply and use tables accounts should let us do it. However it, too, is limited. The accounts track residuals by

product and identify how much of those residuals become inputs into the recycling industry. However, they make a distinction between residuals, which are given away by the enterprise that generates them or which the enterprise has to pay someone to cart away, and secondary products, which the enterprise can sell. Depending on the market, a byproduct of production might either be sold as a secondary product, in which case it is classified using the CPC and does not show up as recycled, or given away as waste, in which case its reuse would be identified as recycling. In addition, when an enterprise filters its own wastes to capture materials for reuse within the plant, this will not show in the accounts as reuse at all, though over time the decrease in input purchases might be discernible if there isn't too much other variation in the data to swamp it. Thus the physical flow accounts are fairly limited in the extent to which they will let us track the sustainability of non-renewable resource use.

C.1.d Residuals and damage to the environment from economic activity

The SEEA aims to provide data with which to ensure that activities affecting service functions of the environment are avoided or minimized and sinks are not used above assimilative capacity. (SEEA 2000, para. 1.6) That means we can continue to benefit from recreation, watershed protection, clean air, and other services, and pollutant emissions are kept low. The discharge of residuals (pollution) can have significant impacts on service functions of the environment. The residuals data in the accounts generally will let us assess whether those discharges are meeting national standards for pollutant emissions. Insofar as those standards are adequate to protect service functions of the environment, and don't go above assimilative capacity, the accounts will tell us something about the sustainability of our pollution levels. However, since the accounts are not spatial, if national standards are do not protect specific sensitive ecosystems, the accounts will not capture that information. In addition, while the physical accounts show emissions that occur, they do not show emissions (or other use of environmental services) that are avoided. The monetary data on pollution control expenditures shed some light on this issue, but it is hard to link them to decreases in emissions or other avoidance of environmental impact. Thus the accounts will provide only a simple assessment of the impacts of pollution on the environment.

C.2 Weak sustainability

C.2.a Concepts of weak sustainability

An economy is weakly sustainable over a time period if its potential to generate income is the same at the end of the period as it was at the beginning. Because income is generated from assets, and the value of assets is based on the expected future income stream to be derived from them, this is, at least conceptually, the same as maintaining the overall combined value of the country's assets over the time period. Individual assets may rise or fall in value as long as the total does not decline. Moreover, if we know (or believe) that future technological change will increase the income-generation potential of our assets, then even a decline in their value this year could be considered sustainable, since future income will rise nevertheless once technology changes. This approach to sustainability, also referred to as "economic sustainability," typically assumes that different forms of capital can be substituted for each other freely as a source of income.

As with strong sustainability, more careful consideration of weak sustainability raises a number of questions about what exactly we want to sustain. Economics and national income accounting (including environmental accounting) are generally concerned about sustainability at the level of the nation, since that is the level at which national accounts are built. This generally focuses on the (relatively) simple

issue of capital maintenance at the national level. Monetary accounts may also be used to look at sustainability at the sectoral level, or with respect to individual assets.

C.2.b Genuine savings

One fairly simple indicator that could shed some light on whether the assets will continue to generate a constant or increasing income flow is genuine savings, an adjusted savings rate. (Hamilton and Clemens 1999) It is calculated as follows:

	national savings, from the national income accounts
less	depletion of natural capital
less	decrease in asset value due to environmental externalities
plus	investment in human capital
equals	genuine savings.

Hamilton and Clemens have estimated genuine savings for 103 countries. As they interpret the indicator, a negative genuine savings figure is a flag that the country's development path is likely to be unsustainable, whereas a positive figure could be consistent with sustainability. This means that not only can natural and human-made capital be substituted for each other, either could also be as easily exchanged for human capital.

In order to calculate compatible estimates of genuine savings for a wide range of countries, Hamilton and Clemens have had to simplify greatly and settle for a "least common denominator" to accommodate severe data shortages in much of the world. Consequently, they use the "net rent" method to estimate changes in the value of assets. This fairly simple method values each unit of an asset at this year's price less the costs of extraction, and values the total stock by multiplying the unit value by the size of the stock. This approach is only correct under restrictive assumptions about trends in resource prices over time, but data shortages make it the only one that can easily be calculated. For similar reasons, they limit their consideration of asset degradation due to pollution to the impacts of CO_2 emissions, because that is the only pollutant whose impacts will be the same worldwide. Finally, they use annual expenditure on education to estimate investment in human capital formation. These practical difficulties mean that the resulting numbers are at best only crude approximations of the concept underlying genuine savings. Even if the data issues were resolved, however, environmental accounts would only allow calculation of some components of genuine savings, since environmental accounts do not address educational expenditures or other elements of human capital.

Following the principles of genuine savings, the SEEA 2000 calls for estimation of the decrease in asset value caused by environmental externalities. Estimating the damages caused by externalities calls for use of non-market valuation techniques such as hedonic pricing analyses, travel demand analysis, and contingent valuation. Because externalities are not marketed, some accountants argue that while such valuation is an interesting exercise, it is more properly part of economic studies relying on the accounts than an integral part of the accounts themselves. Moreover, there is considerable uncertainty in these tools, and the uncertainty in the results may be greater than the trends we seek to measure by using them. For all of these reasons, even those countries implementing environmental accounts are not regularly making these estimates.

C.2.b Sectoral capital maintenance

Thus the environmental accounts will not provide the data fully to calculate genuine savings, and it will be particularly difficult to build meaningful data for international comparisons. They may provide data for tracking trends in the value of individual assets in a single country, however. Atkinson and Hamilton (2001) have taken an ambitious approach to assessing the economic sustainability of forest management practices in a case study of Peru. They conceptualize the forest and the land where it grows as a set of assets, each linked to a flow of goods or services; timber, non-timber forest products, carbon sequestration, land used for agriculture, and so on. They then estimate the asset value of each of those assets. They place this in a cost-benefit framework, looking at the total value of the forest/land complex if it were managed to sustain the ecosystem and if it were converted to timber and agricultural land. They conclude that in the case of Peru, the resources are more valuable as sustainably managed forest than as timber and agriculture.

While this work is conceptually consistent with the forest accounting framework described in the SEEA 2000, in practice both the data limitations and the difficulty of valuing services such as watershed protection or carbon sequestration lead statisticians in most countries to focus only on the simplest forest asset, marketed timber. For example, the monetary portions of the European forest accounts discussed above (European Commission 2000) estimate the value of different types of forest assets based solely on the value of timber. This sheds light on the potential for the forest products industry to continue contributing to national income, but does not provide insight into other goods and services provided by the forest. Thus while forest accounts could in theory provide insights like those of the Peru study, as currently constructed they do not meet the more ambitious aims of those concerned with sustainability of the forests rather than the timber industry.

C.3 Global sustainability

The apparent sustainability of an individual country could depend on its depleting the assets of other countries by importing goods whose production causes environmental harm in the producing country. The environmental accounts of a single country will shed only limited light on such impacts. The accounts cover residual flows of enterprises that are "resident" in the national economy; that is, their physical base is within the country or on national territory (e.g. embassies abroad). This includes transport emissions actually occurring anywhere in the world but discharged vehicles owned by "resident" transport firms, i.e. ships, truck or planes travelling outside the national borderes of the countries in which they are resident. Thus it will be possible to track one portion of the externalities directly imposed by the national economy on the rest of the world, by isolating emissions from the transport industry and estimating where they occur.

However the environmental accounts of a given country will not track the environmental damages caused by production that is resident in a second country but is designed to meet the consumption needs of the first country. For developed countries with large service sectors that import much of the raw materials or manufactured goods they use, this could be very significant. Estimating these impacts is difficult, because data in importing and exporting countries generally are not comparable. To track the damages generated by production of goods imported by a given country, we would want to know what goods are imported, where they are produced, what residual flows result from that production, and, if the concern is economic sustainability, the monetary value of damages associated with those residuals. The conventional economic accounts show what goods are imported, but do not show where they come from. On a pilot project basis, it might be possible to link SNA import data to trade data to identify the sources of some major imports. Then if all of the relevant exporting countries had fully developed environmental

accounts, it might be possible to estimate the residuals caused by production of the imported goods. From there, it might be possible to use data about each of the exporting countries to estimate the damages caused by those residuals.

Clearly, this would be a rather difficult task. To the extent that attempts have been made to do this, they have involved limited examination of individual products, or heroic assumptions such as that the environmental impacts in the exporting country are the same as in the importing one. (Hecht 2000) Thus while this kind of analysis might shed important light on global dimensions of sustainability, we have a long way to go before the environmental accounts would contribute much to carrying it out.

D. IF THE ACCOUNTS WON'T MEET OUR GOALS, WHAT GOOD ARE THEY?

This paper has suggested that the environmental accounts will provide neither clearly defined "green" macroeconomic indicators nor a simple, clear picture of whether we are achieving sustainability. They can be used to produce measures such as the SEEA's environmentally adjusted GDP or the material flow accounts' total material requirements, but the meaning of these indicators is ambiguous. They are, therefore, unlikely to replace conventional macroeconomic measures.

On the sustainability side, the accounts are also limited. They can tell us whether stocks of certain renewable and non-renewable assets are being maintained, which will be sufficient to answer some questions about the sustainability of our resource use. They will also provide some key inputs into calculation of genuine savings, which could evolve into a uniform measure of the sustainability of asset us over time. However, environmental accounts will not shed light on more complex concepts of sustainability of natural systems, at least as they are now implemented.

So what good are they, if they don't meet the ambitious hopes of environmentalists and ecological economists? As in so many arenas, there is no magic bullet - but there are tools that can help us scratch away at our goals, and work towards a wide array of less ambitious objectives that are important for incorporating environment into our decision-making and thus moving towards sustainability. By structuring environmental data so they are compatible with the rest of the SNA, we can link environmental and economic issues in models that let us understand the impacts of the economy on the environment or vice versa. With these data we can analyze the economic impacts of specific environmental policies - to reduce greenhouse gas emissions, implement tradeable permits, or tax "bads" instead of "goods" - to ensure that we protect the environment in the most cost-effective way possible. We can also assess the environmental implications of economic development strategies, so our economic strategies are set in an integrated way. While environmental accounts are not a magic bullet to measure welfare or ensure sustainability, they will help us work towards a more sustainable future.

REFERENCES

Adriaanse, A., Bringezu, S., Hammond, A., Moriguchi, Y., Rodenburg, E., Rogich, D., and Schütz, H., 1997 *Resource Flows: The Material Basis of Industrial Economies.* World Resources Institute, Washington D.C., 66 pp.

Alfsen, K., Bye, T., and Holmoy, E. (Eds.), 1996, “MSG-EE: An Applied General Equilibrium Model for Energy and Environmental Analyses.” Statistics Norway, Oslo-Kongsvinger, 171 pp.

Atkinson, G. and Hamilton, K., 2001. Sustainability, Green National Accounting and Deforestation. Draft.

Daly, H. 1989, "Toward a Measure of Sustainable Social Net National Product." In: Ahmad, Y., El Serafy, S., Lutz, E. (Eds.), 1989. Environmental Accounting for Sustainable Development. `The World Bank, Washington, D.C., 100 pp.

European Commission. 2000. The European Framework for Integrated Environmental and Economic Accounting for Forests - IEEAF. Office for Official Publications of the European Communities, Luxembourg, 106 pp.

Hamilton, K. and Clemens, M., 1999. Genuine Savings Rates in Developing Countries. World Bank Economic Review. 13, 333-56.

Hecht, J., 2000. Lessons Learned from Environmental Accounting: Findings from Nine Case Studies. IUCN/ The World Conservation Union, Washington D.C., 42 pp.

Hicks, J., 1946. Value and Capital. 2nd edition. Oxford University Press, Oxford.

Hueting, R. and de Boer, B., 1999. Valuation and Sustainable National Income According to Hueting. Draft

Jao, C. and Chen, C-S., Bureau of Statistics, Directorate-General of Budget, Accounting and Statistics. 2000. "The Experience of Green Accounting in Taiwan." Paper presented at the Green National Income Accounts, Taipei, Taiwan, June 2000. (In Chinese)

Korea Environment Institute. March 1998. "Pilot Compilation of Environmental-Economic Accounts: Republic of Korea." UNDP- Assisted project - ROK/93/015. Research on Integrated Environmental and Economic Accounting.

Lintott, J.. 1996. Environmental accounting: useful to whom and for what? Ecological Economics. 16, 179-190,

Lintott, J., 1999. Environmental Accounting and Welfare. Journal of Environmental Assessment Policy and Management. 1, 177-193.

Matthews, E., Amann, C., Bringezu, S., Fischer-Kowalski, M., Huttler, W., Kleijn, R., Moriguchi, Y., Ottke, C., Rodenburg, E., Rogich, D., Schandl, H., Schutz, H., van der Voet, E., Weisz, H., 2000, The Weight of Nations: Material outflows from industrial economies. World Resources Institute, Washington D.C., 125 pp.

Munasinghe, M., and Shearer, W. (Eds.), 1995. Defining and Measuring Sustainability: The Biogeophysical Foundations. International Bank for Reconstruction and Development/The World Bank, Washington D.C., 440 pp.

National Statistical Coordination Board, 1998. Philippine Asset Accounts: Forest, Land/Soil, Fishery, Mineral, and Water Resources. ENRA Report No. 2., National Statistical Coordination Board, Manila, 228 pp.

Nordhaus, W. and Tobin, J., 1973. Is Growth Obsolete? In: Moss, M., (Ed.), The Measurement of Economic and Social Performance. Studies in Income and Wealth Volume 38, by the Conference on Research in Income and Wealth. National Bureau of Economic Research, New York, pp. 509-531.

SEEA 2000. System of Environmental and Economic Accounts: Voorburg Draft. Most recent versions are available on the web at http://www4.statcan.ca/citygrp/london/publicrev/pubrev.htm

Statistics Canada, 1997. Econnections: Linking the Environment and the Economy. Ministry of Industry, Ottawa, pp. 149.

United Nations, 1993. Integrated Environmental and Economic Accounting: Interim Version. UN Department for Economic and Social Information and Policy Analysis, Statistical Division. Studies in Methods, Series F, No. 61, Handbook of National Accounting. ST/ESA/STAT/SER.F/61, Sales No. E.93.XVII.12 United Nations, New York, 191 pp.

United Nations and United Nations Environment Programme, 2000. Integrated Environmental and Economic Accounting - An Operational Manual . Handbook of National Accounting. Studies in Methods, Series F, No. 78. Sales No. E.00.XVII.17. United Nations, New York, pp. 235.