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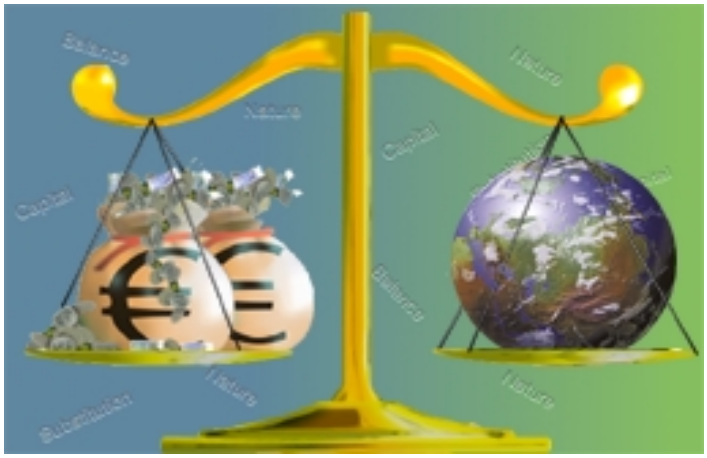
Number 9



Greening National Accounts

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This policy research brief draws on presentations and contributions made at the eighth EVE workshop entitled 'Green National Accounting in Europe: Comparison of Methods and Experiences' held at the Fondazione Eni Enrico Mattei (FEEM), Milan, Italy, 4–7 March 2000, organised by Marialuisa Tamborra.

This policy research brief was written by Martin O'Connor, Anton Steurer and Marialuisa Tamborra and produced by the series editors Clive L. Spash and Claudia Carter.

Front cover: Costing the Earth. Green National Accounting tries to quantify man-made and natural capital in order to balance the economy against Nature. Design by C. Carter, S. Niemeyer and C.L. Spash.

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Overview

The goal of Greened National Accounts is to provide policy-makers with well-structured information on the environment and on economy–environment interactions so that environmental goals and consequences can be incorporated into the political process. This policy brief summarises different methods for and applications of such accounts.

The focus has been on expanding national accounts to include environmental data sets to allow joint economic and environmental analysis.

Historical overview

The 1972 *Limits to Growth* report to the Club of Rome illustrated that environmental pollution and resource depletion caused by population growth and industrial expansion would lead societies to disaster. The concept of economic growth as a positive indicator of society's well-being was criticised. The 1968 version of the worldwide System of National Accounts (SNA) for calculating Gross Domestic Product (GDP), economic growth over time and related aggregate measures – such as Net National Income (NNI), Net Domestic Product (NDP) or Net Saving – was considered to be limited in reflecting natural resource depletion and environmental degradation.

Since the 1980s, extensions to the SNA have been along two main lines. First, the focus was on 'correcting' the SNA aggregate measures to take full account of the depletion of natural resources and the deterioration of environmental functions. Recognising the limitations of this approach, increasingly the focus has been on expanding the national accounts to include environmental data sets to allow joint economic and environmental analysis.

Agenda 21 (United Nations 1993) in Chapter 8 calls for the establishment of integrated environmental and economic accounting as a key tool for integrating environment and development in decision-making. 1993 saw the publication of the interim version of a *Handbook on Integrated Environmental and Economic Accounting* (known as the SEEA) by the United Nations. Work is ongoing on producing a final version of the SEEA handbook by the London Group on Environmental Accounting – a group of national and environmental accountants from various OECD and developing countries. The new handbook (the SEEA-2000) is expected to be published jointly by Eurostat, OECD, The World Bank and the United Nations in 2001.

At the EU level, the directions have been clearly set. The COM(94)670 *Directions for the EU on Environmental Indicators and Greened National Accounting – Integration of Environmental and Economic Information Systems* identified as main lines of actions "continuing and enlarging work on satellites to National Accounts (natural resources accounting, environmental expenditures, etc.)" and "linking economic performance indicators and environmental pressure indices". The Decision on the review of the EU's 5th Environmental Action Programme (2179/98/EC of 28 September 1998), Article 7 (Improving the basis for environmental policy) states "Particular attention will be given to: developing satellite accounts to national accounts".

Framework overview

Figure 1 groups Greened National Accounting under three main approaches: National Accounts directly expanded with monetary and physical information on the environment, Satellite Accounts and Adjusted Aggregates. This distinction helps structuring the debate. It should be noted, however, that Greened National Accounting approaches are often very closely interlinked and built upon each other.

Expanded National Accounts and Satellite Accounts can be in physical or monetary units, or both. The main difference between Expanded National Accounts and Satellite Accounts is that the latter are kept separate from the conventional National Accounts. Accounts expressed in physical units have the advantage of providing detailed information on the environment, allowing multidimensional appraisal. They also allow derivation of aggregate physical indicators for policy purposes.

Approaches to Adjusted National Accounts Aggregates directly integrate monetised environmental components into the National Account System so as to provide aggregate monetary indicators. This approach faces two major practical difficulties. The first relates to scientific uncertainty over the environmental issues in question, including the lack of data on the issue or on values related to the issue; and the second to the possibility of putting monetary values on certain environmental functions.

Policy Research Brief 3 on natural capital introduced the 'Monetisation Frontier'. This concept proposes that the ability to put money values on non-marketed environmental functions and services *decreases* with increasing importance or scale of the issue (such as global climate stability or a nation's diversity of species) and with the kinds of

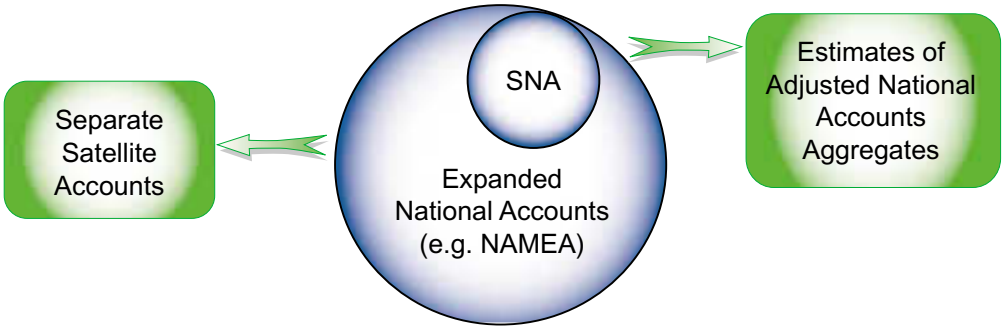


Figure 1. Approaches to Greened National Accounting

values involved (such as existence and non-use values and cultural and ethical aspects being involved). This concept helps structuring the controversy over whether it is appropriate to aggregate different forms of capital ('weak' *versus* 'strong' sustainability; see Policy Research Brief 5) and, in particular, whether produced and natural capital can be aggregated. It has been proposed to treat some environmental assets as 'critical' capital, i.e. assets which cannot be replaced in any meaningful way.

This policy brief focuses on the respective roles that different approaches can play for policy purposes. The section on Extending National Accounts (pp. 6–10) provides some detail on Expanded National Accounts and Satellite Accounts, presenting relevant current applications as well as some potential future uses. The section on Environmentally Adjusted Aggregates presents the two main types of adjusted aggregates and explains their policy uses and the basis for their construction (pp. 11–17). Research Recommendations and Policy Relevance (pp. 18–19) summarise the most relevant issues to policy-making and future research highlighting new areas of work and the potential for integrating different methods. The section entitled Key Points (p. 20) concisely states the main issues raised in this brief and also lists some internet resources relevant to greening national accounts.

Extending National Accounts

Many individual sets of accounts have been developed and successfully applied in practice. Well known types include:

- **Asset Accounts** for natural resources including accounts for forests, subsoil assets, land, soil and water; these accounts may be using physical or both physical and monetary units;
- **Emission Accounts** including accounts for air emissions, energy use, waste and use and pollution of water;
- **Material Flow Accounts**, ranging from specific substance flows (e.g. for carbon) to economy-wide material flows which are used to derive key material use indicators (such as total material requirement) and physical input–output tables;
- **Environmental Protection Expenditure Satellite Accounts** and **Environment Industry Accounts** showing the financial resources dedicated to environmental protection and the employment generated due to environmental protection; and
- **Resource Management Accounts** describing the money flows related to the management of natural resources.

Directly Expanded National Accounts

The basic principle of the **National Accounts Matrix including Environmental Accounts (NAMEA)** is to directly expand national accounts with environmental information. Under different names, this system, developed by the Dutch Statistical Office with a first pilot study in 1993, is currently in use in most member states of the European Union (EU) and several other countries. NAMEAs have already been used as the main database for policy analysis, including assessment of planned policies and projects. A further application is the modelling of alternative scenarios of economic development, for example the estimation of 'Sustainable National Incomes' for the Netherlands which used NAMEA data in its model (see Verbruggen 1999).

NAMEA has the advantage of being fully consistent with standard economic and social data and indicators. This allows calculating the contribution of industries and households to a variety of environmental pressure indicators (emissions to air, discharges into water and solid waste) compared with, for example, their economic performance.

Thus eco-profiles and efficiency indicators can be obtained and changes over time tracked. One example is an indicator of 'CO_2 per value added by type of industry' (Eurostat 1999). Current applications in EU member states tend to be limited to air emission accounts, but some have also looked for the integration of the NAMEA framework with energy accounts, environmental expenditure, environment taxes, the use of natural resources (especially water and energy) and land use.

Satellite Accounts for natural resources

Over the past years, detailed Satellite Accounts for natural resources have been developed. Some of these are so far only expressed in physical units (e.g. water quality accounts). Integrated physical and monetary accounts are becoming common practice for those resources that are traded on the market directly as part of national accounts. Examples are forests and subsoil assets (see Box 1). Other natural assets are more difficult to describe and value, although some progress has been made accounting for pollution of water, land and air. For example, the German Water Flow Accounts represent flows between nature and the economic system in physical units (cubic metres), namely water abstraction rates and wastewater flows in terms of residuals and pollutants. The system is planned to be structured as a physical input–output table (PIOT) indicating the flows by branch of activity and by origin/destination, domestic or foreign, similar to the NAMEA system (Schoer and Flachmann 2001). Progress has also been made to describe ecological dimensions of water quality accounts as developed by the French Environment Institute (IFEN 1999). Furthermore, international reporting formats and methodologies for air emissions and data on land use and land cover (e.g. CORINE Land Cover) have several applications in the field of environmental accounting. Box 2 focuses on a particular application in the field of land cover/use accounting.

Box 1: Forest and Subsoil Asset Accounts

Several European countries regularly produce accounts for natural assets. A comprehensive system of physical and monetary accounts for forests has been developed by Eurostat in 2000. The monetary value of European Union forests has been estimated at about 400 billion Euro. However, it remains difficult, if not impossible, to be exhaustive when estimating the value of environmental and recreational functions of forests.

Advancements in accounting methodologies were also registered in the field of subsoil assets accounting, especially when dealing with oil and gas. The value of oil and gas reserves in the EU is estimated at 200 billion Euro. The value of the stock of forests and oil and gas reserves together represents only about 3.5 per cent of the total value of the man-made capital stock in Europe.

Source: Eurostat 2000a, b.

Box 2: Land Cover Accounting in the Czech Republic

The ideal for spatial inventory purposes would be to simultaneously attribute to each spatial unit a classification in terms of land cover and type of economic activity. This highlights the central challenge for the collection and exploitation of spatial data: the effective linking of the disaggregated geographical data with the categories of economic activity data (sectoral production, services and household consumption).

Work in a recent Czech Republic study has explored prospects for exploiting CORINE Land Cover data for integrated economic (sectoral) and environmental (quality and quantity) accounting. The empirical and statistical results of this study, and other similar ones, show that there is not a tight one-to-one correlation between land cover categories and economic activity type. For statistical purposes, a 'linkage matrix' can be constructed which specifies the share of each economic activity type for a particular land cover category. On the basis of scenario hypotheses on each side – concerning physical or policy constraints on land cover changes on the one hand, and changes in economic output, final consumption, housing and building stock, etc. on the other hand – it is possible to link land cover accounting and conventional economic statistics categories within a single scenario or forecasting framework.

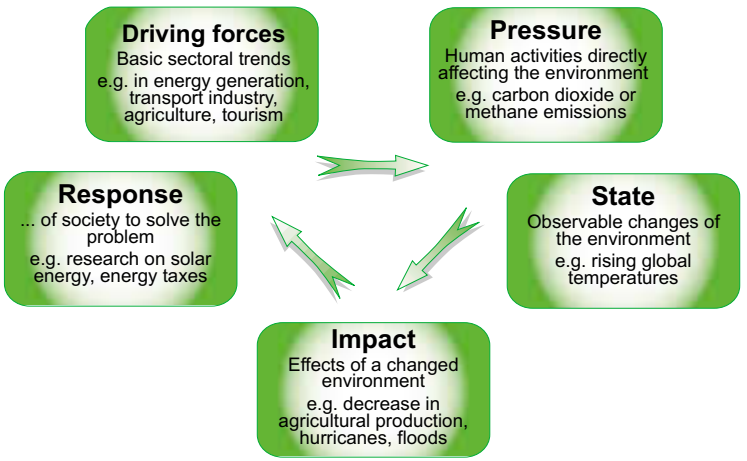
Source: Kolar (1999)

Greened National Accounts and their relation to environmental indicator systems

Environmental accounts provide direct inputs to systems of environmental indicators. The best known frameworks for classifying indicators are the Pressure-State-Response (PSR) framework, first adopted by the OECD's State of the Environment group, and the European Environment Agency's Driving forces-Pressure-State-Impact-Response (DPSIR) model (see Figure 2). NAMEA-type accounts present environmental pressure indicators integrated with economic data and allow tracing back the origin of the pressures to industrial branches. Being directly integrated with the national accounts the system also allows allocating pressures to final demand categories (e.g. to household consumption) using input–output techniques. The advantage is to have a highly integrated economy–environment system, avoiding monetisation.

In many cases detailed indicators do not deliver the type of information required for policy fomulation and more aggregated information is needed. How to obtain such synthesised information is still being debated.

Figure 2. The Driving forces-Pressure-State-Impact-Response (DPSIR) model



Some suggest to use 'headline indicators', i.e. a few selected suitable indicators that are able to highlight major problems. Others prefer aggregating indicators into indices, using specific criteria and procedures. In the first case, a selection among all indicators is made reducing the amount of information, whereas in the second case information is made more manageable from a policy point of view, calculating indices as aggregations of indicators. Aggregation procedures can either be based on scientific criteria or reflect the opinions of experts or the public in general. For instance, Material Flow Accounting seeks to synthesise the array of information on the interaction of human activity and nature through the quantification of their material exchange (see Box 3).

Box 3: Material Flow Accounting

Economy-wide material flow accounts are aggregate descriptions aimed at revealing the quantity and the structure of the total material throughput of national or regional economies. This methodology has been developed by the Wuppertal Institute and is currently applied by the German Statistical Office. The approach provides useful measures for resource productivity which has attracted the interest of policy-makers, also at the European level. In fact, this method of analysis allows to calculate the Total Material Use indicator that is considered one of the headline indicators in the German Environmental Barometer and the EU Set of Headline Indicators, complementing other headline indicators such as total water use or carbon dioxide (CO_2) emissions.

Source: EU Concerted Action on Material Flow Accounting (ConAccount); http://www.wupperinst.org/Projekte/ConAccount/index.html

Monetary valuations

Although we cannot introduce all ecological goods and services into markets, it is nevertheless possible to extrapolate from actual market transactions to get an estimate in money terms of the value of some environmental good, or the cost of some environmental harm. Environmental goods or damages may be assessed in terms of their impact on other sectors of activity; for example, the production of goods having a market price, or it may be assessed on the basis of substitute or complementary goods that have a price. According to the economic literature, these methods can be divided into two broad categories: (i) methods of revealed preferences in relation to existing markets (market price, restoration cost, avoidance cost, travel cost and hedonic pricing methods); and (ii) methods of stated preferences in relation to hypothetical markets (contingent valuation and conjoint analysis methods). Environmental valuation methods are summarised in Policy Research Brief 1.

The existence of a monetary price for an asset or service can have an institutional basis. Sometimes the asset in question entails monetary or legal liabilities (such as emissions fees or fines, or compensation for damages), or the potential for commercial benefits (sale of the asset or derivatives of it). There are then some fiscal elements that can be taken as an indication of the direct economic significance of the asset in question. However, these monetary values will not necessarily signal the opportunity costs of asset use for the society as a whole.

Box 4: The GARP Approach: Valuing Damages

The GARP II project extended the research agenda developed under the previous stage of research (GARP I, see Markandya and Pavan 1999). Both projects were financed by the European Commission and initiated with the objective of developing a consistent methodology for the construction of physical and monetary environmental accounts in the EU, by examining the environmental impacts of economic activities.

The approach mainly focused on the impacts of air pollution on human health, crops and building materials (for health valuation, see also Policy Research Brief 7). There are two main elements to the analysis: damage calculation and damage attribution. Both can be done using the ECOSENSE model, a computer model that combines data on technology, emissions, damages caused by exposure to pollutants and valuation data. Damage calculation involves calculating the value of damage impacts caused by the pollution within a country. Damage attribution allows emissions to be allocated by economic sector and ultimately allocating damages to their sources.

Another important result of this methodology is the estimation of trans-boundary effects of air pollution in Europe. Net imports/exports of damages are calculated by subtracting the damage costs occurring within one country from the corresponding damage costs caused by the same country elsewhere within the EU.

Source: Markandya *et al*. (2000)

There are two approaches to monetisation: supply-side (or cost-based, after the SEEA revision terminology) and demand-side (or damage-based). While supply-side or cost-based estimates answer the question 'how much would it cost to avoid environmental degradation?', demand-side or damage-based estimates answer the question 'how much is the environmental degradation worth (in terms of benefits lost)?'.

Box 4 presents recent research under the GARP projects aimed at establishing monetary values for damage categories. GARP II applied a damage assessment method based on the Impact Pathway Analysis tested first under the ExternE project (see Policy Research Brief 3). The application of this methodology provided good results for air pollution damages, whereas damages to other media still pose some problems, especially where uncertainties are high (e.g. climate change or biodiversity).

An example for valuing ecosystems is a recent EU-funded Czech project. Work was carried out to assign monetary values to different biotopes, on the basis of defined ecological characteristics, and then to furnish a spatial distribution of economic values of ecosystems by combining the monetary values for biotopes with land cover data for the Czech Republic (see also Box 2). This procedure was adapted from a German Law on Environmental Liability that assigns a compensation cost for damages to different types of biotopes. The value of the biotopes is determined by their maturity, naturalness, diversity of structure, species diversity, biotope rareness, species rareness, vulnerability and level of threat. Finally, the CORINE Land Cover data base was exploited in order to define biotope categories and, on this basis, to obtain a map of spatial distribution of biotope types. Using the monetary values per area, the end result was a map of the spatial distribution of the monetary values as a function of the ecosystem, which can be useful for policies at the local and national levels.

Environmentally Adjusted Aggregates

Concepts for Environmentally Adjusted Aggregates

Two complementary concepts have emerged for defining 'environmentally adjusted' macro-economic indicators for a national economy. The first type of adjustment, relative to standard national accounting conventions, is a change in the system boundary, an enlargement of the scope of national accounting to include specified categories of environmental assets. The second is an adjustment of the economy itself, i.e. an 'adjusted economy' with new production processes, new technologies and revised levels of production and consumption activity which respect specified environmental performance standards.

Each of these adjustments can be the basis of an 'environmentally adjusted national income' figure. Table 1 outlines the four combinations of adjustment possible. Segment [A-1] refers to the traditional macro-economic indicators based on the standard national accounting conventions. In segment [A-2] there are 'adjusted' aggregates for an existing economy. These are based on using an enlarged asset boundary when assessing *net asset change* for the national economy during the current accounting period. This can be called AICCAN, meaning 'Aggregate Indicator for the Change in the Current year in the economic Assets of the Nation'. The 'Environmentally Adjusted National

Table 1. Environmental adjustments to national accounts

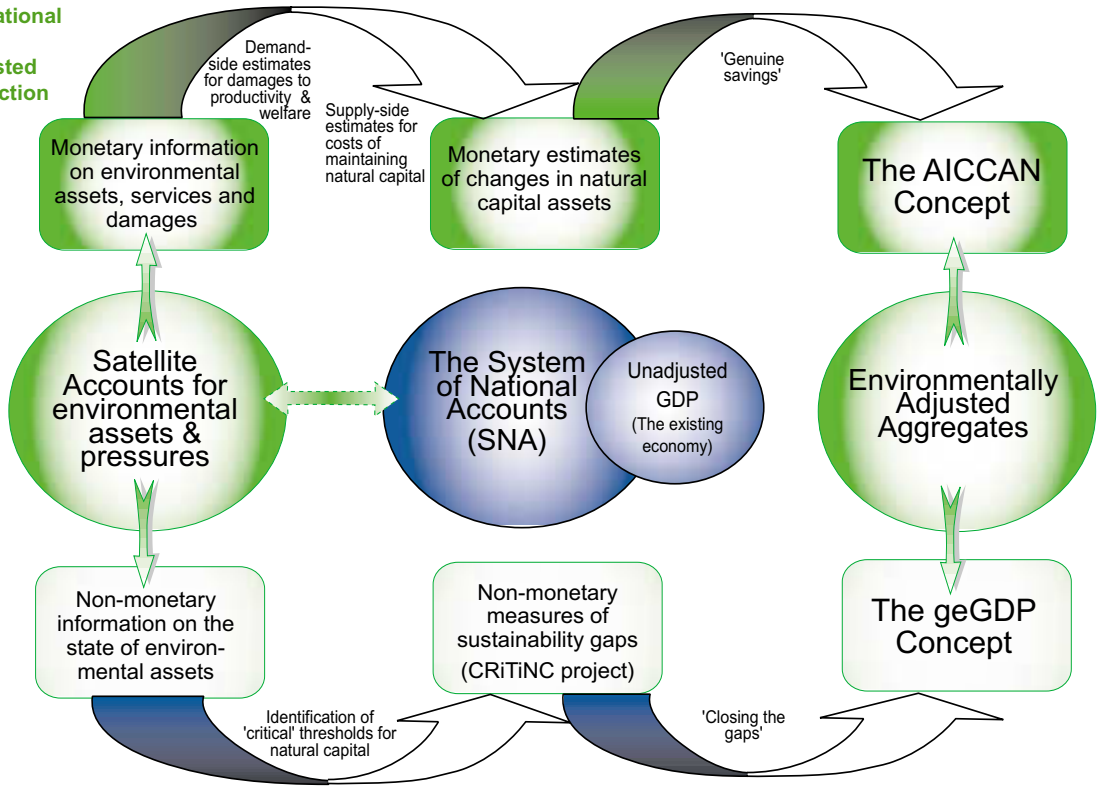
		System boundary (capital stocks included in the measure of asset value change)	
		Usual set of produced economic assets	Enlarged to include all produced assets plus specified environmental assets
Reference economy for estimation	Statistics for the current really existing economy	[A-1] The traditional or 'unadjusted' GDP and NDP (NDP = consumption + net savings)	[A-2] An 'environmentally adjusted' Domestic Product for an enlarged portfolio of national assets
	'Shadow aggregates' for a model economy with environmental performance standards	[B-1] GDP and NDP 'volume' measures for an 'environmentally adjusted economy'	[B-2] ... waiting to be done ...

Income' or 'green NDP' is defined as this net asset change (net savings) plus national consumption. Segment [B-1] refers to ordinary GDP for an 'environmentally adjusted economy'. These are figures obtained for a hypothetical economic structure, responding to the question 'What would be a feasible macro-economic performance if the existing economy were modified so as to respect specified environmental performance standards?' We refer to such figures as 'greened economy GDP' (geGDP). Figure 3 outlines the key concepts and analytical steps of constructing adjusted aggregates.

AICCAN aggregate indicator

At present, work to estimate a 'net asset change' indicator is largely carried out by the World Bank. The value of primary resources (minerals, oil, gas, forests) is estimated using market prices. Attempts are also made to estimate losses in economic potential not directly reflected in market prices, such as health damage due to air pollution (morbidity and mortality) or irreversible ecosystem damages. AICCAN results have been compiled in time series for the past 30 years for selected countries, under the

Figure 3. Green national accounts and the pathways for adjusted aggregate construction



(somewhat misleading) heading of 'genuine savings'. The figures are highly dependent on the categories of environmental assets included. Yet, some rather persistent trends are clear. These include:

- very low or negative 'net savings' over many years for many 'developing countries', for the basket of economic and environmental assets being considered;
- convincing evidence that a large range of environmental assets are being persistently depleted, in many (though not all) of the countries for which figures are produced, without much evidence of investment of the proceeds of this resource exploitation into other productive assets.

The indicators produced inevitably take account only of a few 'natural assets' of a country – those for which some money figure for 'change in the asset value' is easily obtained. Many environmental conditions that are not readily treated as 'assets' with quantifiable money value are nonetheless of great significance for economic vitality and sustainability. Examples are the atmosphere, biota, wetlands and other complex terrestrial and marine ecosystems. Moreover, the diagnosis of an 'asset-stripping' problem – in the case that the AICCAN is negative or very small – does not, in itself, tell where a remedy might be found. For this reason, the development of concepts and country capacities for exploring prospects for economically and environmentally sustainable development strategies is also important.

Environmental values and sustainability standards

The geGDP type of adjustment procedure focuses on the prospects for altering the economic system in order to improve environmental performance in a cost-effective way. Ecological dimensions of sustainability are specified through non-monetary targets relating to maintaining key environmental functions such as vital natural resources, environmental waste absorption and life-support capacities.

In the ecological economics literature, environmental sustainability requirements are typically expressed in terms of three types of constraints imposed on economic growth paths in order to respect ecological limits:

- the utilisation of renewable resources should not exceed their rate of renewal;
- waste emissions should be less than the assimilation capacity of the environment;
- exhaustible resources should be extracted at such a rate as permits their replacement by renewable sources.

Estimates are then developed of economic performance prospects for a national economy that adheres to, or moves towards, these environmental standards.

BOX 5: Sustainability Standards in the GREENSTAMP and CRiTiNC Projects

The requirements of maintaining natural resources, environmental waste absorption and life-support capacities can be approached through defining norms relating to the maintenance of key environmental functions. This has been reinforced in the conclusions of the **GREENSTAMP** research project on 'Methodological Problems in the Calculation of Environmentally Adjusted National Income Figures', carried out during 1994–1996 for the European Commission. This project investigated the different theoretical options for defining an environmentally adjusted national income figure – a geGDP – that could be estimated based on available statistical data and analytical tools.

The concept of the 'sustainability gap' has been systematically developed by Ekins and researchers of the EU-funded **CRiTiNC** project, who built on work by Hueting, de Groot and others. The research explored through case studies how the identification of such 'gaps' may be the basis for analyses of technological, land use and other responses in evaluating policies for sustainable development (see also Policy Research Brief 3).

Sources and further information: Brouwer and O'Connor (1997a, b); O'Connor and Ryan (1999). Ekins and Simon (1999), Hueting (1980), De Groot (1992).

Building on early work by Roefie Hueting at the Dutch Central Bureau of Statistics, the norms-based approaches led first to the identification of 'sustainability gaps'. A **sustainability gap** is the difference between the observed state of natural capital (in quantity and/or quality terms) or level of environmental pressures that may degrade the natural capital in question, and a threshold level that is considered compatible with a sustainable development of the economy (see Box 5). Using this approach, estimates of costs of adjustments of economic activity to respect the sustainability norms can be determined.

A more specific measure is to estimate the **sectorial costs of 'closing the gaps'** derived from the economic costs associated with respecting the sustainability standards for each sector of economic activity. Costs of meeting sustainability standards through technological improvements, pollution treatment and/or substitution of inputs can be estimated with partial equilibrium methods – such as pollutant abatement cost curves (see Rademacher, Riege-Wcislo and Heinze 1999). Analyses at a sectoral level are usually made on the basis of estimating costs of input substitution or pollution control with current market prices. This is a satisfactory procedure as long as the adjustments in question are small compared with the overall volumes of economic activity. At the national aggregate level, quite different considerations apply.

Estimating a 'greened economy' GDP

The greened economy GDP (geGDP) refers to the feasible economic production, for the accounting period(s) in question, subject to the condition that the economy is respecting a specified set of environmental standards. The geGDP is an indicator about possible future performance integrating economic output and environmental standards as complementary criteria. The purpose of geGDP, compared with unadjusted GDP, is to quantify economy–environment policy trade-offs in the sense of estimating output losses or economic opportunity costs associated with improving environmental performance. The key accounting conventions are:

- the Frontier of Monetisation is set at the interface between economy and environment where the non-monetary environmental pressure criteria are specified. No attempt is made to place monetary values directly on environmental assets;
- the GDP adjustments involve the economy being modelled, not the accounting conventions.

There are several variants in the way that a geGDP may be specified. Three sets of binary distinctions should be held in mind, as outlined next.

(i) Ex post versus ex ante appraisal. The *ex post* approach estimates the amount the existing economy might have been able to produce if it had been required to respect tighter environmental performance standards. The Dutch statistical office at the initiative of Roefie Hueting has developed this approach over the years (Hueting and de Boer 2001). The most recent work in this lineage uses a full-economy modelling approach (Verbruggen 1999). The *ex ante* approach estimates the amount the national economy might (hypothetically) in the future be able to produce while constrained to meet specified environmental pressure standards. Studies can use 'back-casting' and comparative static analyses, as well as iterative dynamic simulations. The *ex ante* scenario-based approach was explicitly formulated in the GREENSTAMP project (see Box 5). Its roots go back to 'greened economy' scenarios around the world since the 1970s.

(ii) Snapshot (comparative static) versus dynamic simulation modelling framework. A plausible and internally consistent estimation of economic opportunity costs of 'supplying sustainability' requires use of a multi-sector economic modelling approach using:

- comparative static analyses of economic structures and related environmental performance; and/or
- dynamic scenario modelling.

In a comparative static analysis, alternative feasible structures of economic activity are compared – in the simplest case, a non-greened economy GDP is compared with a geGDP. In comparative dynamic scenario analysis, the time-trajectories for the consumption aggregates can be compared in terms of relative growth/abatement rates for final consumption and environmental pressures (e.g. Schembri 1999a, b).

(iii) Complete or only partial respect of requirements for long-term sustainability. The figures for geGDP will depend partly on the environmental standards specified. So a further distinction is made between:

- a model greened economy or transition path that respects all environmental standards for long-term sustainability of economic activity and the relevant critical natural capital; and
- model analyses for environmentally adjusted economies constrained by an incomplete set of standards. Here the economy is 'greener' than a business-as-usual scenario but does not achieve full compliance with ecological requirements for long-term sustainability (to the extent that such a set can be specified under the current scientific knowledge and uncertainties).

All geGDP estimates, whatever concept they engage, are highly sensitive to model calibration, specification of environmental standards, technological change and other assumptions used.

Valuation concepts underlying the AICCAN and geGDP indicators

The establishment of AICCAN measures of net asset change in monetary terms does not reduce the need *also* to specify targets for the ecological aspect of sustainability, i.e. the maintenance of critical environmental functions. Therefore AICCAN and geGDP complement each other. Both are based on different conventions about where to situate the Monetisation Frontier and how to work at, and across, the boundary (see Policy Research Brief 3).

The AICCAN-type monetary measure of net asset change assesses natural resources and assets from the point of view of their contribution (actual or potential) to the production of commercially priced goods and services (e.g. trees into wood products, human health for its impact on worker effectiveness).

The geGDP approach considers economic costs of reducing disinvestment in natural capital – i.e. costs associated with maintaining or restoring specified environmental functions. There is no monetisation of the environmental assets themselves. However, there is a sense in which the cost-effectiveness approach imputes an 'economic value' to changes in the availability of the environmental functions. An answer is given to the question: 'How much more environmental functions are obtainable in exchange for how much less economic output?' The sectorial estimates of costs of 'closing the gaps' (see p. 13) provide information on the economic opportunity costs of restoring, maintaining or not degrading the specified natural capital quality and quantity; for example the cost of supplying unpolluted water through abatement of chemical fertiliser and pesticide use in agriculture.

Policy uses of adjusted aggregates

Practical experience suggests that there are clusters of problems for which the AICCAN and/or geGDP approaches work well.

Forests being considered for commercial logging, proven mineral reserves, oil and gas are examples of environmental assets that are fairly easily brought within the sphere of monetary accounting. Here the AICCAN approach can provide a quick guide to natural resource depletion, looking at the speed at which a country is depleting its marketable assets in relation to revenues received and their use. Fisheries, climate change, and land cover change are examples where there is still disagreement as to the usefulness of placement into the monetised asset basket.

Resource depletion and ecosystem protection issues which can be quantified in terms of environmental pressure indicators but which are associated with high uncertainties, and hence difficulties in quantifying long-term environmental and economic consequences, can be treated meaningfully with the geGDP cost-effectiveness approach. Examples are marine fisheries (where catch limits can be proposed), water pollution and atmospheric pollution (including greenhouse gas emissions and CFCs implicated in the destruction of the ozone-layer) for which emissions and concentration targets can be made the primary policy reference points.

Some environmental issues, such as biodiversity protection, may pose difficulties for both monetary valuation concepts and standards-based analyses, because there is little consensus about meaningful indicators of biodiversity change and their value on a global scale or across a wide diversity of ecosystems.

Research Recommendations and Policy Relevance

The current SEEA revision aims to organise existing methodologies in a synthesised framework, allowing each country to adopt appropriate methods for their specific context and their policy purposes. The need is now to produce environmental indicators and accounts on a regular basis as support tools for policy-formulation.

Judgements about indicator usefulness cannot be separated from underlying notions of current and future societal well-being. The typology of adjustment concepts presented in this brief, relates to including the maintenance of key environmental functions and ecological services in national asset accounting. Three areas of research need further work:

- integration of welfare issues with sustainability issues;
- international patterns of environmental degradation (the so-called ecologically unequal exchange); and
- relations between societal infrastructures and the maintenance of natural capital.

Coupling sustainability and welfare. Recent research efforts in Europe have been highlighted by two complementary research projects, GARP and GREENSTAMP. These projects have developed from different perspectives, GARP taking a welfare-based approach and GREENSTAMP a standard-based approach.

Both types of information are relevant to policy-making. The binding constraint for some environmental issues is welfare optimisation and for others it is sustainability standards. For example, noise does not have many sustainability implications but strong welfare effects. On the other hand, biodiversity loss entails environmental damages and eventually welfare losses, but sustainability implications are far more important. The two concepts are potential future areas of research, combining the welfare-based and the sustainability standards approaches in order to identify indicators of efficient and sustainable output and welfare.

International dimensions – ecologically unequal exchange. A significant part of environmental changes for the national territory may be 'caused' by foreign activities rather than domestic production and consumption. Conversely, a nation may be the cause of environmental damage outside its own territorial borders, such as the

transportation of pollutants in air, water or solid media beyond its national boundaries. The distinction between 'costs caused' and 'costs borne' obviously is of high policy significance. A nation's relatively good AICCAN or geGDP performance might be neglecting the ways that the national economic activity is 'exporting' environmental damage upstream and downstream. Or a nation's relatively poor AICCAN or geGDP performance might partly be due to the degradation of natural assets being used as a primary resource or as a sink for other nations' activities (e.g. contamination of ecosystems from export-oriented mining operations).

Examples of key indicator concepts are the direct and indirect net requirements of a national economy on the world community for primary energy, water, agricultural land and/or photosynthesis potential, fisheries harvest, stockage of toxic wastes, and emissions of atmospheric pollutants. Analysing the correlation for such indicators can help reveal patterns of vulnerability. It can also be highly relevant for international relations, notably in the negotiation of equitable distribution of access to the benefits of – and the costs of sustaining – the planet's fund of ecological goods and services.

As work matures in this field, it will become easier to assess the extent to which a nation's sustainability potential actually depends on its linkages with the rest of the world.

The social dimensions of sustainability. The interface between environmental assets and societal infrastructures or 'social capital' has received less systematic attention in the 'green' extensions to national accounting systems. For example, the linkages between local community infrastructures, informal and unpaid labours (including community care and subsistence production) and local ecosystem integrity are key to achieving a minimum of economic security in many societies but have largely been neglected.

Recent work by the World Bank looking at 'social capital' is a step in this direction, but as yet only touches the tip of the iceberg. Another example of integrated assessment in view of sustainability is the Dutch system which integrates economic accounts (following the SNA) together with environmental (NAMEA system) and social accounts (SAM system). There is, nonetheless, a rich academic and activist body of research on subsistence economies, local ecosystem degradation and maintenance, gender relations in domestic and community production, and communal infrastructures. All of this can usefully be exploited in future greened accounting work. This is also in line with international developments in the field of indicators (e.g. the United Nations Commission for Sustainable Development) calling for integrated assessments of policy against economic, environmental and social indicators.

Key Points

Greened National Accounts must be policy relevant and useful for policy analysis. They must contribute to processes of priority-setting by providing both relatively detailed data sets for analysis and highly aggregated indicators. A comprehensive system of national accounts must evidently take account of internal *and* external linkages. This requires the definition and estimation of monetary and physical indicators and applying them for examining the linkages between environment, society and economy.

Adjusted National Accounts Aggregates are one specific class of indicators that can be generated from the information organised in green national accounting. Two types of adjusted aggregates are particularly useful and policy-relevant for steering societies towards sustainable development. These are the AICCAN measures of net change in natural and produced assets of commercial value and the geGDP estimates for future macroeconomic and environmental performance prospects. The AICCAN and geGDP are complementary to each other and belong to a wider set of indicators and accounts that are needed for assessing current affairs and for identifying alternative future ways for society. The typology of adjustment concepts given above helps placing such adjusted aggregates in context.

Key areas of research that need to be developed further are: the inclusion of inter-country dimensions; the elaboration of a framework that combines environmental sustainability and welfare; and the social dimension of sustainability in green accounting.

Box 6: Information on the Internet

United Nations
Division for Sustainable Development:
http://www.un.org/esa/sustdev/dsd.htm
Statistics Division: http://www.un.org/Depts/unsd/enviro/environment.htm

The London Group
SEEA revision: http://ww2.statcan.ca/citygrp/london/publicrev/intro.htm

Eurostat
http://europa.eu.int/eurostat.html

JRC
Pressure Indices project site:
http://esl.jrc.it/envind/index.htm
ExternE home page: http://externe.jrc.es/

European Environment Agency
http://service.eea.eu.int/

OECD
Environmental Indicators:
http://www.oecd.org/env/indicators/index.htm

World Bank
World Development Indicators:
http://www.worldbank.org/data/wdi2000/environment.htm

Contributions to the **EVE workshop on 'Green National Accounting in Europe: Comparison of Methods and Experiences'** are published as FEEM Working Papers (Nos 89–97) and can be downloaded from the FEEM website:
http://www.feem.it/web/activ/_wp.html

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EVE Concerted Action

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Concerted Action on Environmental Valuation in Europe (EVE)

This policy briefing series communicates the findings from nine workshops and three plenary meetings under the EVE programme. These showed the diversity of research currently being undertaken in the area of environmental values and their policy expression. The type of information relevant to the decision process extends from ecological functioning to moral values. Thus a range of approaches to environmental valuation, from ecology to economics to philosophy were presented.

EVE was a 30 month project which started in June 1998 funded by the European Commission, Directorate General XII within Area 4, Human Dimensions, of the Environment and Climate RTD programme, Contract No. ENV4–CT97–0558.

The project was co-ordinated by Clive L. Spash and managed by Claudia Carter, Cambridge Research for the Environment (CRE) in the Department of Land Economy, University of Cambridge. The following research institutes were partners in the concerted action:

Bureau d' Econonie Théorique et Appliquée (BETA), University Louis Pasteur, Strasbourg, France
Cambridge Research for the Environment, Department of Land Economy, University of Cambridge, UK
Centre for Human Ecology and Environmental Sciences, University of Geneva, Switzerland
Centre d'Economie et d'Ethique pour l'Environnement et le Développement (C3ED), University of Versailles Saint-Quentin-en-Yvelines, France
Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia, Norwich, UK
Department of Economics and Economic History, Autonomous University of Barcelona, Spain
Department of Economics and Social Sciences, Agricultural University of Norway, Åas, Norway
Department of Environmental Economics and Management, University of York, UK
Department of Philosophy, Lancaster University, UK
Department of Rural Development Studies, Swedish University of Agricultural Sciences, Uppsala, Sweden
Department of Applied Economics, University of Laguna, Tenerife, Canary Islands, Spain
Environmental Economic Accounting Section, Federal Statistical Office, Wiesbaden, Germany
Ethics Centre, University of Zurich, Switzerland
Fondazione Eni Enrico Mattei (FEEM), Milan, Italy
Istituto di Sociologia Internazionale di Gorizia (ISIG), Gorizia, Italy

The purpose of this concerted action was to analyse effective methods for expressing the values associated with environmental goods and services, ecosystem functions and natural capital, with a view to the achievement of the goals summarised in the concept of sustainability. The appropriate role of decision-makers and citizens in environmental policy-forming became a central focus in the debate over how different values should be expressed.

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