LG/12/20

12th Meeting of the London Group on Environmental Accounting
Rome, 17-19 December 2007

An ecosystem approach to SEEA

Jean-Louis Weber

European Environment Agency

AN ECOSYSTEM APPROACH TO SEEA

CLARIFICATION PAPER FOR THE LONDON GROUP MEETING
ROME, 17-19 DECEMBER 2007

Session 9 on ecosystem accounts

Jean-Louis Weber
European Environment Agency
jean-louis.weber@eea.europa.eu

v.2 – 7 December 2007

Introduction

There is a need for further elaboration and the discussion on ecosystem assets and ecosystem services in the SEEA and the London Group meeting in Johannesburg considered the possibility a special manual on the subject and asked for a clarification paper.

This paper addresses the following issues:

- Developing the ecosystem approach into the SEEA
- Framework of ecosystem natural capital accounts
- Classification of stocks and flows of land cover
- Classification of ecosystem services
- Measurement and valuation of ecosystem services
- Measurement and valuation of maintenance and restoration costs
- Integration into SEEA: MFA, PIOT, NAMEA, Expenditure, Assets (Forest, Fisheries, Water and forthcoming soil), valuation, application of E-EA.
- Articulation to SNA (adjustment of net savings, inclusive gross domestic product, full cost of goods and services)
- Implementation strategy

The challenge of addressing ecosystem issues is important for SEEA recognition, with a forthcoming MA2 launched by UNEP, correlated regional projects like Eureca!2012 in Europe, “Beyond GDP” developments or the assessment of the benefits provided by biodiversity demanded by the G8+5 in Potsdam, March 2007 as a necessary input to the Convention on Biological Diversity (CBD) as well as by companies .

1. An ecosystem approach to SEEA

A major flaw of conventional economics is the representation of the economy as a closed system which produces and distributes the values it creates in partial ignorance of its interactions with its own natural resource base. The SEEA is therefore an important step forward, in particular considering sustainability of development. However, whereas SEEA2003 is fully integrated with SNA, relations to nature are scattered between chapters and unevenly developed. Ecosystems assets are indeed part of SEEA 2003 structure: forest, water, land and ecosystem accounts, soil (p.m.), fisheries but few links exist between these assets which are considered more as inventories than systems. As well, "ecosystem service" is not a well identified concept in the SEEA. The description of flows between the economic system and the ecosystem is asymmetric, balancing the economic system (backed up by the SNA) with a mere interface (the "environment" column for arithmetic balances in some tables, the "ecosystem inputs" in others). No place for feedbacks. No comprehensive and systematic measurement of the value of nature in that context.

The main consequence of this situation is the difficulty of presenting clear messages from SEEA and deriving the few aggregated indicators recurrently demanded by policy makers. The SEEA was simply absent of the Millennium Ecosystem Assessment. The recent Beyond GDP conference in Brussels – an event of high policy dimension – acknowledged the importance of economic-environmental accounting but ended in a "basket" of solutions to be explored further on, not in a single recommendation for implementing the SEEA.

1.1. Ecosystems and the SEEA 2003

The ecosystem approach to EEA is recognizing the necessity of highlighting the interaction of 2 co-evolving systems. It clarifies the concept of natural capital by separating non-renewable resources (where the rent and its reinvestment is the main issue) and the renewable resource (for which the conservation of a critical level of stocks in good functioning state is essential). It offers the possibility of a renewed approach of valuation with a clear distinction of values, costs and decision processes.

Most ecosystem components have their place in the SEEA:

- assets (above mentioned),
- stocks and flows (biomass, water, material in general, energy, species…)

They are presented per se in different sets of tables and integrated according to SNA standards: PIOT, hybrid accounts, valuation methodologies, territorial concepts. This is a fundamental property of EE Accounts which are well connected to production accounts, environmental protection and management satellite accounts and to a smaller extent to assets accounts (restriction in scope, no amortisation of the natural capital etc…).

However, the poor integration with the ecosystem has, beyond academic considerations, serious practical drawbacks for the SEEA in particular a failure in delivering one (or a small number of) of clearly established headline aggregate(s), as a

response to recurrent policy demand. The issue is in the difficulty of highlighting credible relations between economic variables which express altogether quantities and qualities (via prices) and nature where statistics of quantities and qualities are disjointed (when qualities are not simply ignored). Therefore there is a difficulty of presenting credible cause-effect relations, at least out of some particular technical context. Extraction of biomass is not a problem as long as it doesn't degrade the quality (health, resilience, reproductive capacity) of the ecosystem. Excessive abstraction contributes as much as (excessive) discharge of residuals to the degradation of water and in rivers ecosystems.

In the recent months, the policy demand for integrated operational headline indicators has been openly expressed in high level initiatives such as:

- the Stern report on the costs of inaction regarding climate change (1.5 £ paid by the UK government and a tremendous success)
- the G8 "Potsdam Initiative" for a Stern-like report on the costs of inaction regarding biodiversity
- the "Beyond the GDP" European Conference – Nov 07
- the multiplication of initiatives for ecosystem assessments and accounting (GAISP-India, Eureca!-Europe, national programmes in UK, France…)
- to which should be added the "Net Genuine Savings" (now "Adjusted Savings") of the World Bank – a solution valuable but partial and of limited echo.

The commercial success of the "Ecological Footprint" – despite obvious weaknesses in terms of practical use and calculation is another clear clue of this high level demand.

One could expect that the SEEA would be the overarching framework for all these initiatives as well as a decisive response in the confusing discussions (disputes) resulting from the multiplicity of lists of indicators and the many proposals of "composite" indicators or "baskets" of standalone indicators. This is obviously not the case and we are still discussing of possible (additional) indicators and of communication issues when the national accounts where developed from the beginning having in view GDP, GNP and NI, if not for calculating them.

1.2. Full or partial (dual) integration of economic and ecological systems

The way forward is based on the correct description of the duality and co-evolution (effects, impacts, feedbacks) of the economic system and the ecosystem. At this stage, two options are open:

- **Full integration** of both systems as socio-ecosystems, respecting the properties of both (such as the general equilibrium of prices and quantities for the economic system, the resilience for the ecosystem or the metabolism of the two).

  Full integration of ecosystem services and assets in money is the objective of environmental valuation in general, summarized by the Inclusive Wealth theory. All ecosystem services are valued with market or shadow prices (sometimes called virtual or accounting prices). The inclusive value of the total capital (including ecosystem resilience considered as a capital asset) is

given by the net discounted value of future services. The change in wealth (stocks) is the measurement of the overall sustainability of human activity.

Important research is going on these lines. Beyond the common problem of choosing credible shadow prices for the non-market end use services, the theory has to find acceptable solutions for solving the conflict between the need of discounting over long future – typically 100 years, and the resulting difficulty in identifying resilience thresholds and even high uncertainty in some cases about "ecological surprises". If inclusive wealth could be computed, it would definitely constitute a valid normative indicator combining at the same time weak sustainability (the flows of services) and strong sustainability (ecosystem resilience) criteria.

Another approach to full integration of economic and ecosystem accounts is with the current enlargements of material and energy flow accounting for capturing impacts on the environment. One can imagine that the development of such accounts will lead to comprehensive economy-ecosystem metabolism accounting in energy units (e.g. the so-called "emergy synthesis" proposed by Odum et alii). Ultimately, accounts in energy terms could be monetized in reference to energy prices.

Both inclusive wealth valuation and emergy synthesis lead to strong normative aggregates.

- **Partial or dual integration** can be achieved in the short-to-medium term, a major step forward with important outcomes.

  Partial or dual integration doesn't contradict the concepts of inclusive wealth or metabolism; it refers to them as a theoretical background guidance instead. Simply, partial integration acknowledges that not every required condition is presently met for starting to-day broad scale implementation programmes. Instead of assessing the integrated economic-social-ecological system, the dual integration model acknowledges the existence of a pair (or more pairs – when incorporating human and social capital) of co-evolving systems and their reciprocal feed-backs.

  Therefore, instead of trying to define a norm from accounting, dual integration refers to norms established by the society from multiple criteria.

1.3. The dual model of economy-ecosystem integration

It is an attempt to answer three basic questions related to economy-nature relation:

- is the renewable natural capital maintained over time at the amount and quality expected by the society?
- is the full cost of maintaining the natural capital covered by the price of goods and services?
- is the total of goods and services supplied to final uses by the market (and government institutions) and for free by ecosystems, developing over time?

The question on natural capital requests at least 3 answers:

(a) the amount and quality of ecosystem assets: it is measured by natural capital accounts in physical units;
(b) the amount and quality of ecosystem assets expected by the society, which depends on willingness by the various social groups to keep ecosystem services for productive and non productive purpose, to keep as well existence values not translatable into services and to the budgetary constraints that the society is ready to face. This willingness to maintain the natural capital is expressed in standards endorsed by international or regional conventions, regional regulations or directives, national laws. These standards can be translated into the accounting framework.
(c) the gap between actual natural capital and the society objectives, which is the difference between (b) and (a).

The additional cost of maintaining the natural capital is obtained by pricing the amount of work (or the abstention of use) necessary for filling the gap measured from physical accounts. It comes in addition to actual management and protection expenditures. As long as the restoration of a given ecosystem is generally necessary for maintaining the whole ecological infrastructure, restoration costs are included. The additional maintenance cost has to be computed for domestic ecosystems as well as for imports. The additional maintenance cost can be added to the respective products, for computing a full cost of goods and services to compare to production output; this is a strong sustainability indicator. It makes sense as an aggregate, by sectors, by companies or by products.

The ecosystem services contribute to a large part to the value of goods and services or are enjoyed individually or collectively by end-users as free non-market services. The market value of marketed ES is entangled into prices. If, because of unaccounted externalities, market prices are undervalued, an adjustment will result in terms of "full cost of goods and services". From a demand perspective, market prices are taken as such. In addition to market, some ecosystem services are enjoyed for free: recreation services, regulation of climate or water regime… They have to be added to the conventional GDP for measuring an Inclusive Domestic Product. This aggregate will tell, for example that the increase of GDP is balanced by a decrease of the free ecosystem services resulting either from their commercialisation of from environmental degradation. Accordingly, the inclusive domestic product would not grow as fast as GDP and even decrease in some case. The free end use non market ecosystem services have to be measured in physical units first, from land use and people actually using it. Valuation comes in a second step, in reference to the willingness to pay for these services.

Remarks:

- Ecosystems are understood as cycling and living systems; they are broader than natural habitats and include human population and activities; the term socio-ecosystem is an appropriate name.
- Non renewable assets are only considered in relation to ecosystem degradation resulting from excessive use of fossil resource – the main source of global pollution. They cannot be maintained as such. Their depletion or reduced use is generally favourable to the ecosystems. They will be accounted for in that perspective. For example, the maintenance cost of the atmosphere in relation to

the regulation ecosystem service is measured by the amount of C to be abated – referring to the Kyoto (and/or post-Kyoto, or "carbon neutral society") objectives.

- The loss of ecosystem wealth in the dual methodology is NOT the difference between the monetary values of Stock t2 and Stock t1. This method applies first to sub-soil assets, which are considered as inventories. When currently applied to forest or fisheries, it gives only a partial measurement of what happens to timber – and not to forest ES – and to fish – and not the fishery systems. Only accounting for the capital value of ecosystem resilience could fill this gap. In the dual approach, changes and distance to target are assesses in physical units and valued.

The dual model is fairly neutral and can accommodate in a common framework the main positions and approaches:

- continuation of GDP
- physical accounting for ecosystems (including metabolism, health, resilience…) and ecosystem services
- streamlining of the methodology and implementation of main physical "accounting" aggregates (Ecological Footprint, HANPP, MFA…)
- valuation of ecosystem services consistent with the accounting of physical services and stocks (geographical location, scales, resilience…) and – in a different step – possible extension to inclusive wealth assessment
- ecosystem maintenance costs for domestic and external ecosystems
- contribution to broadening the scope of the "genuine savings"
- norms resulting from decisions based on multiple criteria and values, not from one single aggregate

As it will be shown below, the dual framework allows a more comprehensive and systematic use of the full set of tools of the SEEA2003.

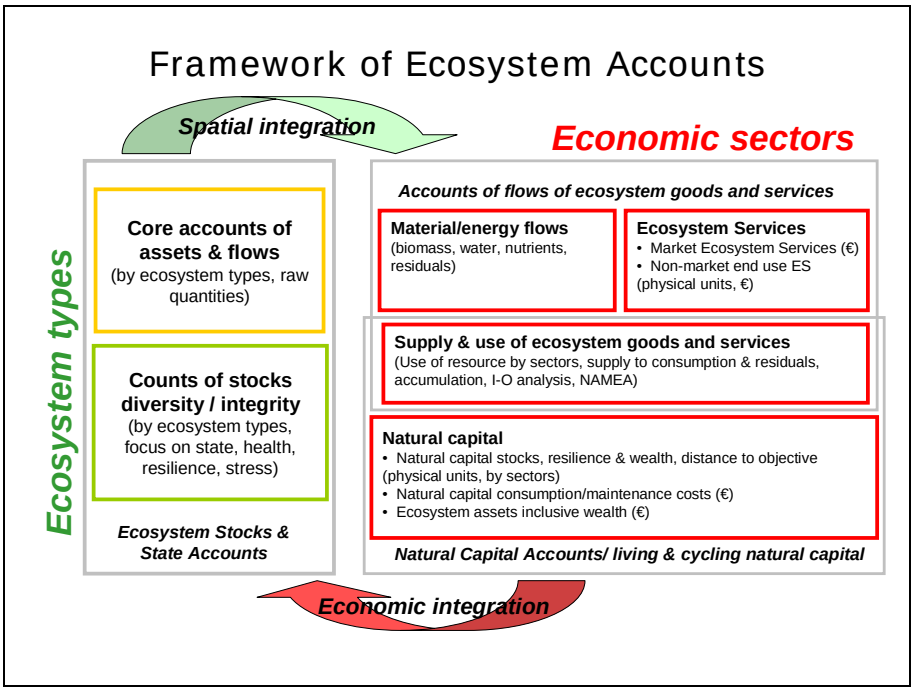
2. Framework of ecosystem natural capital accounts

A draft framework of physical accounts of the ecosystem natural capital has been published in Ecological Economics[1]. It can be summarized as such:

- Accounts established by ecosystem types (stocks, flows, resilience, services, stress) on the one hand and by sectors on the other hand (material energy flows and ecosystem services by origin, supply & use, natural capital) on the other hand.
- Ecosystem services in money (when imbedded in products) or in physical units and then in money (free end use services)
- Maintenance and restoration costs of ecosystems (up to society stated objectives) in physical units and then in money.
- Natural capital (ecosystems) in physical units only in the "dual integration" perspective.
- Inclusive wealth calculation as the ultimate step but not a pre-requisite to the implementation of the other accounts.

1 Weber, Jean-Louis, *Implementation of land and ecosystem accounts at the European Environment Agency*, Ecological Economics, Volume 61, Issue 4, 15 March 2007, Pages 695-707

- Integration of geographical information (land cover, rivers, thematic information, zonings) with socio-economic statistics.
-



3. Classification and measurement issues

3.1. Analytical and reporting units

- Analytical units: ecosystem and socio-ecosystems; ecosystem functions and ecosystem services

"An ecosystem is a dynamic complex of plant, animal, and micro-organism communities and the nonliving environment interacting as a functional unit"[2].

Social-Ecological Systems (SES) are places where ecosystem production functions meet the social demand:

- Via transformation into commodities
- Directly as individual or collective end use of recreational or regulation services

They are generally made of more than one ecosystem. Other names for SES are socio-ecosystems, geo-systems, ecozones, eco-complexes, landscape character unit, and small functional region (various labels such as agriculture or forest or coastal…), river small sub-basins… They correspond all to landscape units where relations between people and nature have developed over time. They can be described in terms of their components (land cover

[2] Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC

units, ecosystems, habitats…). Urban systems are socio-ecosystems relevant from ecosystem accounting.

SES are the spatial units generally used in the process of identification, measurement and valuation ecosystem services.

"Ecosystem services are the benefits people obtain from ecosystems"[3]. Therefore, not all ecosystem functions have to be considered as services, only those which are an outcome used by people, individually or collectively. In particular the so-called "supporting services" of the MEA are excluded from an accounting perspective. Supporting "services" (e.g. photosynthesis, primary production) or functions are (1) input to the production of provisioning, recreational/cultural and regulating services. *(see below)*

- Reporting units
  It may happen that socio-ecosystems are management entities (e.g. the natural park of Doñana in Spain), and reporting for them makes sense. Frequently, reporting is asked within other kind of breakdowns such as river basins (e.g. in the context of the European Water Framework Directive), natural regions and of course administrative regions and countries. In some cases, reporting might be limited by the geographical breakdown of the less detailed geographical entities.

3.2. Classification and measurement of stocks and flows

- **Stocks and flows**
  The main types of stocks of ecosystems are:
  - Land cover: land cover is the synthetic image of ecosystems and land use. This property makes land cover a key information infrastructure for ecosystem accounting. The European Environment Agency has produced land cover accounts (LEAC) 1990-2000 for 24 countries from its Corine inventory[4]; a 2006 update is going on for circa 35 countries. The EEA looks forward to a Pan-European and Mediterranean extension of LEAC, with GlobCover2005 and other sources. Principles for land cover classification developed in the mid-1980 by FAO/UNEP and the European Commission/Corine. De facto, the establishment of the Corine land cover nomenclature has followed the same principles as FAO-LCCS when coming to a practical implementation (Land Cover Classification System, which is a set of rules and a software for building up a nomenclature). Comparing Corine and the LCCS application for Global Land Cover 2000 and its revision for Globcover 2005, beyond similarities, the main differences are a Corine focus on the detail artificial land cover when LCCS/Globcover pays more attention to shrubs, grassland and forests types and physiognomy. Cross analysis at the EEA and at GOFC-GOLD shows that the two nomenclatures are complementary, Corine capturing better the land use processes linked in particular to urban

[3] MEA, 2005, op. cit.
[4] EEA (2006) Land accounts for Europe 1990-2000, EEA Report No 11/2006 prepared by Haines-Young, R. and Weber, J.-L. – http://reports.eea.europa.eu/eea_report_2006_11/en

sprawl when LCCS/Globcover gives useful details for ecosystem assessments.

- Rivers: the principles of classification of river ecosystems in SEEA2003/ water accounts and SEEAW. The elementary units of rivers or river reaches are analogous to land cover units and the two databases can be easily combined. River units (ecosystems) are measured in standard-river-km (1 srkm = 1 km * 1 m^3/second). They are classified according to their size and their hierarchical position in the river basin.
- Coastal systems and sea units are more difficult to define due to their fluid and dynamic nature. Coastal ecosystem can be mapped however (existing projects in several EU countries). In the sea, particular stocks, resilience, flows and services can be addressed by ecosystem accounts. They are of course fishes and other wildlife, fish farms, algae and sea grass beds, coral reefs. Erosion and accretion of the coastline is also part of the subject.
- Soil is at the same time a vital asset in the present as in the long run and an extremely heterogeneous ecosystem. Therefore, stock accounting will be framed restrictively from the point of view of soils functions and resilience. Main functions are support to vegetation, water buffering and storage and carbon sequestration.
- Atmosphere: there is no stock account of the atmosphere presently foreseen although some elements could be accounted as CO_2 and other pollutants concentration or (un)stability regarding climate events. Instead, the maintenance cost of services of climate regulation can be calculated in reference to international agreements.

- **Flows:**

Beyond C/ CO_2 exchanges of terrestrial and sea ecosystems with the atmosphere, basic flows are of water, biomass, N, P, species and land cover. Land doesn't generally flows, but he cover of land yes, when a given type is consumed for producing (formation) a new one[5].

- "**Quantityquality" measurement**

One of the aims of integrated accounting for ecosystems and services is to come to a holistic approach of quantity and quality aspects. This is in no way an academic position but a very practical one instead. Which water agency would not care of the quality of the water abstracted, distributed and returned? Is maintaining a stock of timber a sustainable policy as such when most of all other forest services[6] are sterilised by the plantation management and the resilience of the new system very problematic? Is it possible to account for the sustainable use of fish stocks of particular commercial value without accounting for the whole food chain and anticipate possible "flips" in populations dynamics?

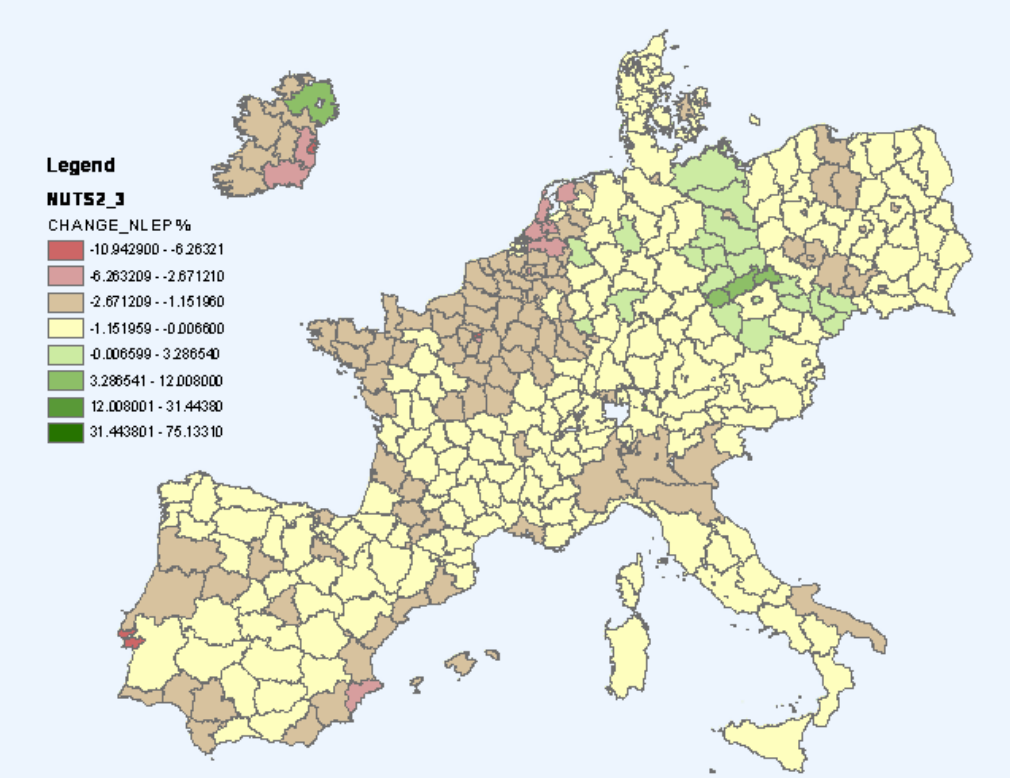
[5] See "Land accounts for Europe", op. cit.

[6] In the "green" accounts of Indian States, these services are shown to have a monetary value of the same magnitude as that of timber. Reports can be downloaded from http://www.gistindia.org/index.asp

The stocks of ecosystems and associated flows (which measure their functioning or their "production function") are therefore measured in quantities with quality attributes. These attributes are observed according to the "ecosystem distress syndrome" approach based on the observation of symptoms. More detailed explanations can be found in (Weber, 2007). One important point is that the EDS methodology can be implemented at any scale, from the complete micro modelling of ecosystems in case studies up to particular ecosystem types and up to the macro level, as the example is given in annex 2 with the Net Landscape Ecological Potential. Other macro EDS indicators currently foreseen for ecosystem accounting in Europe are one indicator based on the specialism degree of species communities and the Human Appropriation of Net Primary Production (HANPP). One promising way for these eco-integrated assessments is accounting in energy terms (exergy of systems, emergy).

Net Landscape Ecological Potential (NLEP) variation, Europe, 1990-2000

NLEP is the combination of 3 different geographical datasets:
1. The so-called green background landscape index which expresses the vegetation potential of the territory according to land use intensity. The data are computed from Corine land cover and updated accordingly.
2. The value given to nature assessed via the importance of their designation by science and policy; this is computed from national, European (Natura 2000) and international designations databases; it captures what cannot be seen from the satellite images, namely, the species richness of landscape.
3. The fragmentation of landscape by roads and railways, which is not captured in the previous 2 layers. The indicator retained is the "effective mesh size" (MEFF).

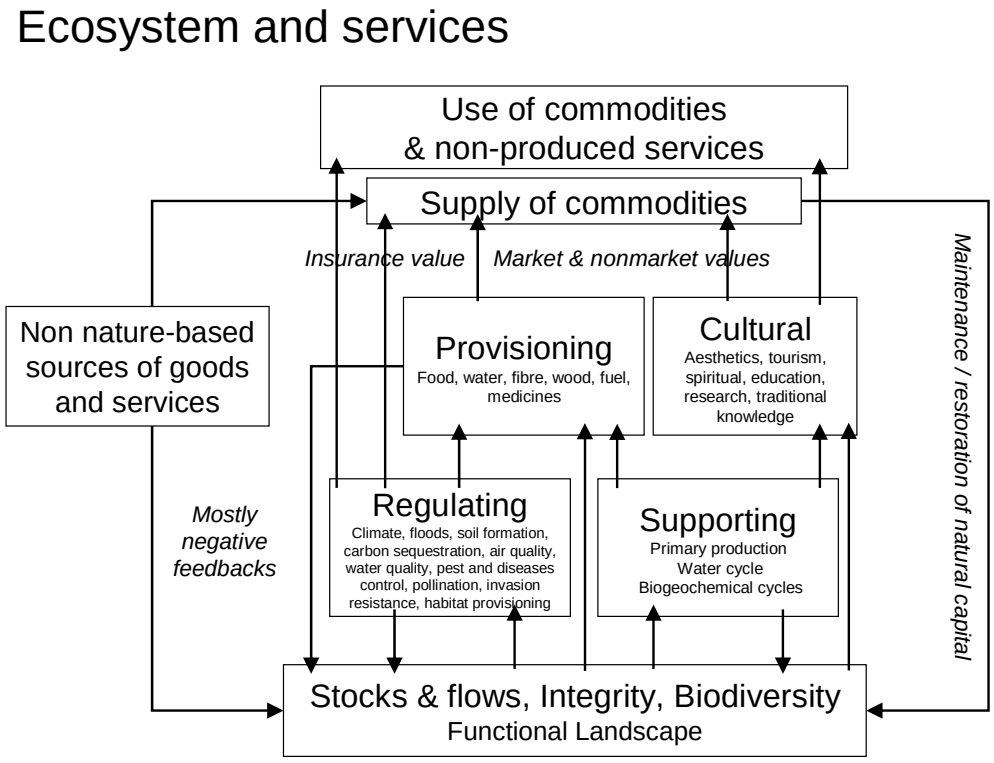


3.3. Classification of ecosystem services

Ecosystem services are outcomes of ecosystem functions but are just a subset of them, what is used by the people. The distinction between internal ecosystem functions and ecosystem services is essential both for avoiding double counting and framing the scope of the activities. The ecological functions in general are assessed in the asset account as stocks, flows and quality counts.

The ecosystem services are classified in reference to MA, the Millennium Ecosystem Assessment, with some adjustments which are currently discussed for MA2.

An updated classification of ES, matching requirements of both MA and SEEA has still to be elaborated in full and validated. However, a consensus exists on the principles of its elaboration – according, for example to the scheme below – if not on every detail yet.



Adapted from Scholes, 2007, Lomas, 2007

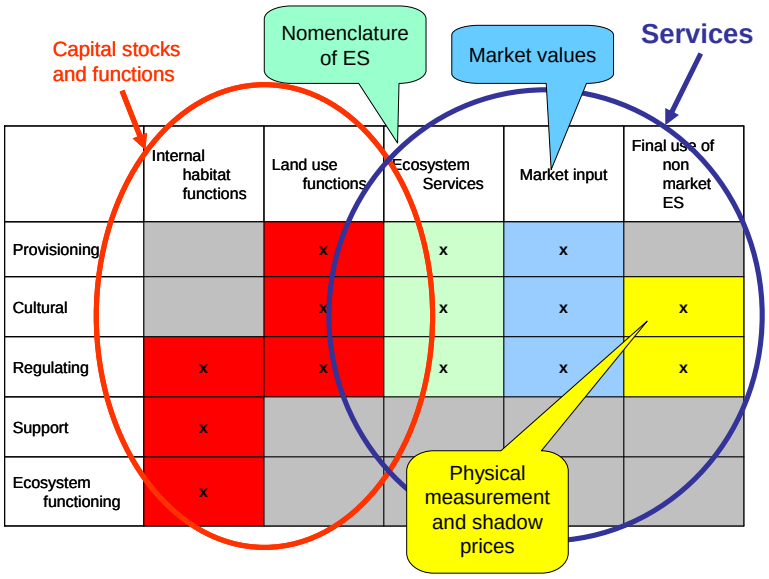
The nomenclature used for the case study of the Doñana socio-ecosystem in Spain is currently tested in the Mediterranean wetland ecosystem accounts project. It illuminates how the future ES classification could look like.

Doñana social-ecological system				
Service-type	**Category**		**Service**	**Function-type**
1 Provisioning	1.1 Food	1.1.1	Hunting prays	Production
		1.1.2	Gathering/ picking up goods	Production
		1.1.3	Fishing	Production
		1.1.4	Seafood	Production
		1.1.5	Livestock	Carrier
		1.1.6	Agriculture	Carrier
		1.1.7	Aquiculture	Carrier
		…		
	1.2 Materials	1.2.1	Fresh water	Production
		1.2.2	Salt works	Production
		1.2.3	Construction materials ("Arids")	Production
		1.2.4	Fiber crops	Production
		1.2.5	Tree plantations	Carrier
		…		
	1.3 Forest trees-related	1.3.1	Timber	Production
		1.3.2	Fuel / wood	Production
		1.3.3	Cork	Production
		1.3.4	Pines	Production
		…		
	1.4 Plant-related	1.4.1	Genetic resources	Production
		1.4.2	Medicinal & cosmetic plants	Production
		…		
	1.5 Physical support	1.5.1	Communication	Carrier
		1.5.2	Housing	Carrier
		…		
2 Cultural	2.1 Amenity	2.1.1	Recreation / relax	Information
		2.1.2	Ecotourism	Information
		2.1.3	Landscape beauty	Information
		…		
	2.2 Identity	2.2.1	Sense of place	Information
		2.2.2	Cultural heritage	Information
		2.2.3	Religious / spiritual	Information
		…		
	2.3 Didactic	2.3.1	Education / interpretation	Information
		2.3.2	Scientific research	Information
		2.3.3	Traditional Ecological Knowledge	Information
		…		
3 Regulating	3.1 Cycling	3.1.1	Soil retention & Erosion control	Regulation
		3.1.2	Hydrological regulation	Regulation
		3.1.3	Saline equilibrium	Regulation
		3.1.4	Pollination for useful plants	Regulation
		3.1.5	Climate regulation	Regulation
		…		
	3.2 Sink	3.2.1	Soil purification	Regulation
		3.2.2	Waste treatment	Regulation
		3.2.3	Water purification	Regulation
		…		
	3.3 Prevention	3.3.1	Flood buffering	Regulation
		3.3.2	Pest prevention	Regulation
		3.3.3	Invasive species prevention	Regulation
		…		
	3.4 Refugium	3.4.1	Habitat maintenance	Habitat
		…		
	3.5 Breeding	3.5.1	Food web maintenance	Habitat
		3.5.2	Nursery	Habitat
		…		

Source: Berta Martin, Pedro Lomas et alii, Autonomous University of Madrid, 2007

3.4. Measurement and valuation of ecosystem services

Distinctions have to be made between market and non-market ES.



In a dual integration approach, only final use non-market ecosystem services need to be measured and valued. The services entangled in the market goods and services are considered as being part of their price – whatever the price. A low price can mean that externalities are not covered in particular regarding the resilience value of the natural capital. Inclusive wealth calculation aims at integrating fully this dimension. In dual integration, instead market prices (and GDP accordingly) are taken as observed.

One important point is that the same service (e.g. enjoying sea-side scenery) can be either marketed or not, according to the existence of an actual payment or imputed payment (housing rents) or not. Regulation services provided by ecosystems when used as collective goods have to be considered as natural capital input to add to current market values. A systematic measurement and valuation of the “free end-use” recreational and regulating ecosystem services will probably lead to substantial amounts.

In any cases, the final use non-market ecosystem services are first measured in physical units considering land use types in particular places, people and time allocations. These services are valued in a second time according to the most credible methods of shadow pricing; it may vary from case to case. Important research and large number of case studies have been carried out these last year. Therefore, the issue is not so much to invent new valuation methods but to screen and assess existing ones according to their specific purpose, and then to address the difficult question of the “benefit transfers”.

3.5. Measurement and valuation of maintenance and restoration costs

Part of the maintenance costs of ecosystems is paid by economic agents as management and environmental protection expenditures. Additional costs would be necessary to cover in some cases to keep the ecosystems at the level desired by the society. These costs can relate to works for repairing the ecosystem (or compensating degradations) or to loss of profit resulting from avoidance of use. In both cases, physical measurements are the basis of cost calculations.

Using exergy (the energy free for use at a given point of a system) as a general proxy for measuring costs is a promising solution. Physical costs are calculated accordingly as the energy which would need to be reinvested into or spared in the system to reach stated society objectives. Valuation of physical can be done in a second step in reference to energy market prices. This methodology is operational for water systems, as demonstrated by Naredo in Spain.

Measurement and valuation of full ecosystem maintenance and restoration costs is crucial, for public policies a well as for the companies. Public policies are generally designed and implemented by broad sectors – the competencies of ministries. Efforts for integrating environmental concerns in sector policies in Europe have shown obvious limitations resulting from unwanted consequences of one sector action to another sector. A similar situation is faced by companies which are in a position of establishing a detailed balance of their direct environmental costs but are missing information for their indirect costs – in short their costs on the global ecosystem. Therefore, accounting for and valuing the additional (or hidden) ecosystem maintenance and restoration costs is essential.

Note that the reference to stated society objectives makes ecosystem accounts a good candidate for scenario development (e.g. additional costs for maintaining climate regulation atmosphere ecosystem services can be computed in reference to Kyoto, post-Kyoto or an objective of carbon neutral economy). Another advantage is those accountants have no more to face the question of the (infinite) cost of irreversible change, at least when they are endorsed by the society…

4. Integration within SEEA: MFA, PIOT, NAMEA, Expenditure, Assets (Forest, Fisheries, Water and forthcoming soil), valuation, application of E-EA.

Ecosystem accounts are not different from the SEEA. They just mirror the SNA-integrated accounts. Therefore, except for some foreseen extensions of the "non-standard accounts" part of the work of developing ecosystem accounts is already done. However, the inter-linkages need to be made explicit. It will require in several places of the system the introduction of specific requirements from the ecosystem integration.

In addition to the integration of environmental variables into macro-economic accounting and further on modelling, modelling the statistical system is expected to contribute in giving wider access to social statistics for understanding threats (health, noise), benefits, well being, behaviour… by social groups. This may reflect on statistical programmes, for example by extending house budget to the use of ecosystem services.

A particular dimension of this integration relates to the spatial resolution of statistics. Access to local statistics made available by more and more national statistical institutes; a practical solution (minimizing problems re confidentiality while giving

detail) is to report statistics according to 1 km² grid, following examples of Sweden, Norway (other countries?)[7].

This aspect of ecosystem accounting development is particularly relevant to the London Group's expertise.

5. Articulation to SNA (adjustment of net savings, inclusive gross domestic product, full cost of goods and services)

This is of course the most appealing issue. EEA's has drafted a position paper for the Beyond GDP Conference, Brussels, November 2007. It states that the major policy needs relate to unknown benefits from nature and unknown costs of maintaining ecosystems, in countries and abroad. For that purpose, the quantification of ecosystems capital stocks, resilience, flows and services need to be done in physical terms. From this physical accounts can be derived:

- on the demand side, the value of non-paid ecosystem service to add to the GDP for calculating an Inclusive Domestic Product and,
- on the supply side, the additional maintenance and restoration costs necessary to meet society objectives and calculate a full cost of domestic goods and services, to which should be added the hidden ecosystem costs of imports, leading to a second aggregate so-called 'Full Cost of Goods and Services". The additional cost of domestic ecosystem maintenance should be in addition incorporated in the calculation of Adjusted or Net Genuine savings.

The EEA document is annexed to this position paper as a basis for discussion.

6. Implementation strategy

6.1. Implementation opportunities

The Millennium Ecosystem Assessment's major contribution has been to put ecosystems, ecosystem services and human wellbeing in the centre of nature conservation policy. The justification of this choice has been confirmed since 2000 by the understanding that climate change issues are to a large extent a matter of adaptation of the socio-economic and ecological systems. Despite the fact that MA was some kind of an accounting project, the SEEA was not a reference in any way.

This regrettable situation can change with the simultaneous launch of an MA update by UNEP (of which Eureca!2012, the European ecosystem assessment will be a regional programme) and the revision of the SEEA make possible a joint international action for the mutual benefit of more operational MA and SEEA. The process can profit of the venue of the ISEE2008 conference hosted by UNEP in Nairobi for involving better the research community. Although in a too much standalone way, GEO/GEOSS (GMES in Europe) develops important monitoring capacities, as it was reported at the International Workshop jointly organised by UNSD and the European Environment Agency in Copenhagen, 2006.

[7] In Europe exists a standard grid define in the context of the Inspire regulation; EEA's spatial datasets a compatible with this grid (CLC, LEAC)

Other initiatives should be considered as well as the joint UNEP-IUCN-CBD initiative on International Payments for Ecosystem Services (IPES), the assessment of forests ecosystem services by UICN with FAO, the continuation of the CBD process for the valuation of costs of inaction for biodiversity (with the COP10 deadline in 2010) and of course the coming steps in relation to climate change (sequestration/de-sequestration of carbon in/by soil and vegetation, adaptability of ecosystems and continuation of ecosystem services).

The SEEA should be recognized by the statisticians' community as an operational tool but as well by programmes of ecosystem assessment as the main way of integration of their accounting with the SNA. Ecosystem accounting is the needed gateway.

6.2. Implementation challenges

They are of course many, but the main ones can be listed before considering how work could be shared between institutions for implementing ecosystem accounts. 3 points only will be addressed here, considering that: (1) the political interest is high enough for providing adequate budgets to ecosystem accounting and (2) that first accounts have to be produced using existing databases, although we all know that they are to a large extent insufficient and that the first accounts will be blurry in many areas.

- **Classification and measurement** issues have been addressed previously. The scales issues need to be clarified both in terms of feasibility and operational interest of accounts. They relate to space and time scales.

- **Geographical scales**

The issue is to play with heterogeneous datasets:

- Exhaustive but rather contents-poor geographic datasets, frequently updated by satellite images
- Exhaustive, contents-rich but rather poorly geographically detailed socio-economic statistics
- Scattered in situ monitoring of the physical world
- Detailed analysis and modelling of the socio-ecosystems and valuation of ecosystem services available as case studies

The solution is in the correct combination between macro, meso and micro scale data, using GIS, monitoring and statistics integration, modelling. The addition of individual accounts is not the way to proceed.

Top-down, from global to regional, national and local scales, the issues are to produce conceptually correct proxy aggregated accounts (and derived indicators and maps) as (1) a first answer to policy demands and (2) for framing (stratification) sampling strategies.

Bottom up, from local to national, regional and global scales, the issue is to make the best use of monitoring data and, more difficult the knowledge of thresholds values of ecosystem resilience and monetary value of ecosystem services (the famous "benefit transfers" issue).

In addition, the global impacts and responsibility of countries (the full cost of imports) requires access to the relevant international trade statistics and estimates of the full maintenance costs of the ecosystems in the countries from which are extracted the ecosystem goods and services.

Another case is that of the "heritage objects" which are beyond geo-statistical analysis and will request ad hoc assessments.

Last, further clarifications is needed considering the spatial approach of coastal/sea ecosystems for ecosystem accounting.

- **Time scales**

The first issue is with times series and trends which are in one way or another behind any forecasting or scenario exercise. Historical data do exist for some variables such as population, meteorology, satellite images (land cover, vegetation indices/biomass)…

The second issue is timeliness referred to decision making. Even though resulting from modelling annual updates, nowcasting and need to be considered for ecosystem accounts to be present in the policy debate.

Third, in some cases, quarterly accounts may be relevant. One foreseeable case is Carbon emission, sequestration & trade where IPCC reporting will be done on that basis. Another one is water stress which requires in most countries seasonal accounts.

Last, the "ecological accidents" will have to be recorded in an appropriate way.

6.3. Work sharing for a fast track implementation

The dual integration of SEEA with SNA and Ecosystem and the need of operational outcomes help in sketching the necessary cooperation inside the UN family between UNSD, the other UN agencies (UNEP, FAO, WMO, UNWater, UNDP…) as well as with other international and regional organisations. The international conventions (CBD, IPCC, IGBP, HDP, Ramsar, Desertification…), the space agencies (via GEO/GEOSS) and some key NGOs in the domain (IUCN, WWF, ISEE) need to be involved. The regional organisations (statistical and environmental) will have the responsibility of coordinating the national contributions.

One example of action would be to liaise with the WCMC/UNEP manual currently drafted for supporting MA2 ("The Ecosystem Assessment Manual – MA Methods Manual) in order to come to common definitions from the scratch.

Cooperation with UNEP's programmes on biodiversity and ecosystem services valuation and trade should be developed (UNEP, 2007) – which would certainly facilitate the selection of "credible" shadow prices while giving some more echo to the SEEA.

Another action would be to coordinate with GEO/GEOSS and FAO/GOFC/GLOD for discussing approaches to land cover and ecosystem classifications and access to space and other data (GTOS, GCOS).

Last, the statistical system should be informed of the priority needs of socio-economic data and their specification for being in a position to contribute to the process.

Conclusion:

The agenda is tight but the opportunity should not be missed.

Annexes:

1. Background document of the position paper presented by the EEA at the Beyond GDP Conference, Brussels Nov. 2007. The position paper itself is on http://www.eea.europa.eu/highlights/beyond-gdp

2. Short note on LNEP (tabled in the meeting)

Short bibliography

EEA (2006), *Land accounts for Europe 1990-2000*, EEA Report No 11/2006 prepared by Haines-Young, R. and Weber, J.-L. *(downloadable)*
http://reports.eea.europa.eu/eea_report_2006_11/en

Green Accounts of Indian States – several monographs can be downloaded from
http://www.gistindia.org/index.asp

Naredo, J.M. and Parra, F., eds. (1993) *Hacia una ciencia de los recursos naturales*, Madrid, Siglo XXI

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC *(downloadable)*

UNEP Financial Initiative, *Biodiversity and Ecosystem Services: Bloom or Bust?* CEO briefing, October 2007*(downloadable)*
http://www.unepfi.org/fileadmin/documents/CEOBriefing_biodiversity_01.pdf

Weber, J.-L., *Implementation of land and ecosystem accounts at the European Environment Agency*, Ecological Economics, Volume 61, Issue 4, 15 March 2007, Pages 695-707 *(downloadable)*

Annex 1

Contribution to an EEA position at "Beyond the GDP" conference
(and to the many related projects where the same question is put to us!)

Jean-Louis Weber, Ronan Uhel, Jock Martin - 17 Sept 2007

1. The GDP debate and our potential contribution

1.1. On the approaches so far…

There is a clear policy demand with Beyond GDP, the same as G8's Potsdam, the same which has been expressed many times in the economic-environmental accounting process, as always: policy makers want a small number of aggregated indicators, ideally one, to help them integrating correctly the environment into the highest levels of economic decision making. We should consider this demand even more seriously than before and try in no way to escape the challenge by proposing, as we usually do, either only a set of indicators (so many) or a set of accounting tables (as presently in the SEEA). The power of indicators and accounting tables is in their integration. Indicators on decoupling work because they integrate (in a ratio) production and resource use or emissions; they achieve useful partial integrations, but they are not yet fully connected to environmental or socio-economic impacts. We should add that, in general, stand alone indicators or accounts don't tell so much as long as their bottom-lines, when they exist (!), are legal or conventional and not as much stringent as can be a budget or an accounting balance – e.g. the GDP. Thus the weak character of many indicators which frequently contradict each other; thus the multiplication of lists of indicators… thus the success of the Stern numbers: 1 % annual expenditure to avoid 20 % future loss (of GDP).

Of course, we all know that there is no magic in one number – even a monetary value – and that decisions are based on multiple criteria where costs and monetary benefits are an essential component, but not the only one. It means that policy makers should not only use one aggregate, but several physical and monetary indicators – and accounts; it means as well that these indicators need to be correctly connected to "the" aggregate.

No answer to this question has reached so far a minimum consensus – and the Commission has paid for a study is order to sort out the basket of "aggregates" or "composite indicators". The "Green" GDP (and its variants such as Sustainable Income) is simply not used when calculated. The Genuine Net Savings of the World Bank, more correct in terms of methodology and computed has not gained the status of favourite.

So, the demand is still clearly on table; we think that the EEA can contribute to the answer on the basis of the progress in:

- Economic-environmental accounting: the SEEA describes correctly the statistical infrastructure

- Economic theory (Ecological economics, valuation methods, etc.)
- Ecosystem understanding and assessment of the natural capital (Inclusive wealth of ecosystems with resilience, etc.)
- Data infrastructure and modelling: Earth Observation/in situ, IPCC-like processes, networks, RTD projects – all reflected by SEIS & GMES developments.

1.2. What can be the EEA proposal to "Beyond the GDP"

The EEA proposal to "Beyond the GDP" should be based on the framework of ecosystem accounting and cover the eight following core elements (the "core 9"):

1. natural capital stocks of socio-ecosystems (stocks, internal flows, integrity/health/resilience, services) – are accounted in physical terms in a first step.
2. non-market benefits from ecosystem services, need to be added to GDP for computing the Inclusive Domestic Product (IDP) which acts as a monetary measure of human well-being.
3. non-financed costs necessary for maintaining and/or restoring the natural capital need to be added to GDP for calculating a Full Cost of Commodities (FCC)
4. full ecosystem cost of imported goods and services, is part of FCC – it is a monetary measure of the ecological footprint
5. breakdowns by sectors/ products with NAMEA (monetary x physical tables) and SAM-SEEA (monetary tables decomposing IDP and FCC) are important
6. these full cost calculations are relevant at the National level as well as at the company level (it echoes the concept of eco-balances)
7. non-financed depreciation of the natural capital is a Debt (or Liability) to Nature which should be entered in the financial balance sheet.
8. A useful indicator would compare [a] the actual ecosystem protection and management expenditures (as computed in the SERIEE) and [b] the additional depreciation allowance (what still needs to be done).
9. The ratio GDP/FCC (and/or IDP/FCC) measures a "Sustainable Development Gap" aggregate (SDG). SDG < 1 means that the costs of our current welfare are not covered.

On the basis of the above, the EEA should restrict its proposal at this stage to ecosystem assets and services. This would mean:

- be open to incorporate into the framework, if possible, the depletion of subsoil assets on the one hand and the human / social capital on the other hand;
- Inclusive Wealth calculation, though relevant, still requires lot of research before being implemented at the macro scale;
- the basket of physical indicators (the big 4 –EF, HANPP, MFA, LEAC) is part of the accounting framework; harmonisation of methodologies and streamlining of data sources (e.g. Globcover) should be proposed;
- the simultaneous development of networking and geographical, statistical and monitoring data infrastructure at the EEA put us in the position of proposing practical solutions for assimilating data and integrating models in both ecological and socio-cultural realms.

2. Fleshing out the EEA proposal

2.1. Arguments

Subtraction of environmental damages from GDP has often appeared as an attempt at punishing it (us?) as much as the proposal of an efficient tool for policy making. Add that the prices used in pioneering applications where often uncertain and the theoretical grounds (the general equilibrium conditions of the adjustment) disputable; it is then easy to understand that the national accountant have quite systematically opposed any adjustment. An option was once considered for the depletion of subsoil assets where the issue is very different (splitting the sales of subsoil products between added value and the rent component – which should be partly reinvested for sustaining the income from extracting activity) but recently, the group for the revision of the SNA (UN, OECD, WB, IMF, Estat) has rejected this proposal.

Considering the sense of GDP adjustments (what is the meaning of what remains after the subtraction?), the difficulty has finally been understood by the World Bank which proposes now a "net genuine savings" indicator (to-day called adjusted net savings). This is a nice indicator, except that savings are not a very popular indicator in National Accounting, and NET savings (the most relevant expression) even less. The reason is that the Consumption of Fixed Capital (in short, the depreciation of economic capital) is tricky to compute and that many developing countries (and some developed ones) simply don't do it correctly or not at all. That is why a second adjustment that would be like a "consumption of natural capital" it not so much appealing, although correct. We could add that the first elements published by the World Bank give a large room (the largest numbers) to the depletion of oil and other subsoil assets – the only additional item being CO2. So, no problems with the genuine savings, but they don't sell so well.

There is another solution … if we simply consider the things differently. Two examples should help us:

- The work in India by the GAISP (the Green Accounting for the Indian States Project). Their approach is pragmatic: first account for the non accounted ecosystem services and add them to the GDP; then deduct degradation and depletion. No "General Equilibrium" problem in that case. Note that results are generally presented as a ratio between environmental losses and the adjusted (increased…) GDP.
- The work in Spain (*Naredo et al*) on water accounts. The approach doesn't focus any more on the valuation of ecosystem services but on the costs necessary for maintaining the whole range of services provided by the rivers (water supply for municipalities and irrigation, hydroelectricity, ecological quality, amenities) at a level fixed according to "preferences" expressed by the society. These preferences combine criteria on economic costs and benefits as well as other values; they are expressed in physical terms – the state of the water ecosystem. The calculation of costs is first in physical terms – what has to be done for meeting the social objective? –and priced according to the physical measurement. The costs are not normative – but strongly indicative.

2.2. Structuring the content of the proposal

Considering the good examples indicated above, which approaches can be combined as such from an environmental perspective, how should we elaborate on the "core 9" elements of our proposal (leaving temporarily aside the human/social capital and the subsoil assets):

1. Accounting of natural capital stocks of socio-ecosystems (stocks, internal flows, integrity/health, services); this can be done in physical terms on the basis of the integration of monitoring, statistical and geographical data. Monetary valuation of the natural capital, which requires systematic disentangling of ecosystem services from market values of commodities (for calculating the net present value of future income) is more complicated and requires additional research (e.g. on Inclusive Wealth calculation, choice of discount rates and correlated integration of risk…).

2. A major part of the ecosystem services is an input to the GDP; they **are** in the monetary value of the GDP (under the conditions of the general equilibrium). Remain ecosystem services used for free, i.e.the non-market benefits directly enjoyed by people (individually or collectively) from ecosystem services (socio-cultural and regulating in the MA sense). They can be counted in physical units (e.g. number of persons x time spent x frequented area) and then valued with shadow prices. Their value should be added to the GDP; the sum total is the Inclusive Domestic Product (IDP). If GDP is related to the economic welfare, IDP tells about human well-being, in the sense of MA. IDP can measure that, for example, the economic product increases at the expense of the previously free services; or that the degradation of the ecosystems has negative consequences on the total amount of goods and services available.

3. On the market, the goods and services made available for consumption (and export) have an economic value equal to their cost. This cost is made of factors income (wages, profit, transfers, taxes…), intermediate consumption (to be counted when analysing industries only) and fixed capital consumption. This last item is similar to an allowance for depreciation of the economic capital, the money which needs to be spared for maintaining and renewing the capital. As there in no consumption of natural capital in the SNA, maintenance and restoration expenditures are entangled in current economic flows. When the ecosystems are degrading or are not at the level decided by the society, it means that the full cost of their use is not covered by any economic expenditure. In this case, the additional necessary maintenance and restoration costs have to be considered as an allowance for depreciation of the natural capital, not covered in the current GDP and therefore forwarded to the future period: in other terms, a debt on nature or on the future generations. Accounting for the depreciation allowances of the natural capital can be done in reference to the desired level acknowledged by the society. This level (objective, norm) is expressed in physical terms in policy document (International Conventions, WFD, Natura2000…). In reference, the physical costs of meeting it (e.g. tons of CO2 to be abated, thermodynamic cost of river basin management, areas to be restored…) can be calculated and valued using

appropriate market prices (C, energy …). This depreciation allowance should be added to the current value of the goods and services – that is, when aggregated, the GDP plus the imports – for calculating a new aggregate: Full Cost of Commodities (FCC).

4. FCC includes the full ecosystem cost of imported goods and services, calculated in relation to the necessary depreciation allowance for maintaining / restoring ecosystems up to the levels acknowledged in international conventions (as a minimum, binding for the importing country). When they exist, international prices should be used for valuation. Therefore, FCC in industrial will not decrease by the mere effect of delocalisation of production in the case when cheaper prices of products in the exporting country are offset by higher hidden costs of natural capital degradation.

5. Ecosystem services and physical costs of maintenance/ restoration can be analysed by sectors/ products with NAMEA. The I-O analysis should be expanded to IDP and FCC (money) following (with some needs for adaptation) the SAM-SEEA framework. developed in Japan. Comparisons between different industries in a country or between the same branches in different countries is certainly of high relevance. A domain such as CO2, where EEA manages IPCC data and Eurostat their translation into NAMEA could be candidate for some kind of a SAM-SEEA, using C prices (see below).

6. Full cost calculations are relevant at the National level as well as at the company level – it echoes the concept of eco-balances, with an emphasis on what is often for a company an indirect cost.

7. The additional (non financed) cost of maintenance and restoration of ecosystems is a depreciation allowance measuring what should be spent in the future period, analogous to a debt on Nature or on the future generations – a liability in the sense of ELD. It should be recorded as an additional liability in the financial balance sheets of the national accounts (SNA). In the perspective of a Potsdam G8/ Stern-like report on the cost of inaction regarding biodiversity, this liability is the “benefit of inaction”.

8. A useful indicator would compare [a] the actual ecosystem protection and management expenditures (as computed in the SERIEE) and [b] the additional depreciation (what still needs to be done). **[a] / ([a]+[b])** is an indicator of effectiveness in ecosystem management.

9. When FCC > GDP or > IDP, it means that the costs of our current welfare (or well-being) are not covered, that we are living above our livelihood. This could be summarized in a ratio: FCC/GDP or FCC/IDP which is a sustainable development aggregate (for the environmental pillar at least, but it is our primary mandate, isn’t it?). It could be named Sustainable Development Gap (SDG).

Re conditions to develop and implement gradually these objectives, the following considerations should be addressed:

- in our view, the EEA should restrict its proposal at this stage to ecosystem assets and services, but be open to incorporate into the framework, if possible, the depletion of subsoil assets on the one hand and the human / social capital on the other hand;
- first steps can be done quickly on the basis of existing methodologies; but research is still needed in order to frame more precisely the physical and monetary accounts of ecosystem assets and services in reference to the main valuation frameworks: CGE, Inclusive Wealth …;
- the Big Four indicators candidate for the "basket" of indicators: EF, HANPP, MFA and LEAC/land cover are all build on the same data and accounting principles as physical accounts of the natural capital. There is room for harmonising methodologies and streamlining data collection. (see Gorm's comments);
- the simultaneous development of networking and geographical, statistical and monitoring data infrastructure at the EEA put us in the position of proposing practical solutions for assimilating data and integrating models in both ecological and socio-cultural realms, and offer researchers solutions to the recurrent questions: revelation of users preferences in the relevant geographical context and subsequent stratification of benefit transfer methodologies, estimation of risks to ecosystems as a way of integrating resilience in natural assets valuation, multiple scales assessments (Corine, Corilis, CartoChange, integration of land cover and hydrosystems …) and strategies for sampling and optimal programming of case studies (research), reallocation of socio-economic data to geographical objects …

3. How to get things working for the EEA proposal?

3.1. Link up several processes –getting them to support us!

IDP and FCC are straightforward indicators of SD. The proposed adjustment generates no damages to GDP, which may its acceptance by statisticians – in particular in the context of ESEA and UNCEEA/ London Group.

To get there requires quick up the pace and coordinating several processes:

- Physical accounts of the natural capital/ ecosystem assets: development of the physical accounts as a continuation of LEAC, water accounts, SEBI2010…
- Mobilisation of knowledge on valuation methods (FP7 project, various national and international networks and initiatives…)
- Streamlining the contribution of Eurostat and the National statistical offices: make operational (annual production) experienced methodologies on environmental protection expenditure, MFA, NAMEA and production of an annual revised SAM-SEEA (integrated to ecosystem accounts)
- Streamlining the contribution of EIONET
- In all domains, development of modelling to support scenarios and nowcasting
- Orchestrating the implementation of the aggregates in the context of Eureca! and Potsdam!! In particular by launching Europe-wide case studies. First candidates are:

- CO2 (taken as a proxy of degradation of the climate regulating service – see below)
- Wetlands (continued to all Europe): focus on Nature policy, biodiversity values
- Grassland, altogether large pastures, mosaic agriculture and semi-natural grassland: focus on Nature in the wider countryside, agri-environment, biofuels, carbon sequestration
- Water systems: focus on WFD requirements (ecological quality of water bodies and basins, full cost recovery…)
- Forest – in relation to Eurostat forest accounts, FAO, MCPFE… focus on carbon sequestration, non timber values…

3.2. A CO_2 case study for the short term?

In response to Jock and his CO_2 proposal: fine!

In intellectual terms, CO_2 net emissions (= minus sequestration) are a proxy of :

1. An intermediate consumption of a basic regulating service of the atmosphere – which allows economic and social anticipations.
   This service is a public good – what is more public? –with no exclusive property right at all. The emission of CO_2 by the economy is explicitly (counterpart of tradable permits) or implicitly in the GDP. As a proxy, it should be accounted as well as a decrease of the total free service of climate regulation, therefore a fall in IDP.
   As long is there is no consensus yet on the value of the climate regulation, this solution doesn't seem workable in the short term. It would mean anyway some kind of a global programme (difficulty discussed in the workshop on Accounting for Ecosystem Services, Stockholm, 3-6 Sept07).

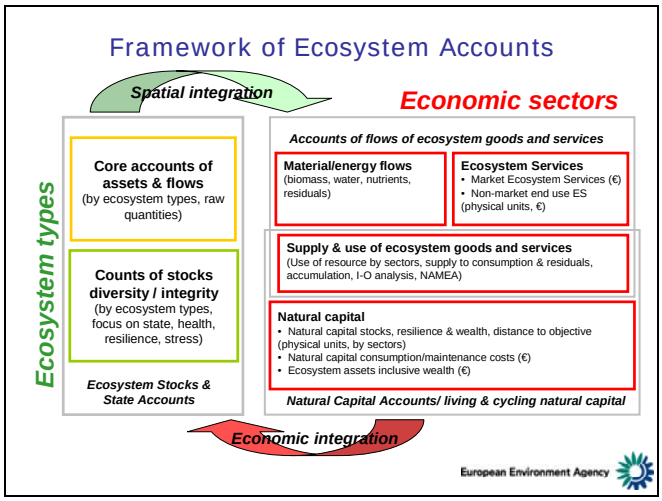
2. A hidden cost which can be defined in relation to social objectives of quality of the atmosphere ecosystem. This objective is determined on a multi-criteria basis (science, assessment of future risks, costs of adaptation, Stern numbers…). The gap between the present situation and a decided benchmark – e.g. "carbon neutral" or another one, lower (Kyoto, more or less ambitious…) can be measured as CO_2 net emissions; it can be assigned to industries and final consumption in a NAMEA (nice piece of work for Eurostat); import contents of CO_2 can be added (and exports subtracted for symmetry); it can be priced; it can be connected to macro-economic variables.

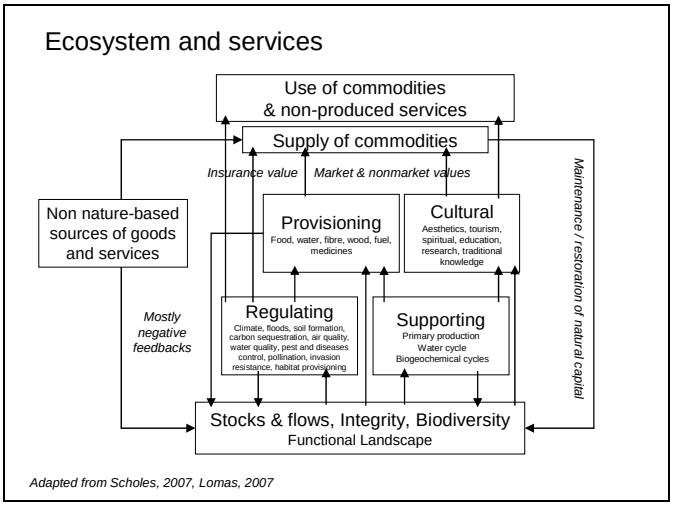
   In aggregate terms (beyond GDP), a FCC/ CO_2 could be computed, as a first attempt.

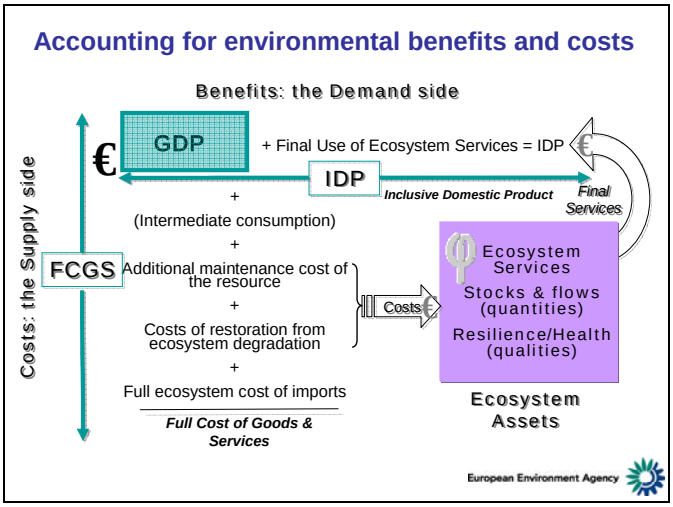
   A NAMEA + SAM-SEEA for CO_2 could be proposed as a tool for implementing the application. SAM-SEEA is a Japanese framework developed by Prof. Aryioshi; it has still to be revised for matching fully the ecosystem accounting concepts, but the idea is there.

Annexes:

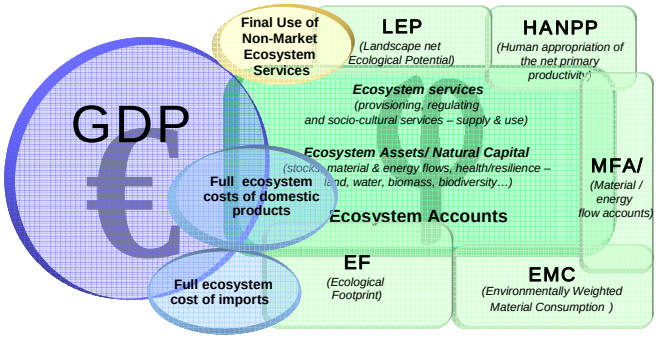
Figures:





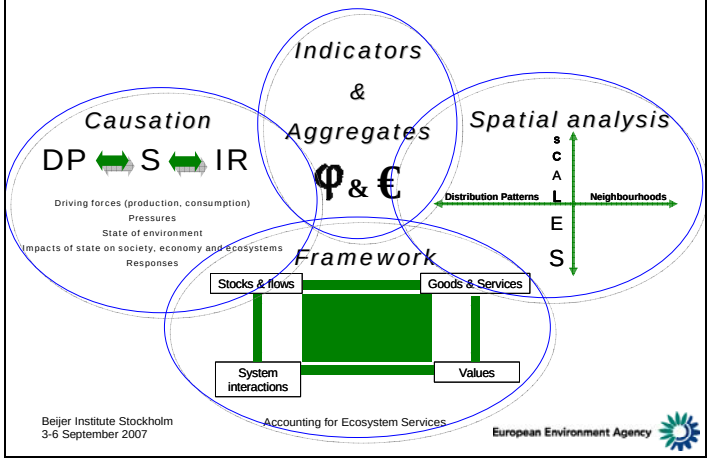


Integrated National Accounts: GDP, Ecosystem Services & Assets, Monetary & Physical Indicators



European Environment Agency

Implementing accounts for ecosystems: Conceptual Model

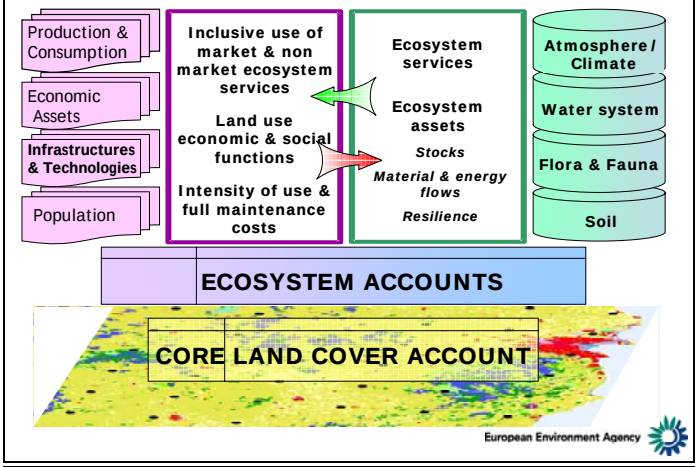


Beijer Institute Stockholm
3-6 September 2007

Accounting for Ecosystem Services

European Environment Agency

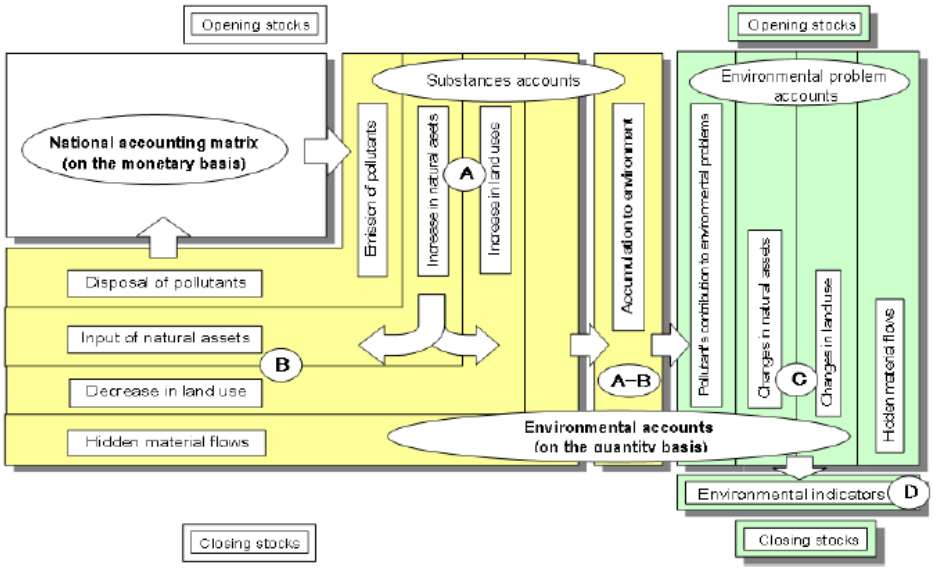
Spatial integration of ecosystem accounts



European Environment Agency

NAMEA: "Environmental problem accounts" can be interpreted in "ecosystem services" terms – Example from Aryioshi et alii, 2006

Figure 2.1 Sketch of Japanese NAMEA



SAM-SEEA according to Aryioshi

(eco-margin is what is called Debt to Nature in the text above; this matrix needs to be adapted for matching more closely the ecosystem accounting concepts.)

Table 3.1 a SEEA-type SAM with Monetary Valuation of Environmental Pressures (1995)

Account (Classification)			Goods & services (products)	Production(activities)	Final consumption(purpose)	Income accounts		Capital accounts				Imputed environmental costs				Rest of the world
						Generation of income (items of value added)	Use and distribution of income (institutional sector)	accumulation(institutional sectors)	produced assets: Environmental protection facilities (types)	produced assets: Other produced assets	Non-produced assets (types)	Environmental impacts: Air pollutions	Environmental impacts: Quality of water	Environmental impacts: Waste	Eco-margin	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Goods & services(products)		1		431040.2	349633.1				6105.5	134225.3						45230.1
Production(activities)		2	922938.0													
Final consumption(purpose)		3					349633.2									
Income accounts	Generation of income (items of value added)	4		458525.0					-204.2	-8912.7						108.7
	Use and distribution of income (institutional sector)	5	973.1	33372.6		369345.0										19372.2
Capital accounts	accumulation (institutional sectors)	6	4051.6				57549.1									-214.4
	produced assets: Environmental protection facilities(types)	7						5901.3								
	produced assets: Other produced assets (types)	8			Imputed environmental cost valuated by maintenance cost approach			45313.1								
	Non-produced assets(types)	9										Deterioration of non-produced assets by production activities				
Imputed environmental costs	Environmental impacts: Discharge of residuals (CO2,SOX,NOX,SPM etc)	10		68568.0							-68568.0					
	Environmental impacts: Quality of water (T-P,T-N,waste water)	11		6969.8	(-) sum of imputed environmental costs valuated by maintenance cost approach						-6969.8		(-) sum of deterioration of non-produced assets by production activities			
	Environmental impacts: Waste (final disposition)	12		11428.0							-11428.0					
	Eco-margin((-)sum of imputed environmental costs)	13		-86965.8							86965.8					
Rest of the world		14	38272.4			171.8	15880.6	10171.8								