European Environment Agency

LAND & ECOSYSTEM ACCOUNTS IN THE SEEA REVISION

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Session 11 on ecosystem accounts

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Background

In the recent years, land and ecosystem accounts have got a higher attention in the overall framing of economic-environmental accounting. Acknowledged as an item on the research agenda by early UNCEEA meetings, it has been repeatedly discussed by the London Group: New York 2006 (creation of a sub-group), Johannesburg 2007 (issue paper on ecosystem services), Rome 2007 (clarification papers on ecosystem and soil accounting). In Copenhagen, November 2006, an international workshop co-chaired by UNSD and EEA has taken stock of recent developments in land accounts in Europe and formulated recommendations for new progress towards ecosystem accounting. In echo to this process, ecosystem accounting is considered with interest in communities like ecological economics and in processes such as Beyond GDP, TEEB, MA or IPES. In 2008, the European Strategy for Environmental Accounting has endorsed ecosystem accounting as one of its priority issues. In June, the EEA has tabled a proposal to UNCEEA of supporting the edition of the relevant chapters in the SEEA revision, in order to be able to present the full picture of economic-environmental accounts including ecosystems.

A) Land and ecosystems in the SEEA

The SEEA classification of assets (Chapter 7 – Table 7.2) refers to 3 categories:

1. *natural resources*
2. *land and water surfaces*
3. *ecosystems*

When categories 1 and 2 are mirroring SNA "tangible assets", the 3rd one is a creation. Ecosystems are addressed in correct terms with reference to functions,

services as well as fundamental issues such as the need to *"incorporate(s) all the services offered by the system"* (7.310), the issue of the competing functions and the consequence that *"the current use of the environment for production and consumption inhibits current and future availability of environmental functions, including those needed for future production and consumption"* (7.34), or "*the collective nature of a complete ecosystem"* (7.308).

This basic classification of assets has been followed in the development of land and ecosystem accounts which can be considered as an application which confirms its overall relevance and leads naturally to some limited adjustments referring to the experience gained. Therefore, the proposed development of land and ecosystem accounts within the SEEA revision process will not result in a modification of the system but in the supply of methodologies for accounting for critical issues and improvements in the few areas where streamlining is necessary.

Indeed, the SEEA states that *"The chapter is mainly theoretical and draws significantly on the economic accounting system of the SNA"* (7.03). In the SNA1993, assets are: *"entities over which ownership rights are enforced by institutional units, individually or collectively, and from which economic benefits may be derived."* (7.24). Benefits can be obtained by extracting a resource or by renting or selling the asset. The natural resource is used after extraction. Non extracted "resources" such as soil are attributed to land.

The SEEA broadens the scope of the assets while elaborating mainly (only) on natural resources. Several reasons can be found for that:

- the paradigm of sub-soil assets management and the derived rationale of returns and valuation;
- availability of data: timber for forests, fish catches for fish stocks (systems);
- the linear connection with MFA, PIOT, SUT and hybrid accounts.

This imbalance and the primacy given to natural resources can be found all over Chapter 7, 8 (and in fact all the SEEA), with an excessive attention to sub-soil assets and a difficulty in formulating the relation between economy and ecosystems with basically the 2 concepts of "ecosystem input" and "residuals". Table 7.11 is revealing of that difficulty where no natural resource comes from ecosystems or to say it differently, where there are no relations between natural resources and ecosystems. The later remains a mere interface, similarly to "environment" in PIOT or SUT.

A particular expression of this difficulty is with the classification of soil within SEEA natural resources. When all other EA.1 Natural Resources are used by extraction, soil is used in situ – with the 2 exceptions of:

- some use by horticulture and green houses, and flowers in pots; note that in this case, soil is used more than once and should be accounted as a capital good.
- destruction of soil without using its biological properties (sealing, compaction) and partly erosion (an unwanted consequence)

Therefore, attempts of describing the main use of soil resource in the same way as the other resources are vain. Erosion or other losses such as of organic matter, carbon, and buffering capacity… are closer to capital consumption than to intermediate

consumption. These losses are not input in a production function (the input is the bundle of all soil functions, not the loss), but a consumption of natural capital. Losses don't happen everywhere, only where the capital resource is not maintained. One may note that there is a contradiction between EA.12 Soil resources and EA.13 Water resources, restricted to water which can be pumped and excluding water in soil which is used by the vegetation. Regarding water, it is a very restrictive approach, which is not the one finally adopted in SEEA Water where rain fed agriculture has even been added up.

Both for soil and water, and for timber, fish and crops as well, the natural resource account should be integrated into the account of the ecosystem from which it originates. The depletion calculations have been defined and broadly applied to subsoil assets. When coming to biological resources, namely timber and fish, the same mantra is at work, based on the value of the stock and/or to the return to be maintained over time. This is a short term economic calculation which doesn't reflect that:

- a given ecosystem asset generally delivers more than one particular service and that the depletion of the latter (or of the stock regarding the latter) may cause losses of many other services, now and in future time;
- threshold effects linked to ecosystem resilience lead to considering jointly quantitative and qualitative aspects (or depletion and degradation together). Examples can be given with excessive deforestation causing soil erosion and impairing forest reconstitution or with over-fishing of large fishes (typically cod) making smaller fish in a position to eat eggs and juveniles of their predators.

B) Resource, ecosystem and valuation

The SEEA acknowledges in several chapters the importance of accounts in physical terms when coming to complex issues, in particular related to ecosystem, warning of risks of mismanagement resulting from arbitrary valuations.

At the same time the importance of monetary valuations is stressed when feasible with a clear focus on resources (7.130). As long as contradictions between the use of a particular resource and the sustainability of the ecosystem functions which generate it, the valuation of ecosystem functions as such is not straightforward.

Active research is taking place on valuation of ecosystem services in the perspective of the calculation of an inclusive wealth. It has gained convincing results at the site level, for particular ecosystems and/or for important ecosystem services. In those circumstances, the conditions of the valuation exercise are well established, with clear trade off between opportunities as well as sufficient access to the scientific knowledge on ecosystem resilience.

Further generalisation or aggregation is more difficult. "Benefit transfer" methods when implemented with not enough data (the most frequent case) may lead to somehow arbitrary results. "Accounting prices" for services such as resilience or for existence values are difficult to assess, because of uncertainties or because of contradictions between possible appreciations by different social groups. Aggregation of multiple services from the same ecosystem is possible only when they are not

exclusive one to the other. Discounting the future is subject to different views when addressing the capacity of ecosystems to maintain their potential for delivering services over time.

Therefore, a fully integrated approach relates presently to long term research and a solution has to be found for the shorter term in order to answer the hot recurrent demands addressed to the environmental accountants on the basis of the best available developments.

This is the sense of the EEA's proposal of an interim solution based on a partial integration of the SEEA:

- integration of the SEEA with the SNA: mostly done by SEEA2003
- integration with ecosystem accounts to be developed during SEEA2012 revision
- technical integration of both sub-systems [classifications, balances]

C) Purpose of ecosystem accounting

The objective of ecosystem accounting is to:

- assess the impacts on ecosystems from the pressures which have supposedly generated them, in order to provide realistic policy guidance regarding environmental liability;
- highlight and quantify non market values related to the full contribution of ecosystem services to human wellbeing;
- highlight and quantify the cost of maintaining the overall flow of services by restoring ecosystems when degradation results from excessive use;
- assess the feedbacks at the economy from ecosystem degradation in order make better trade off between options.

In that way, ecosystem accounts provide a closure element which is still missing to the SEEA2003.

A first set of key aggregates has been identified for supplementing current SEEA indicators:

- **ecosystem capital potential** of delivering services over time [capacity to continue functioning]. The indicator is based on ecosystem abundance, integrity, health, resilience..., state and change. This aggregate needs to be computed in physical units only.
- **consumption of (domestic) ecosystem capital.** The amortization of the domestic ecosystems is not recorded in corporate books or in the national accounts. The consumption of ecosystem capital (CEC) takes place when normal maintenance (such as replanting of new trees after felling or purification of waste water before returning it to rivers or the sea) is not sufficient to overcome degradation or when harvesting is too intensive for the ecosystem capacity. CEC is equivalent to a negative transfer in capital to the next period or a virtual debt. The question of considering CEC for adjusting NDP for calculating NI is open. The total of production at market price and CEC gives an assessment of the full cost of the domestic products. CEC is measured by the physical gap between stated objectives (e.g. ratified international conventions and agreements) and observed

situation of the ecosystems (distance to target). This gap is valued at restoration costs.

- **consumption of ecosystem capital concealed in import/exports.** In addition to recorded commodities, "virtual flows" are included in international trade. They are made of virtual water, virtual land, virtual carbon (emissions to the atmosphere) necessary for making the exported products… This is the basis of the footprint accounting or of the TMR proposed by MFAs. In an ecosystem maintenance perspective, accounting will limit to the CEC of the exporting countries and to the CEC amounts assigned to their exports and symmetrically to the imports of the buyer. In other terms, virtual water from a wet country will not be considered in the same way as the one coming from a dry country. This CEC not accounted in the value of traded products is a concealed transfer in capital between countries – a virtual debt. It can be added up for computing resp. the full cost of imports and the full cost of exports.
- **Full Cost of Goods and Services** = GDP + Domestic CEC + Imports + CEC in imports
- FCGS can be adjusted from the full cost of exports in order to reflect the **Full Cost of the Final Demand**. FCFD = FCGS – Exports – CEC in Exports. FCFC is neither a substitute nor a better indicator than FCGS. FCFD tells that an amount of CEC is not used for the domestic consumption. In the case of export of products made from imported raw material with high CEC content, the country might seem exonerated from its liability when it is more likely the giver which has contracted the initial purchase of goods produced in unsustainable conditions.
- **Value of the Final use of non-market Ecosystem Services (VFES)**. The production of all goods is included within the production boundary of the SNA93. Therefore, the value of "provisioning services" which contribute to the making of these goods is entangled into the market prices. If, because of unaccounted externalities, market prices are undervalued, an adjustment will result in terms of "full cost of goods and services" and "full cost of the final demand". In addition to market values, some ecosystem services are used for free, individually or collectively: recreation services, regulation of climate or water regime…
- The addition of the value of non-market ecosystem services to final consumption gives an **Inclusive Final Consumption**. This aggregate tells, for example that the increase of final consumption is balanced by a decrease of the free ecosystem services resulting either from their commercialisation or from environmental degradation. Accordingly, IFC would not grow as fast as the SNA93 Final Consumption and could even decrease in some case. The adjustment for CEC and the adjustment for non-market ecosystem services (VFES) should not be added up for two reasons: firstly, CEC relates to costs when VFES relates to values; secondly CEC itself refers to the whole bundle of market as well as non market ES.

D) Framework for land and ecosystem accounting

Research on land and ecosystem accounting has started as far as the early 1990's in Europe in the context of the UNECE working group on physical environmental accounting. The findings of this first phase have been presented in the

IARIW/UNU/Japanese Government Conference on "Environmental Accounting in Theory and Practice", Tokyo, 1996[1].

The development of land and ecosystem accounts has been continued in the context of the statistical research on environmental accounting supported by Eurostat and the experience gained has supported the drafting of the section on the subject in Chapter 8 of the SEEA2003. Another feasibility study was undertaken in 2003 by the EEA with the support of Eurostat in view in particular of preparing the implementation of land accounts with the new European survey so-called Corine land cover. On that basis the EEA has undertaken the production of land cover accounts[2]. The first accounts are currently being updated with the results of Corine land cover 2006.

Several elements of a (draft) framework for ecosystem accounting has been developed and are being tested. They have been presented in several papers[3].

The framework of ecosystem accounts can be summarized as such:

Asset accounts by ecosystem types include:

- Core Accounts for
    1. systems (land systems, rivers, soil, sea, atmosphere) and
    2. resource components (biomass, water, C, N, P, stocks of species…).
- Counts of ecosystem integrity/health
- An ecosystem rating procedure

Ecosystems ac counts are linked to the economic sectors by flows (physical and monetary) and stock tables (physical only):

- Material/energy flow accounts for biomass, water, nutrients, residuals, in physical units and connect though them to standard SEEA tables: SUT, PIOT, Hybrid accounts
- Accounts for other ecosystem services (ES) of a more functional nature (in physical and monetary units); these other services are connected in the same way to the SEEA standard.
- As a consequence from the dual approach of EA, ecosystem services are considered in two separate ways:
    - 1 by 1 accounting, starting from specific [important] ES. In that way, identified priority issues are addressed but the approach includes the risk

[1] Uno K. and Bartelmus P. , 1998, *Environmental Accounting in Theory and Practice*. Kluwer Academic Publishers. Dordrecht/Boston/London.

[2] 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

[3] 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

An Ecosystem Approach to SEEA (J.-L. Weber, European Environment Agency) - 12th Meeting of the London Group, 17 - 19 December 2007, Rome, Italy
http://unstats.un.org/unsd/envaccounting/londongroup/meeting12/LG12_20a.pdf

of neglecting the “difficult” services or values [regulation, “non-use”, future use...]; this is the basis for ES valuation.

- holistic observation/assessment of the sustainable functioning of the ecosystem natural capital which is its capacity of delivering services. The restoration costs needed when the exploitation is too intensive and/or the maintenance not sufficient are the measurement of the consumption of ecosystem capital.

- CEC, the consumption of ecosystem capital is split by sectors and products.
- The stocks of systems are analysed by sectors in physical units only. Some ecosystem stocks of components (timber, fish...) are valued as well. The market or NPV value of ecosystems is mentioned per order; indeed, both methods refer de facto to resources only (or mainly?) and ignore broadly the public good value of the ecosystem capacity of continuing functioning. The value of the resource is an important information but should not be confused with that of the ecosystem.
- Work on inclusive wealth assessment tries to solve the theoretical and statistical difficulties of valuing the ecological dimension of the natural capital, altogether with the conventional economic capital as well as the human and social capital. This is a long term objective and the present proposal is to delay the full integration of the SEEA framework and develop instead an interim dual integration which allows answering a range of key demands recurrently addressed to economic-environmental accounting.

The Figure below summarizes the main features of the accounting framework of SEEA land and ecosystem accounts.

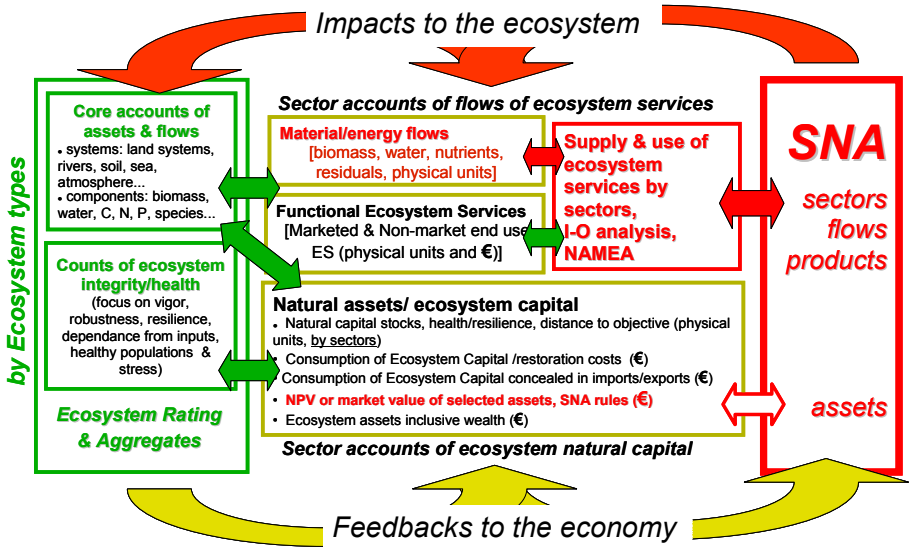

Figure 1: Framework of land and ecosystem accounts within the SEEA

In order to facilitate the understanding of the accounting framework for ecosystems, a mock-up account has been established and is presented in Annex 1. The tables are organised in the following way:

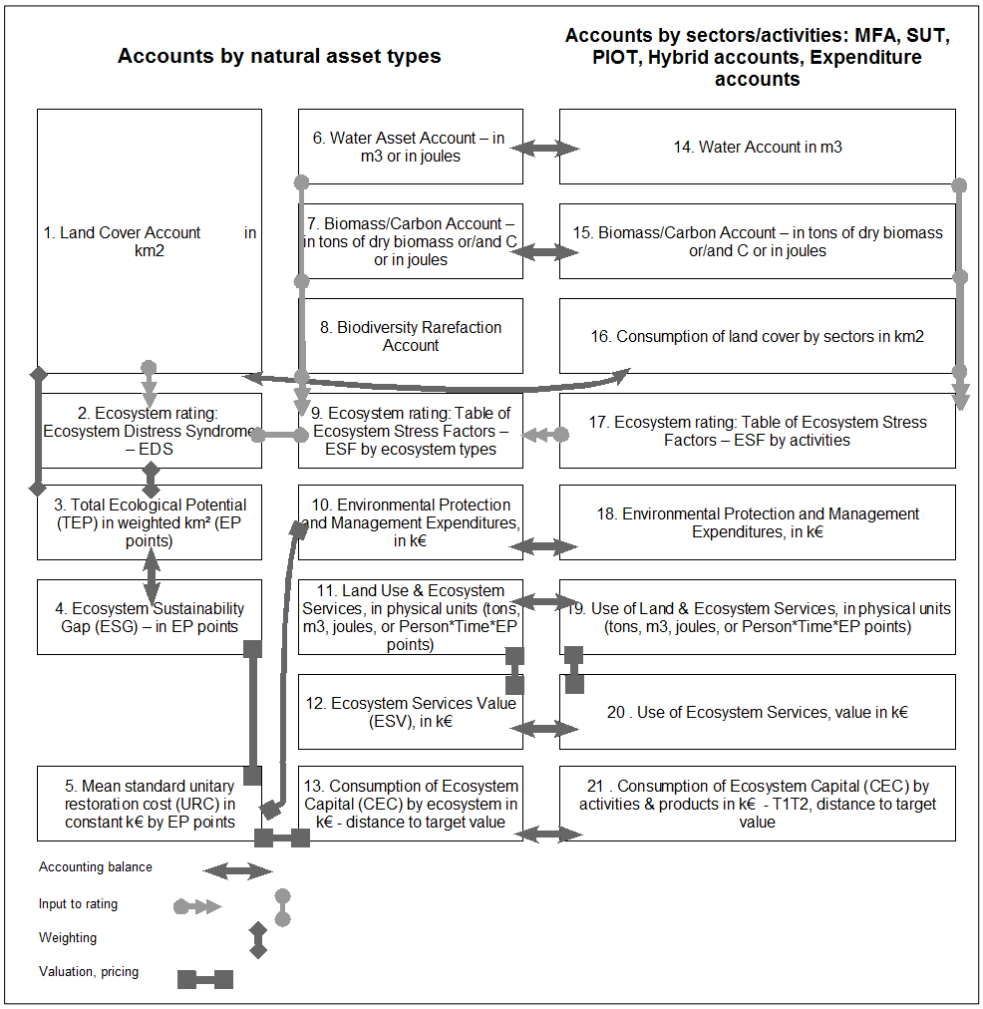

Figure 2: Example of organisation of the main tables of ecosystem accounts

The various types of arrows highlight the relations between the tables:

- accounting balances for land cover and resource components;
- input from these accounts into the rating procedure of ecosystem distress and stress factors;
- weighting of ecosystem stocks and calculation of the ecosystem potential for delivering services;
- calculation of the ecosystem sustainability gap and valuation of the consumption of ecosystem capital [restoration cost] by ecosystems;
- calculation of the consumption of ecosystem capital by activities/sectors and by domestic and imported products;
- calculation of ecosystem services [by types, in physical units] and valuation.

E) Land and ecosystem accounts in the SEEA revision process

The EEA has presented a proposal of steering further the development of land and ecosystem accounts in the June 2008 meeting of the UNCEEA[4]. Without prejudging the conclusions of the review of this paper asked by the committee, which will be presented to the London Group, land, on the one hand and ecosystems, on the other hand are likely be presented in two different chapters and possibly volumes, and follow the current assets classification.

F) Land accounts

Land cover accounts are information per se as well as the skeleton of most spatially distributed accounts, in particular ecosystem accounts. The methodology developed and implemented in Europe for 35 countries (as well as in Burkina Faso), with results in Europe for 1990-2000 and now 2006 can be endorsed as the basis for framing a core set of accounts. Amendments are foreseen in order to make sure of its general applicability.

The classification of satellite images on which accounts are produced has been tested out of Europe in Africa (Burkina Faso, Morocco, Tunisia), in West Indies (Guadeloupe), Central America (a transboundary catchment) and recently in Colombia. The compatibility between these applications is very good at the level 2 of the nomenclature, level 3 being open to regional adaptations. It guaranties a good comparability of accounts of land cover change. The classification of land cover flows might need to be reviewed to accommodate a multiple scales approach.

Two issues should in particular be addressed further on:

- **Land cover and land use:** land cover is, at the same time the image of vegetation patterns and of land use. Particular difficulty raises from the fact can one given land cover type supports a number of different land uses – can deliver a range of ecosystem services. Assessing land uses requires therefore an adequate mapping of land cover and combined additional information on uses. To a large extent, this information cannot be collected from remote sensing but requires field surveys (in particular area based sampling and population and agriculture censuses) and the use of administrative registers (local data, cadastre, monitoring networks...).
- **Scales**: simplification (upscaling) and detail (downscaling). The European methodology assesses land in a way which is relevant for analysing fragmented landscapes at the national and regional levels and change. Large uniform areas may not deserve such a detail. In such regions, permanent exhaustive monitoring of change at medium resolution can supply necessary warning and help focus more detailed investigations to areas of interest. Symmetrically, the standard land cover monitoring might not be sufficient for assessing some changes with enough details. This is the case of urban areas or urban sprawl in countryside or of agriculture crops. High resolution images can be used in that case as well as other sources of data such as cadastre, local urban databases, agriculture censuses, or sampling. These sources are far from

[4] Ecosystem accounts within SEEA revision, An EEA proposal – Paper prepared by the European Environment Agency (for discussion), ESA/STAT/AC.157 – UNCEEA/3/10 - http://unstats.un.org/unsd/envaccounting/ceea/meetings/lod3.htm

being harmonised from one country to another but they can all being combined with the standard land cover data, using GIS and statistical methods.

Classification of land cover and nomenclature

Land cover is at the same time the image of vegetation patterns and land use. It is observed at different scales using satellite images of various spatial resolution, aerial photograph or field surveys. Therefore, classifications may differ according to purposes. At the international level, two classification systems are mainly in use, the FAO's LCCS (Land cover classification system) and EEA's Corine land cover. Both systems are hierarchical and present similarities at the highest level, but differ when coming to details. To some extent, Corine land cover nomenclature can be presented as an application of LCCS hierarchical principles to Europe, with a focus on landscape patterns and land use physiognomical attributes. The legends developed from LCCS for various FAO, UNEP, IGBP and ESA programmes give the priority to vegetation patterns, including structure and density. In terms of land cover change, Corine can be better related to land use drivers. LCCS current legends give a more detailed picture of ecological characteristics, in particular for forests. In that respect, the combination of the two approaches makes a bridge from land to ecosystem accounting. At the national level, land cover legends/nomenclatures present a similar situation of de facto rather standardised high levels [urban, agriculture, forest, natural land, water...] with ad hoc details. The establishment of an international classification [or a couple of classifications] should not be a major problem. Recently, ESA, the European Space Agency and EEA have decided to test the feasibility of a second classification of the GlobCover map [currently following LCCS] in order to produce a GlobCorine version more appropriate to land accounting.

G) Ecosystem accounts

The possible specific part of the second volume of the SEEA2012 on ecosystems could be made of two main chapters:

- The accounting framework
- Accounts by ecosystem types

The second chapter would detail case by case the classification of assets, services, distress symptoms and stress factors. It would present the most adapted observation and valuation methods. However, the second chapter should remain relatively short, leaving the implementation issues to possible specific volumes.

1. The accounting framework

Tentatively, the first chapter could follow this outline:

1 Introduction

1.1 Policy demand

1.2 Ecosystem goods and services – food, energy, fiber, clean water, climate regulation, amenities

1.3 State of the natural capital – abundance, natural potential, resilience

1.4 Pressure and threats – over-harvesting, land restructuring, disposal of chemicals and residuals, introduction of species, climate change

2 System analysis

2.1 Functional units

a. Habitats, ecosystems, land cover units, socio-ecological systems

b. Socio-ecological systems (SES)

• Landscape functional units: urban, cropland, pasture & natural grassland, forest, wetlands, hydrological systems

• Soil

• Marine systems

• Atmosphere

c. Other landscape systems: bio-geographical sub-units, rivers basins, coastal systems, ecological networks

2.2 Accounting units

a. Functional units

a.1 Basic balances of stocks and flows

• System units: units by size, surface, length, srkm (standard river km), m3, mass

• Components: C, N, P, biomass, water, species, populations, habitats, land cover

a.2 State accounts (Ecosystem Distress Syndrome method)

• Health / distress diagnosis: vigor, organization, resilience, independence, support to healthy populations

• Stress / pressure

• Ecological rating

b. Ecosystem services

• ecosystem functions and ecosystem services – matrix

• ecosystem services and commodities – matrix

• ecosystem services and land use functions - matrix

c. Reporting units

• Individual socio-ecological systems

• Geographical units: natural and administrative regions

• Institutional and other statistical units: sectors, branches, products

3 Valuation of services and maintenance/restoration costs

3.1 Market commodities, primary goods and services – market prices, statistics, production accounts

3.2 Final use of free ecosystem services

• Individual and collective use

• Valuation methods

• Scale issue

3.3 Maintenance costs – full cost of products

a. Actual environmental protection expenditure – ecosystem protection, management, restoration

b. Additional allowances for non-covered depreciation (repositioning costs)

• Principle

• Case of ecosystem cost contents in imports

• Computation

4 Integration and Aggregates

4.1 Integration of Ecosystem accounts with NAMEA/ hybrid accounts

• Sector analysis, values and costs

• NAMEA/ hybrid accounts's environmental themes and impacts on ecosystems

• NAMEA/ hybrid accounts for ecosystem services

4.2 Integration of Ecosystem accounts with Material and Energy Flows Accounts

4.3 Integration with environmental protection expenditure accounts

4.4 Ecosystem accounts and aggregated physical (composite) indicators: Land Ecological Potential, HANPP, Human Footprint [water, land, Carbon], Biodiversity Rarefaction.

4.5 Ecosystem accounts and monetary aggregates:

• Value of end use free ecosystem services and Inclusive Final Consumption (IFC),

• Additional repositioning (maintenance and restoration) cost of domestic and external ecosystems and Full Cost of Goods and Services

(FCGS – including ecosystem cost of imports) and Full Cost of Final Demand (FCFD – imports minus exports)

• Ecosystem sustainability gap

4.6 Aggregation of socio-ecosystems and double counting issues

5. Nomenclatures and tables

5.1 Ecosystems and socio-ecological systems – types and components

5.2 Ecosystem services

5.3 Reporting units

5.4 Tables

2. Accounts by ecosystem types

The structure of the chapter should follow the broad categories used in various international assessments, in particular the Millennium Ecosystem Assessment which revision is planned by UNEP by 2015 and which could benefit of the first ecosystem accounts as well as contribute to their development. These categories are:

- Urban ecosystems
- Cropland systems
- Pasture, mosaics and natural grassland systems
- Forest ecosystems
- Non cultivated dryland, sparse vegetation and bare soils
- Wetlands
- Lakes and rivers
- Soil
- Sea
- Atmosphere
- Ecological regions (mountains, coastal zones, islands, catchments, biogeographic zones)

The chapter would detail the contents and boundaries of each ecosystem type and the main accounts.

H) Process

1. Consultation and reviewing

The EEA proposal is to continue steering the development of ecosystem accounting within the London Group and revitalise the subgroup on land and ecosystem accounting. The subgroup will be asked for contributions and review of the work in progress. The EEA will coordinate the drafting and editing of the chapters on land accounts and on ecosystem accounts. An annual 2-3 days expert meeting is planned. It will bring together London Group experts altogether with edition with EEA expert and international panel of experts UNEP.

A first meeting on the classification of ecosystem services planned for December 2008. Its purpose is to bring together the various communities working with this concept in order to come to a consensus on a standard nomenclature to be used in the various processes taking place in parallel: SEEA revision 2012, MA2015, TEEB phase 2, 2010, Eureca! 2012, "Beyond GDP" follow-up, PES and IPES, UNEP's Green Economics, as well as national initiatives in ecosystem assessment.

2. Prioritisation

I. Drafting of Land cover accounts methodology for SEEA revision volume 1. It will take place according to the general drafting and editing agenda of this volume.

II. Drafting of ecosystem accounting methodology

III. Support to simplified global accounts based on aggregates:
- using ESA/GlobCover and other international monitoring and statistical programmes as input
- land cover accounts
- ecosystem accounts of potentials and consumption of ecosystem capital
  - Landscape ecological potential (LEP)

- NPP (Net primary production), EPP (Ecosystem primary production), HANPP (Human appropriation of the NPP)
- Biodiversity rarefaction
- Exergy loss [river basins]
- Ecosystem dependence from external inputs [material/energy, footprint]
- maintenance/restoration costs up to stated targets [international, regional and national commitments] and calculation of the consumption of ecosystem capital by ecosystems/countries.

IV. Support to simplified ecosystem services accounts by topic (physical units and valuation) such as currently done in projects such as GAISP, various applications in Eastern and Southern Africa, or TEEB/Mediterranean Wetlands. This should be considered as well as a contribution to the "green economics" project currently prepared by UNEP or the Eureca! European ecosystem assessment, as well under preparation in the MA context.

Annex 1: Mock-up tables of land and ecosystem accounts

Accounts by natural asset types [1]

1. Land Cover Account in km2	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Stock T1	19185	151241	79487	6268		256181
Urban sprawl	-101	-1907	-157	-2	0	-2167
Agriculture internal conversions	0	-3870	0	0	0	-3870
Conversion from forest/nature land to agriculture	-83	-17	-64	-3	0	-167
Withdrawal of farming	0	-240	0	0	0	-240
Forests creation and management	-117	0	-800	0	0	-917
Water bodies creation and management	-98	-72	-14	-2	0	-186
Changes due to natural and multiple causes	-175	-7	-217	-105	-2	-503
Total Consumption of land cover T1 (-)	*-573*	*-6113*	*-1252*	*-111*	*-2*	*-8052*
Urban sprawl	2167	0	0	0		2167
Agriculture internal conversions	0	3870	0	0		3870
Conversion from forest/nature land to agriculture	0	167	0	0		167
Withdrawal of farming	0	22	218	0		240
Forests creation and management	0	0	917	0		917
Water bodies creation and management	0	0	2	184		186
Changes due to natural and multiple causes	0	0	437	65	2	505
Total Formation of land cover T2 (+)	*2167*	*4059*	*1574*	*250*	*2*	*8052*
Stock T2	20779	149187	79809	6406		256181
Indicators					*0*	
Consumption of land cover as % initial year	*3*	*4*	*2*	*2*		*3*
Formation of land cover as % initial year	*11*	*3*	*2*	*4*		*3*
Net Formation of Land Cover (formation-consumption)	*1594*	*-2054*	*322*	*138*	*0*	*0*
Net formation as % of initial year	*8*	*-1*	*0*	*2*		*0*
Total turnover of land cover (consumption+formation)	*2741*	*10172*	*2827*	*361*	*4*	*16105*
Total turnover as % of initial year	*14*	*7*	*4*	*6*		*6*

2. Ecosystem rating: Ecosystem Distress Syndrome – EDS	Urban	Agriculture	Forest/Nature	Water bodies	Sea	
Overall diagnosis, 0 to 100						
Vigor (nutrient cycling, NPP, abundance of species)	*40*	*75*	*80*	*70*	*60*	
Organisation, disruption of substrates	*50*	*60*	*82*	*85*		
Resilience	*50*	*75*	*75*	*75*		
Dependence	*35*	*45*	*80*	*70*		
Population's health	*70*	*75*	*90*	*85*	*95*	
EDS synthesis - Mean value – T1	49	66	81	77	78	
Vigor (nutrient cycling, NPP, abundance of species)	*40*	*72*	*78*	*65*	*50*	
Organisation, disruption of substrates	*47*	*54*	*85*	*85*		
Resilience						
		75	*78*	*75*		
Dependence	*32*	*45*	*82*	*70*		
Population's health	*65*	*70*	*93*	*85*	*95*	
EDS synthesis - Mean value – T2	46	63	83	76	73	

Ecological Target Value [ETV] in EDS points	65	70	90	95	85	

3. Total Ecological Potential (TEP) in weighted km² (EP points)	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Ecological potential T1, TEP = EDS * LC_T1	940065	9981906	6470242	482636	0	17874849
Ecological potential T2, TEP = EDS * LC_T2	955833	9428623	6640092	486867	0	17511416
ChangeT1T2 in total ecological potential	15768	-553283	169850	4231	0	-363433
Change in total ecological potential, % of TEP_T1	2	-6	3	1		-2

4. Ecosystem Sustainability Gap (ESG) – in EP points	Urban	Agriculture	Forest/Nature	Water bodies	Sea	
Ecosystem Sustainability Gap T1, ESG = (ETV-EDS)*LC_T1	306960	604964	683588	112824	0	
Ecosystem Sustainability Gap T2, ESG = (ETV-EDS)*LC_T2	394800	1014472	542700	121717	0	
Ecosystem Sustainability Trend	-87840	-409508	140888	-8893	0	
Ecosystem Sustainability Trend % of 1990 potential	-9	-4	2	-2		

5. Mean standard unitary restoration cost (URC) in constant k€ by EP points	Urban	Agriculture	Forest/Nature	Water bodies	Sea	
Mean standard unitary restoration cost	100	30	25	50		

Accounts by natural asset types [2]

6. Water Asset Account – in m3 or in joules

	Land/Soil			Surface water bodies				
	Urban	Agriculture	Forest/Nature	Rivers	Lakes	Ground water	Sea	Total
Stock1	200	2500	2300	500	2744	150000		158244
Inflows/imports				9200		1100		10300
Precipitation	135	9200	4501	168	210			14214
Net internal transfers	-50	-1618	-700	2103		265		0
Primary abstraction & supply	1900	817		-2123	-300	-295		-0
Returns	-1482	-218		1263		299	238	100
Evapotranspiration	-396	-8223	-3800	-333	-416			-13168
Outflows/exports				-10100		-1379		-11479
Stock2	307	2458	2301	679	2238	149990	0	157973
Indicators								
Net accumulation of water	*107*	*-42*	*1*	*179*	*-506*	*-10*		*-271*
Net available resource	*1985*	*8400*	*3801*	*3535*	*210*	*564*	*238*	*18731*

7. Biomass/Carbon Account – in tons of dry biomass or/and C or in joules

	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Stock1	50	5000	8000	100	-	13150
Imports	300	200	500			1000
Net Primary Production	*60*	*2000*	*3000*	*100*		*5160*
Ecosystem Respiration	*-60*	*-1000*	*-2000*	*-80*	-	*-3140*
Ecosystem Primary Prod.	0	1000	1000	20		2020
Effect of land cover change		-80	-100			
Abstraction/harvesting & supply	-2	-900	-1200		-280	-2382
Use	2382					2382
Returns/residuals (net)	-1100	100	200	150	650	0
Combustion/degradation	-950	-100	-52			-1102
Exports	-500	-300	-100			-900
Stock2	180	4920	8248	270	-	13618
Indicator						
Net biomass accumulation	*130*	*-80*	*248*	*170*	-	*468*

8. Biodiversity Rarefaction Account

	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Stock1						
Mean Species Abundance index T1	*0.10*	*0.50*	*0.60*	*0.70*	*0.70*	
Mean Species Abundance T1 – weighted km2	1919	75621	47692	4388	pm	129619
Species Communities Specialism Index T1	*0.01*	*0.30*	*0.80*	*0.50*		
Species Communities Specialism T1- weighted km2	192	45372	63590	3134		112288
Change in mean species abundance	-48	-12962	991	-224	0	-12243
Change in species communities specialism	16	-6584	-3733	69	0	-10232
Mean Species Abundance Index T2	*0.09*	*0.42*	*0.61*	*0.65*	*0.55*	
Mean Species Abundance T2 – weighted km2	1870	62659	48683	4164	pm	117376
Species Communities Specialism Index T2	*0.01*	*0.26*	*0.75*	*0.50*		
Species Communities Specialism T2 - weighted km2	208	38789	59857	3203	0	102056
Stock2						
Change in mean species abundance %	97.48	82.86	102.08	94.90		90.55
Change in species communities specialism %	108.31	85.49	94.13	102.20		90.89

9. Ecosystem rating: Table of Ecosystem Stress Factors – ESF by ecosystem types

	Urban	Agriculture	Forest/Nature	Water bodies	Sea	
Natural disturbances			x		x	
Physical restructuring	xxx	x	x	xx		
Over harvesting/overuse		x	x	xx	xxx	
Residuals & force feeding	x	xxx	xx	xx	xx	
Introduction of species		xxx	xx	x		
ESF – T1T2						

10. Environmental Protection and Management Expenditures, in k€ by ecosystem types

	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Nature & sites protection	21000	20000	100000		20000	161000
Water protection				1250000	522000	1772000
Soil protection		150000		20000		170000
Forest management			150000			150000
Coastal management	1300000				311000	1611000
Total Expenditure T1T2	1321000	170000	250000	1270000	853000	3864000

11 Land Use & Ecosystem Services, in physical units (tons, m3, joules, or Person*Time*EP points)

	Urban	Agriculture	Forest/Nature	Water bodies	Sea	
Marketed ecosystem services						
Provisioning services/ Primary goods & energy	100	150000	50000	2717	5000	207817
Recreational & Cultural / marketed services	2500	5000	3000	1000	5000	16500
Recreational & Cultural / non marketed services	12000	10000	30000	5000	10000	67000
Regulating ecosystem services	5000	25000	60000	10000	20000	120000
ES – T1T2						

*LU = LC*ES*

12. Ecosystem Services Value (ESV), in k€

	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Marketed ecosystem services	109200	6510000	2226000	156114	420000	9421314
Provisioning services/ Primary goods & energy	4200	6300000	2100000	114114	210000	8728314
Recreational & Cultural / marketed services	105000	210000	126000	42000	210000	693000
Recreational & Cultural / non marketed services	504000	420000	1260000	210000	420000	2814000
Regulating ecosystem services	50000	250000	600000	100000	200000	1200000
ESV – T1T2	663200	7180000	4086000	466114	1040000	13435314
Unitary price for all:	*42*					

13. Consumption of Ecosystem Capital (CEC) by ecosystem in k€ - distance to target value

	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Consumption of Ecosystem Capital T0T1, CEC = ESG*URC	30696000	18148920	17089705	5641200	-	71575825
Consumption of Ecosystem Capital T1T2, CEC = ESG*URC	39480043	30434164	13567496	6085843	-	89567546

Accounts by sector: MFA, SUT, PIOT, Hybrid accounts, Expenditure accounts

14. Water Account in m3

ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Final consumption	Total
Import													
Primary abstraction	817	50	100	150	1300			100		200			2717
Net Supply[-] & Use [+]	200		90	310	-1300			200		100		400	0
Transfer of waste water to sewerage		50	190	460	-1700			300		300		400	0
Returns/Residuals	218				1482								1700
Consumption [evaporation & returns to sea of used water]	779				238								1017
Export													
Indicator 1													

15. Biomass/Carbon Account – in tons of dry biomass or/and C or in joules

ISIC	* A - Agriculture,	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity,	* E - Water supply;	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households	* R - Arts, entertainment	Final consumption	Total
Import							1000						1000
Abstraction/harvesting	1802									300			2102
Supply			2232							100		1050	3382
Use	1500		1582				100			200			3382
Residuals	82		200							100		718	1100
Combustion/degradation	220		450							100		332	1102
Export							900						900
Indicator 1													

16. Consumption of land cover by sectors in km2

ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Final consumption	Total
Urban sprawl		100	700	200	50	957	100	60		100			2167
Agriculture internal conversions	3870												3870
Conversion from forest/nature land to agriculture	167												167
Withdrawal of farming	240												240
Forests creation and management	617							250		50			917
Water bodies creation and management				93	93								186
Consumption of land cover T1 by sectors	4894	100	700	293	143	957	100	310		150			7548
Changes due to natural and multiple causes													505
Total Consumption of land cover T1T2	4894	100	700	293	143	957	100	310	0	150		0	8052

17. Ecosystem rating: Table of Ecosystem Stress Factors – ESF by activities

ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Final consumption	Total
Natural disturbances													
Physical restructuring	xxx	x	x	xx	xx	xx		x			xx		
Over harvesting/overuse	xx			x	x						x		
Residuals & force feeding	xx	x	x	x	x					x	x	xxx	
Introduction of species	xx										x		
ESF – T1T2													

18. Environmental Protection and Management Expenditures, in k€

ISIC	* A - Agriculture,	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity,	* E - Water supply;	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households	* R - Arts, entertainment	Final consumption	Total	
														0
														0
Nature & sites protection	100000							10000			1000	50000	161000	0
Water protection	1000	5000	10000	5000	1500000			200000		1000		50000	1772000	0
Soil protection	50000				20000			100000					170000	
Forest management	150000												150000	
Coastal management						10000	1000	1600000					1611000	
Total Expenditure T1T2	301000	5000	10000	5000	1520000	10000	1000	1910000	0	1000	1000	100000	3864000	

19. Use of Land & Ecosystem Services, in physical units (tons, m3, joules, or Person*Time*EP points)

ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Final consumption	Total
Marketed ecosystem services													
Provisioning services/ Primary goods & energy	817		110000	150	1300	15550		20000		50000		1000	20817
Recreational & Cultural / marketed services											16500		16500
Recreational & Cultural / non marketed services												67000	67000
Regulating ecosystem services												120000	120000
ES – T1T2													

20 . Use of Ecosystem Services, value in k€

ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Final consumption	Total
Marketed ecosystem services	34314	0	4620000	6300	54600	653100	0	840000	0	2100000	693000	42000	9043314
Provisioning services/ Primary goods & energy	*34314*	*0*	*4620000*	*6300*	*54600*	*653100*	*0*	*840000*	*0*	*2100000*	*0*	*42000*	*8350314*
Recreational & Cultural / marketed services	*0*	*0*	*0*	*0*	*0*	*0*	*0*		*0*	*0*	*693000*	*0*	*693000*
Recreational & Cultural / non marketed services	0	0	0	0	0	0	0	0	0	0	0	2814000	2814000
Regulating ecosystem services	0	0	0	0	0	0	0	0	0	0	0	1200000	1200000
ESV – T1T2	34314	0	4620000	6300	54600	653100	0	840000	0	2100000	693000	4056000	13057314

21 . Consumption of Ecosystem Capital (CEC) by activities & products in k€ - T1T2, distance to target value

CPC ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Virtual CEC in goods and services – Total T1T2	Virtual CEC in Exports [-]	Virtual CEC in Final Consumption
0 - Agriculture, forestry and fishery products	29109452	12500	25750000	23500000	3739189	259943	50000000	0	0	1673500	739189	134783773	22463962	112319811
1 - Ores and minerals; electricity, gas and water	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
2 - Food products, beverages and tobacco; textiles, apparel and leather pr	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
3 - Other transportable goods, except metal products, machinery and equi	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
4 - Metal products, machinery and equipment	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
5 - Constructions and construction services	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
6 - Distributive trade services; accommodation, food and beverage serving services; transport services; and utilities distribution services	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
7 - Financial and related services; real estate services; and rental and leas	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
8 - Business and production services	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
9 - Community, social and personal services	5821890	2500	5150000	4700000	747838	51989	10000000	0	0	334700	147838	26956755	4492792	22463962
Virtual Consumption of domestic EC – T1T2	58218905	25000	1500000	17000000	7478377	519886				3347000	1478377	89567546		
Virtual CEC in imports – Total T1T2			50000000	30000000			100000000					180000000		
Total Virtual CEC T1T2	58218905	25000	51500000	47000000	7478377	519886	100000000	0	0	3347000	1478377	269567546	62899094	314495470

Implementation requires coordinating the various approaches

- **Data/information**: need correct articulation between policy needs and ecological economic research [resilience assessment, econometric valuation, scenario/modelling...] ➔ classifications, detail, timeliness, access
- **Scales/governance levels**: specific requirements at action/ government/ global levels... and micro-macro [or macro-micro] integration [aggregation/disaggregation, stratification, sampling, modelling] – 1 km2 grid as a useful tool for data assimilation

Comment [MER1]: There might be a third point: Data availability and needs