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Ecosystem Natural Capital Accounting (2)

ECOSYSTEM NATURAL CAPITAL ACCOUNTS: A QUICK START PACKAGE

For implementing Aichi Biodiversity Target 2
on Integration of Biodiversity Values in National Accounting Systems
in the context of the SEEA Experimental Ecosystem Accounts

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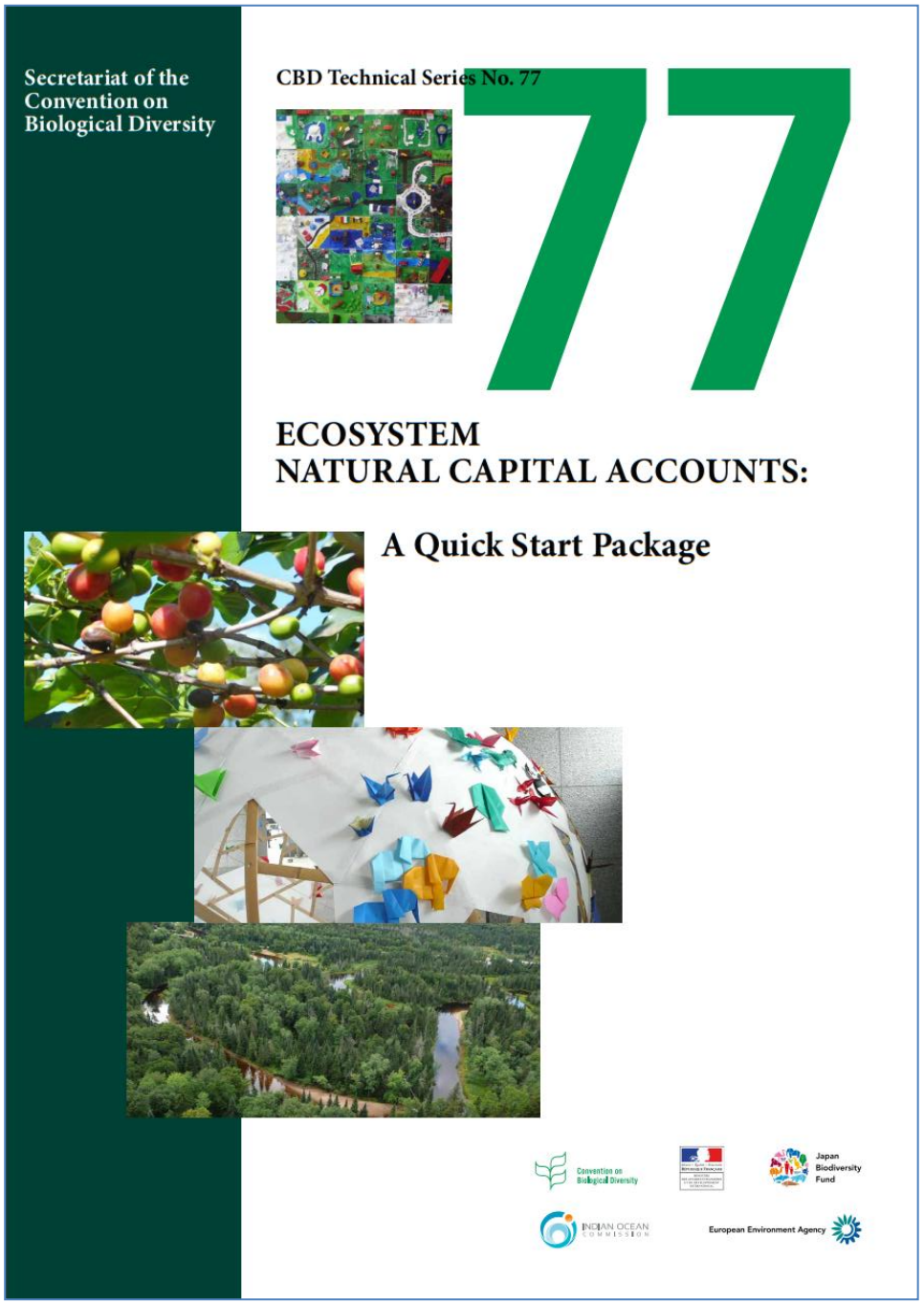


ENCA: a Quick Start Package

- Meet an **urgency (by 2020…)**
- **Focus on core accounts in physical units** and calculation of ecosystem capability and degradation or enhancement.
- **Fast track implementation** with existing data; learning by doing
- **First test accounts**:
  - ➔ involvement of producers, data holders and stakeholder.
  - ➔policy relevance of results discussed with stakeholders.
  - ➔identification of data gaps and framing of an action plan for regular implementation
- In the **last chapter, further steps** are described : liability of economic sectors and ecological balance-sheet, restoration costs, valuation of services...

CONTENTS

ACKNOWLEDGEMENTS 5

FOREWORD BY EXECUTIVE SECRETARY 8

EXECUTIVE SUMMARY 9

Ecosystem Natural Capital Accounts: A Quick Start Package 9

0. INTRODUCTION 11

0.1 The context 11
0.2 Scope, objectives and target audiences for ecosystem natural capital accounts 15
0.3 Policy relevance of ecosystem accounting 17
0.4 Overview of the document structure and links between chapters 19

1. A QUICK START PACKAGE FOR PUTTING THE SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING - ECOSYSTEM TO WORK 22

1.1 Priorities for the Ecosystem Natural Capital Accounts Quick Start Package 22
1.2 Setting principles 22
1.3 Choosing an operational accounting framework 24
1.4 The choice of the ecosystem natural capital accounts framework 26
1.5 How does ENCA-QSP relate to SEEA? 26
1.6 Roadmap 28

2. CHARACTERISTICS OF ECOSYSTEM NATURAL CAPITAL ACCOUNTS 32

2.1 An integrated accounting framework 32
2.2 A simple, robust infrastructure 39

3. THE DATA INFRASTRUCTURE 52

3.1 Reference geographical layers 53
3.2 Producing the geographical layers of statistical units 59

4. THE LAND COVER ACCOUNT 69

4.1 Land-cover maps, stocks and changes 69
4.2 The land-cover accounting framework 88
4.3 Producing and analysing land-cover accounts 95

Contents

INTRODUCTION

1. A QUICK START PACKAGE FOR PUTTING THE SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING - ECOSYSTEM TO WORK

2. CHARACTERISTICS OF ECOSYSTEM NATURAL CAPITAL ACCOUNTS

3. THE DATA INFRASTRUCTURE

4. THE LAND COVER ACCOUNT

5. THE ECOSYSTEM CARBON ACCOUNT

6. THE ECOSYSTEM WATER ACCOUNT

7. THE ECOSYSTEM INFRASTRUCTURE FUNCTIONAL SERVICES ACCOUNT

8. THE ECOSYSTEM CAPITAL CAPABILITY ACCOUNT

9. THE ECOSYSTEM NATURAL CAPITAL ACCOUNTS QUICK START PACKAGE AND BEYOND

CONCLUSION

0. INTRODUCTION

"Because national accounts are based on financial transactions, they account for nothing in nature, to which we don't owe anything in terms of payments but to which we owe everything in terms of livelihood." **Bertrand de Jouvenel, Arcadie, 1968**

0.1 THE CONTEXT

0.01 This report aims to contribute to the process of testing the System of Economic and Environmental Accounts – Experimental Ecosystem Accounts (SEEA-EEA) endorsed by the UN Statistical Commission in 2013. The publication of SEEA-EEA was an important first step towards accounting for ecosystems, their services and resilience, which to a large extent depend on biodiversity. This volume intends to provide further practical guidance, motivated by the requirements of the Strategic Plan for Biodiversity 2011-2020 and its Aichi Targets [3], which aims at integrating biodiversity into mainstream policies by 2020.

0.02 Goal A of the Strategic Plan seeks to address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society, and Aichi Biodiversity Target 2, under this goal, reads as follows: "*By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems*". [4]

0.03 These goals and targets reflect the Convention's ecosystem approach, "*a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way*", recognizing that "*humans, with their cultural diversity, are an integral component of many ecosystems*".

0.04 The revision of the System of Economic and Environmental Accounts (SEEA 2003), agreed in 2007 by the UN Statistical Commission, led to the creation of an international statistical standard for accounts for which sufficient experience exists. In 2008, the UN Statistical Commission decided to supplement the standard accounts, now called the *SEEA Central Framework* [5], with a second volume on *Experimental Ecosystem Accounts*.

0.05 The 2012 SEEA Central Framework represents an international statistical standard on a par with the Systems of National Accounts (SNA), which do not cover accounting for ecosystems. The Central Framework covers physical resource flows, natural assets and their depletion (physical and monetary), and expenditure on environmental protection and resource management. "*Accounting for degradation and other measurement topics associated with ecosystems are not covered in the SEEA Central Framework. The relevant material is discussed in SEEA Experimental Ecosystem Accounts*" [6].

3 *CBD Aichi Biodiversity Targets: http://www.cbd.int/sp/targets (accessed 21 July 2014).*

4 *These important CBD targets have been endorsed by the United Nations General Assembly's Open Working Group on Sustainable Development Goals at its last meeting, 19 July 2014. (para. 0.24)*

5 *SEEA 2012 Central Framework: http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf (accessed 21 July 2014).*

6 *SEEA-Central Framework, op. cit. para. 14*

CONTEXT:

Aichi Target 2

International statistics: SNA & SEEA

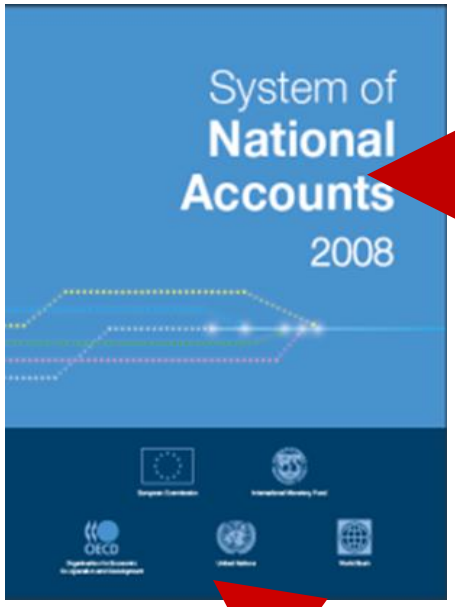
SCOPE, TARGETS

POLICY RELEVANCE

International statistical context: SNA and SEEA volumes 1 & 2

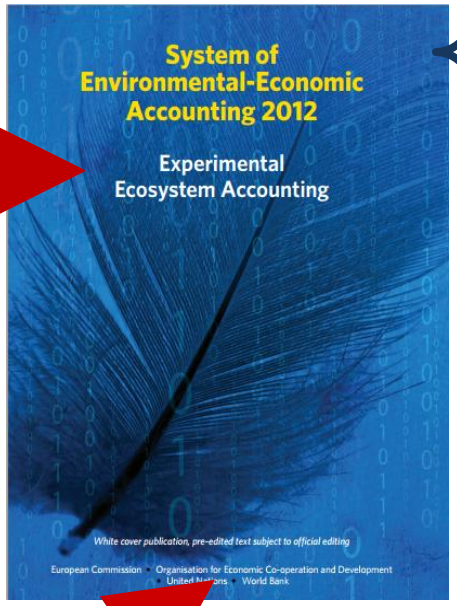
The System of Environmental-Economic Accounts "Central Framework" (SEEA-CF) adopted by the UN Statistical Commission in 2012 as an international statistical standard on par with the System of National Accounts (SNA 2008). 12) has been supplemented in 2013 by a volume on "Experimental Ecosystem Accounting" (SEEA-EEA). While the SEEA-CF is recommended for implementation, the SEEA-EEA which is a conceptual framework is now tested in various projects for which additional methodologies need to be defined. The CBD TS77 ENCA-QSP is a contribution to the development of such tests.

SNA



SEEA volume 1 "Central Framework"

SEEA volume 2 "Experimental Ecosystem Accounting"



SEEA-EEA Experiment

XXX

SEEA-EEA Experiment

EU: ECA & MAES

Ecosystem Capital Accounts Mapping and Assessment of Ecosystem Services

SEEA-EEA Experiment

ENCA-Mauritius

Ecosystem/ Natural Capital Accounts

0. INTRODUCTION

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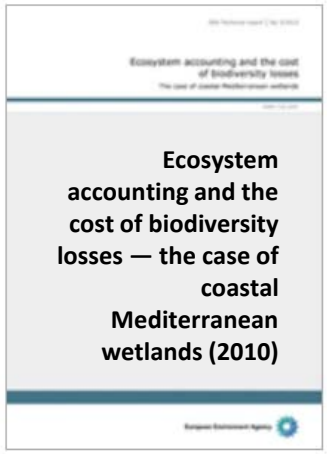
6 *SEEA-Central Framework, op. cit. para. 14*

Comptes du Patrimoine Naturel [Natural Patrimony Accounts] (France, 1986)

ENCA-QSP inherits from the SEEA & from other related accounting projects

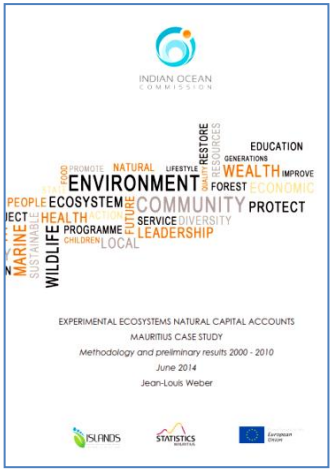
Land accounts for Europe (2006)

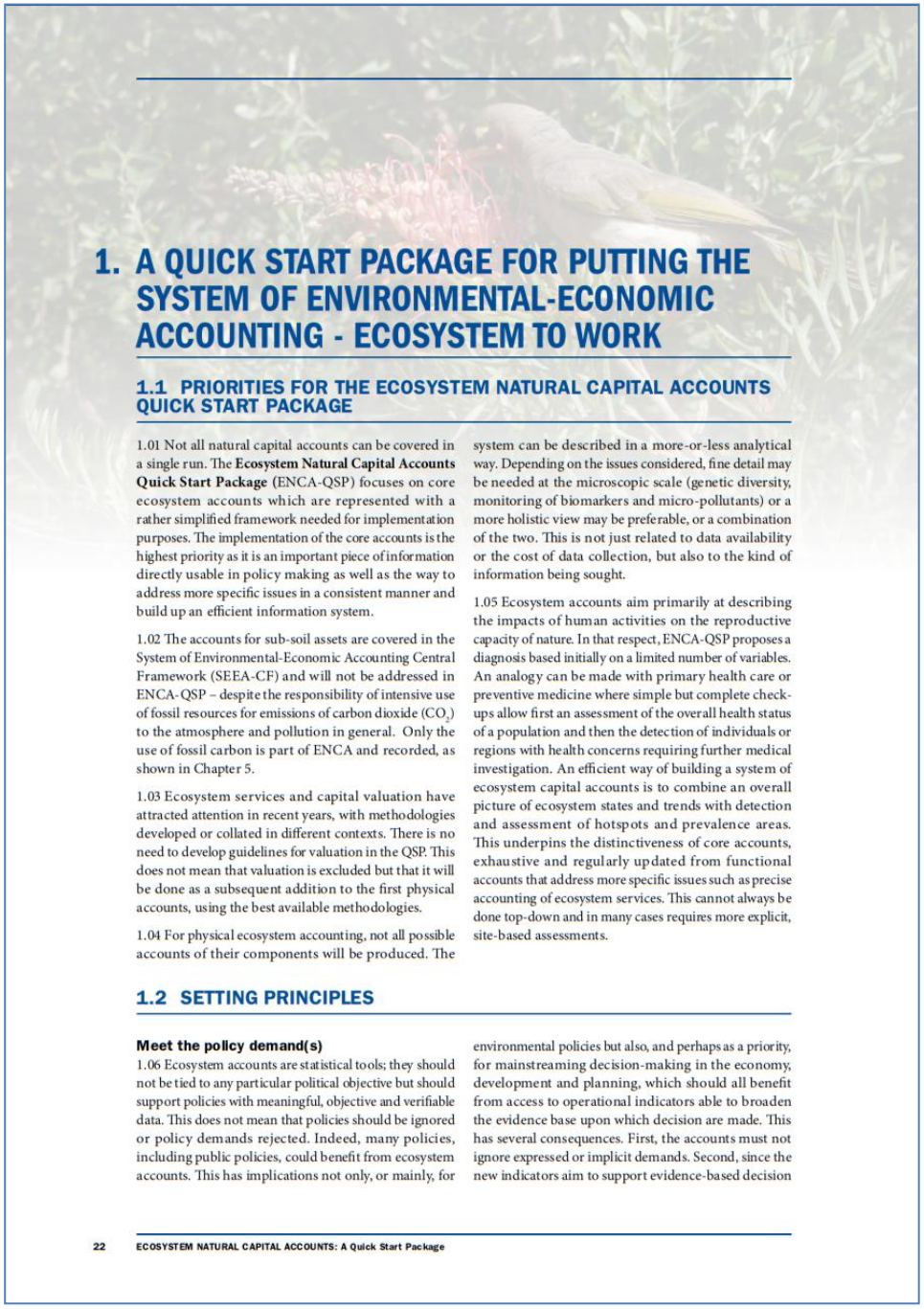


Ecosystem accounting and the cost of biodiversity losses — the case of coastal Mediterranean wetlands (2010)

An experimental framework for ecosystem capital accounting in Europe (2011)

Experimental ENCA, Mauritius Case Study (2014)





1. A QUICK START PACKAGE FOR PUTTING THE SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING - ECOSYSTEM TO WORK

1.1 PRIORITIES FOR THE ECOSYSTEM NATURAL CAPITAL ACCOUNTS QUICK START PACKAGE

1.01 Not all natural capital accounts can be covered in a single run. The **Ecosystem Natural Capital Accounts Quick Start Package** (ENCA-QSP) focuses on core ecosystem accounts which are represented with a rather simplified framework needed for implementation purposes. The implementation of the core accounts is the highest priority as it is an important piece of information directly usable in policy making as well as the way to address more specific issues in a consistent manner and build up an efficient information system.

1.02 The accounts for sub-soil assets are covered in the System of Environmental-Economic Accounting Central Framework (SEEA-CF) and will not be addressed in ENCA-QSP – despite the responsibility of intensive use of fossil resources for emissions of carbon dioxide (CO_2) to the atmosphere and pollution in general. Only the use of fossil carbon is part of ENCA and recorded, as shown in Chapter 5.

1.03 Ecosystem services and capital valuation have attracted attention in recent years, with methodologies developed or collated in different contexts. There is no need to develop guidelines for valuation in the QSP. This does not mean that valuation is excluded but that it will be done as a subsequent addition to the first physical accounts, using the best available methodologies.

1.04 For physical ecosystem accounting, not all possible accounts of their components will be produced. The system can be described in a more-or-less analytical way. Depending on the issues considered, fine detail may be needed at the microscopic scale (genetic diversity, monitoring of biomarkers and micro-pollutants) or a more holistic view may be preferable, or a combination of the two. This is not just related to data availability or the cost of data collection, but also to the kind of information being sought.

1.05 Ecosystem accounts aim primarily at describing the impacts of human activities on the reproductive capacity of nature. In that respect, ENCA-QSP proposes a diagnosis based initially on a limited number of variables. An analogy can be made with primary health care or preventive medicine where simple but complete check-ups allow first an assessment of the overall health status of a population and then the detection of individuals or regions with health concerns requiring further medical investigation. An efficient way of building a system of ecosystem capital accounts is to combine an overall picture of ecosystem states and trends with detection and assessment of hotspots and prevalence areas. This underpins the distinctiveness of core accounts, exhaustive and regularly updated from functional accounts that address more specific issues such as precise accounting of ecosystem services. This cannot always be done top-down and in many cases requires more explicit, site-based assessments.

1.2 SETTING PRINCIPLES

Meet the policy demand(s)

1.06 Ecosystem accounts are statistical tools; they should not be tied to any particular political objective but should support policies with meaningful, objective and verifiable data. This does not mean that policies should be ignored or policy demands rejected. Indeed, many policies, including public policies, could benefit from ecosystem accounts. This has implications not only, or mainly, for environmental policies but also, and perhaps as a priority, for mainstreaming decision-making in the economy, development and planning, which should all benefit from access to operational indicators able to broaden the evidence base upon which decision are made. This has several consequences. First, the accounts must not ignore expressed or implicit demands. Second, since the new indicators aim to support evidence-based decision

DEFINING PRIORITIES

SETTING PRINCIPLES:

- Meet the policy demand(s)
- Be outcome-oriented
- Use existing data
- First produce accounts in physical units, then value services and restoration costs

CHOOSING AN OPERATIONAL ACCOUNTING FRAMEWORK:

- Integrative
- Interoperable with other data and statistics frameworks
- Open to developments, extensions

THE CHOICE OF THE ECOSYSTEM NATURAL CAPITAL ACCOUNTS FRAMEWORK

HOW ENCA-QSP RELATES TO THE SEEA?

A RODMAP FOR IMPLEMENTATION

All ecosystems are addressed in ENCA

- Natural, semi-natural, managed, even urban ecosystems; the soil ecosystem is accounted as a sub-system of each surface ecosystem; the atmosphere is also an ecosystem...

- In the context of the QSP, priority is given to inland ecosystems and sea coastal ecosystems.

- Programmes on oceans and atmosphere can be started if sufficient involvement of the respective scientific communities can be found; linkages with IPCC are indispensable.

2. CHARACTERISTICS OF ECOSYSTEM NATURAL CAPITAL ACCOUNTS

2.1 AN INTEGRATED ACCOUNTING FRAMEWORK

2.1.1 Ecosystem capital degradation or improvement, (and their counterparts in terms of ecological debts or credits), are at the core of the ENCA accounting framework.

2.01 The central concept of ENCA is the measurement of the sustainable capacity of ecosystems to supply the services needed by humankind and to assess human accountability for ecosystem degradation by inappropriate or free-rider management, or for ecosystem conservation, restoration or enhancement. Degradation is the sum of depletion of the renewable resource and the loss of other potential services that may affect the owner of the ecosystem asset or the community as a whole. When degradation can be imputed to economic actors, it is a non-paid cost (an externality) that corresponds to a consumption of ecosystem capital. This ENCA approach goes one step further than SEEA-EEA that does not deal with aggregation issues.

2.02 The ENCA approach to degradation starts not from the loss of ecosystem services but from the capability of the ecosystem. Capability encompasses ecosystem productivity as well as health, in terms of robustness, organization, resilience, dependence on artificial inputs, and disease prevalence. For resources used by extraction, capability assessment requires recording the amount that is accessible in a sustainable way, not the stock itself or the total stock plus inflow. It takes into account that part of the resource is needed by the ecosystem for its own renewal and that only part is sustainably exploitable. The accessibility of resources that are not depletable is measured indirectly, in terms of the integrity and health of the systems which generate them. They are all the intangible services that depend on ecosystem function, integrity and biodiversity, the regulating and cultural services in the SEEA-EEA provisional CICES interim classification. In that way, risks of omission or double-counting are avoided.

2.03 Degradation is the decrease, for which human activities are responsible, of capabilities between two dates. This means that a distinction is made between deterioration resulting from natural disturbances and degradation from anthropogenic factors[1]. Increases in ecosystem capability are recorded as enhancement when they result from human activities[2], natural improvements being recorded separately.

2.04 Breakdown of degradation and enhancement by SNA sectors and industries is carried out in later steps, after QSP. As long as degradation results from an unpaid economic cost (an externality) that is passed to others (current or future generations), it is a debt. In a symmetric way, investment in ecosystem restoration can partly be recorded as a reduction of debt (when considering degradation that has taken place in a recent period) or as a creation of credit, which can be taken into account in mitigation mechanisms. Recording of ecological credits and debts is an adjunct to SEEA-EEA. Currently, SEEA considers ecosystems as assets for which depletion or degradation is recorded as decrease in stock (or increase in the case of a positive change). ENCA follows this treatment only for the depletion of assets that corresponds to a loss for their owner. Ecosystem degradation is more than just a loss for asset owners since it results in a loss of potential services for others and for the community[3]. It is therefore right to record it as a debt created by the unit responsible for the degradation, and a credit in the case of enhancement.

2.05 Since ecosystem degradation is a measure of physical consumption of ecosystem capital, it can be

1 *This is consistent with the recording of forest fires in IPCC guidelines for LULUCF as well as the SEEA-EEA definition that states that ecosystem degradation "is the decline in an ecosystem asset over an accounting period due to economic and other human activity. It is generally reflected in declines in ecosystem condition and/or declines in expected ecosystem service flows".*

2 *Chapter 9 gives additional indication of how enhancement is recorded in the ecological balance sheet, either as a reduction of debt (in the case of restoration from previously recorded degradation) or as a new credit (in the case of a creation of capability by an acknowledged programme.*

3 *This treatment echoes the analysis by Graciela Chichilnisky of ecosystems as "privately produced public goods" in her article on North-South trade and the global environment (The American Economic Review, 1994).*

AN INTEGRATED ACCOUNTING FRAMEWORK

- Integration within the ecosystem
- Integration of the ecosystem and the economic system
- Integration and aggregation: need for a common accounting unit

A SIMPLE, ROBUST INFRASTRUCTURE

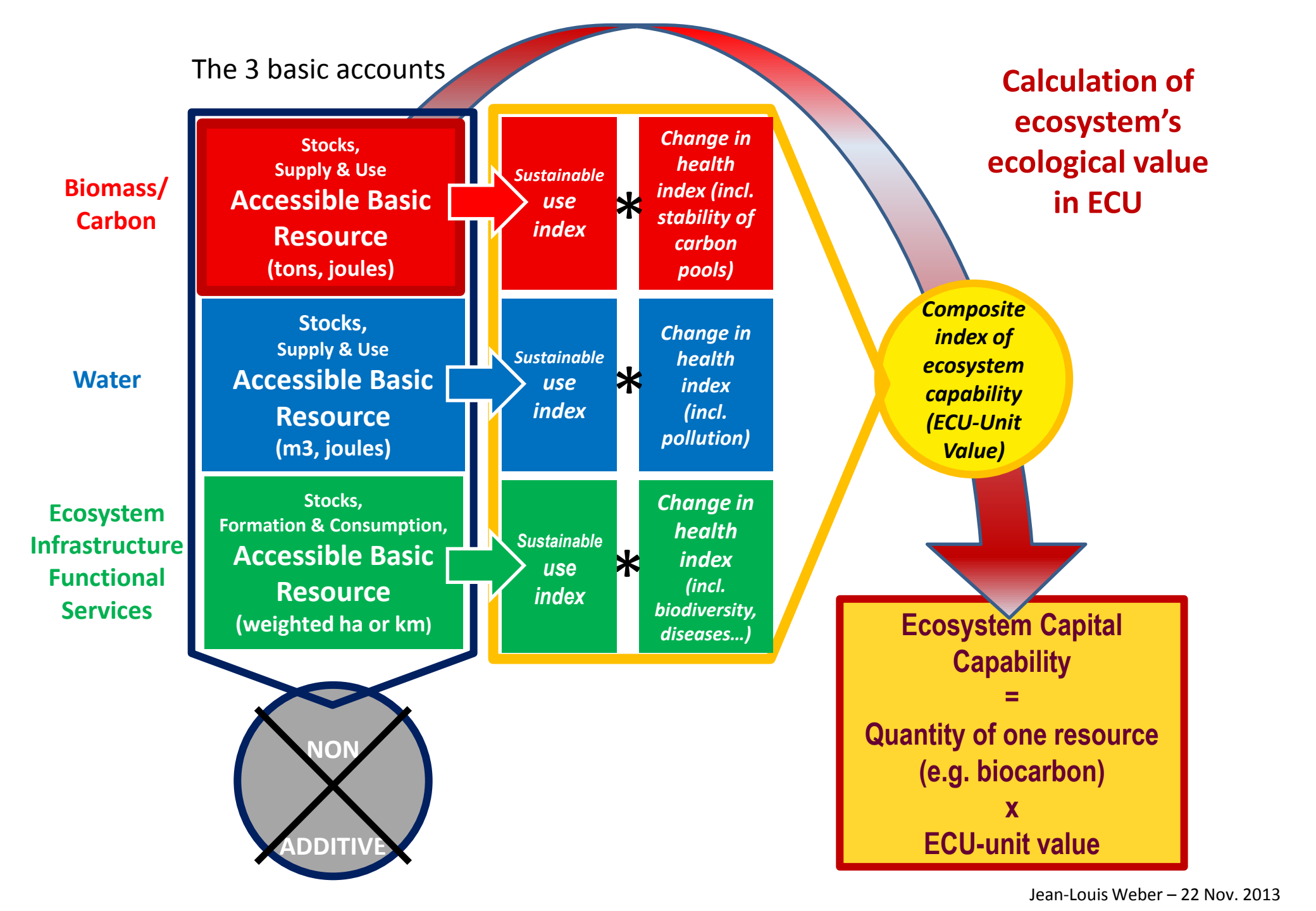
- Practical definition of statistical units for accounting
- Use of regular data sources
- A straightforward data model
- Implementation not bound to any specific software packages

Need of a common unit for accounting

- Without a common unit, accounts aggregation is not possible.

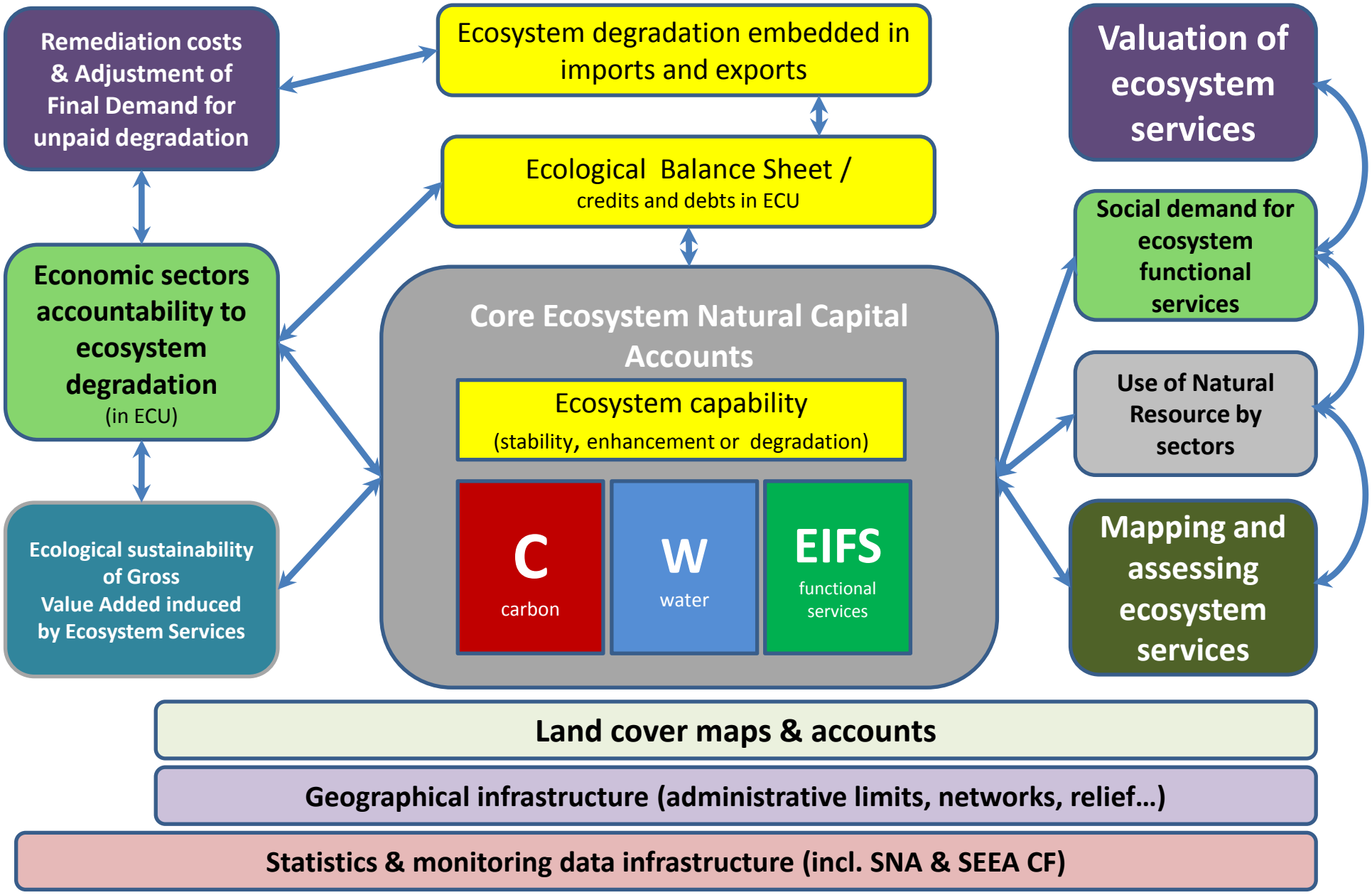
- Simple physical units don't do the job...
- Climate change: CO_2-equivalents to measure contributions to global warming
- Green Growth: tons (-equivalent) to measure resource use efficiency

- Ecosystem/biodiversity: Ecosystem Capability Unit (ECU) to measure total ecosystem performance in delivering ecosystem services, now and in the future; stability, degradation or enhancement
- Ecological value (in ECU) vs. Economic value (in $)

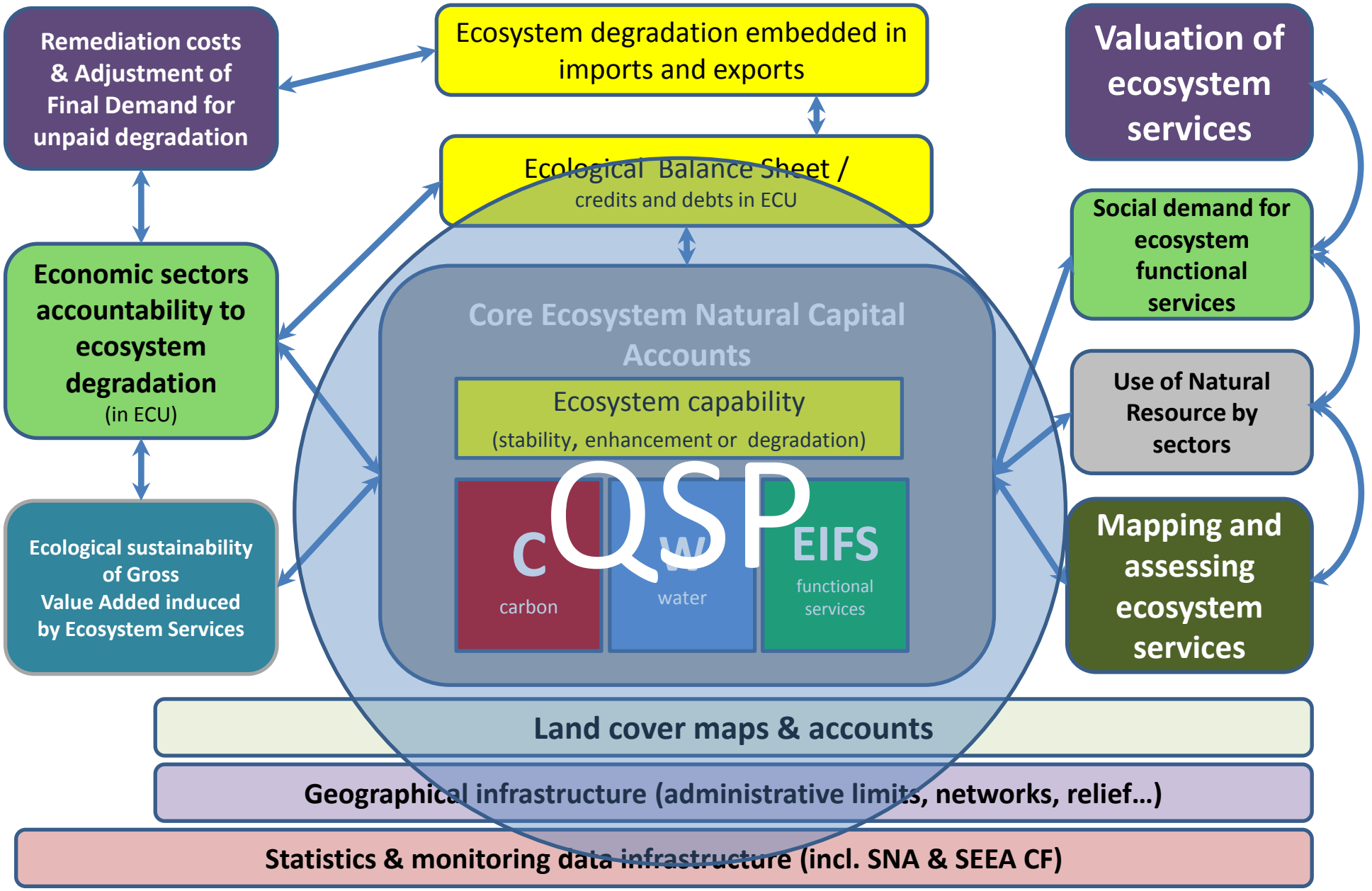


Jean-Louis Weber – 22 Nov. 2013

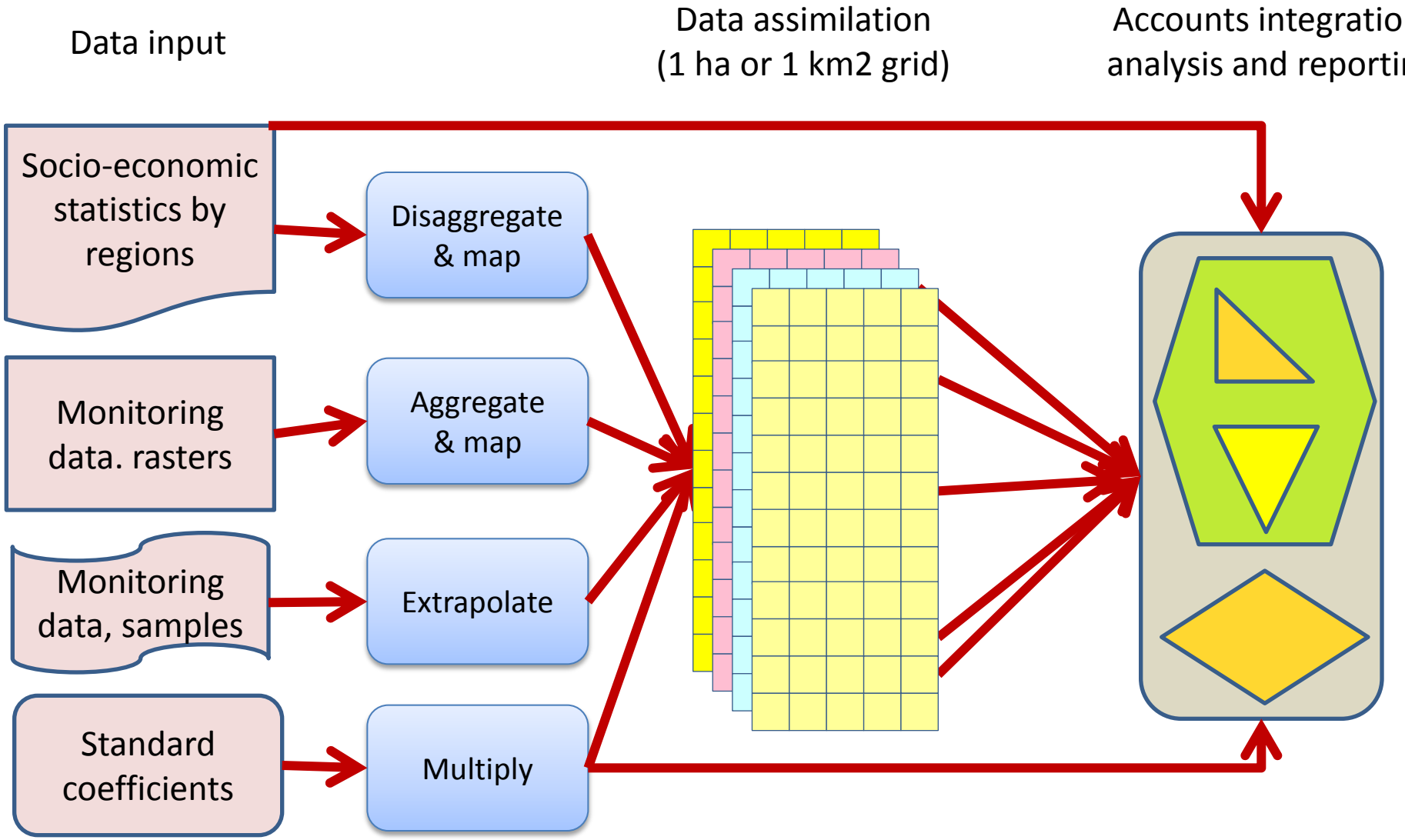
Structure of Ecosystem Natural Capital Accounts



Structure of Ecosystem Natural Capital Accounts



Main data flows to compile ecosystem capital accounts



3. THE DATA INFRASTRUCTURE

3.01 The SEEA-ENCA Quick Start Package (QSP) aims at starting to implement ecosystem natural capital accounts without delay. The first step will be a double test: of the relevance of the accounts for stakeholders, and of their feasibility for the institution(s) in charge of their production.

3.02 The first test will allow assessment of whether the accounting model delivers the information required for current and future policies, and of whether it can be adopted by players such as ministries of economy and finance and of planning, agriculture, forestry and fisheries, and of course environmental agencies. This is essential for setting the priorities for a second phase of development, in particular regarding functional analysis, which will depend strongly on national circumstances.

3.03 The second test will be of feasibility. Experimental accounts can definitely be produced from existing data but their quality depends on the quantity and quality of the inputs. One high merit of an integrated national accounting framework with double and quadruple accounting is that it requires the cross-checking of data sets compiled by many organizations for many different purposes. When data gaps are not too important, the statistician proceeds to what is called arbitration between two more numbers. When gaps are more serious, an explicit adjustment item can be introduced to balance the table. In both cases, identification of gaps helps to check quality and improve future data collection.

3.04 The following chapters of this report address technical and data issues. They do not pretend to be definitive. Conditions, practices and skills vary from place to place and technological change accelerates obsolescence. Attention should therefore be not on the data as such, but on the capacity of the data to match the requirements of the accounts. Better data, meaning more accurate, quality-assessed and controlled data, will make better accounts, without losing sight of their relevance to the accounting framework.

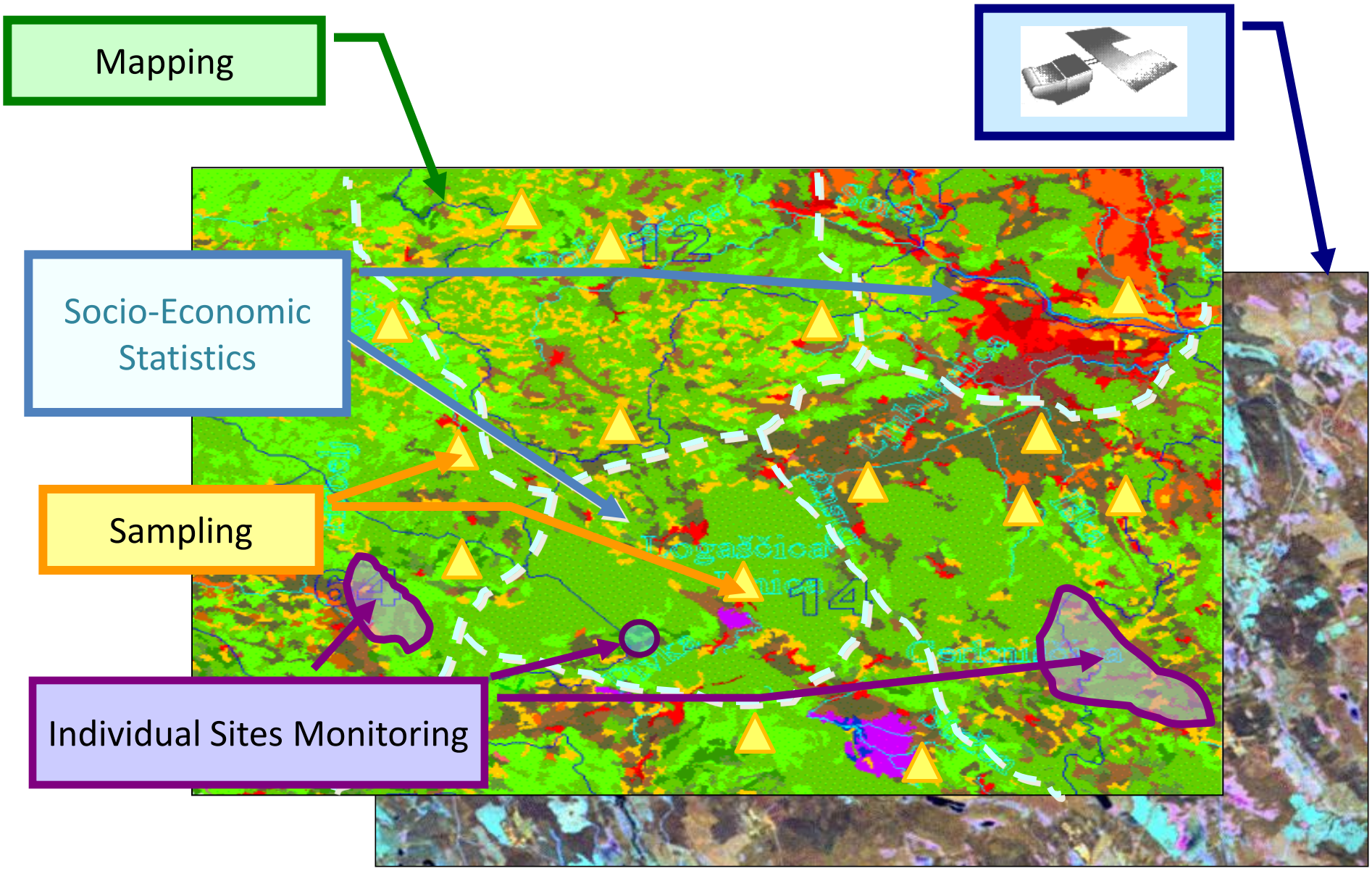
3.05 It is important to note that the primary user of these guidelines is the person involved in the production of ENCAs, who may not be a specialist in the data and their processing. Make a quick start is therefore in the hands of the accountant, who, ideally, will try to establish partnerships with specialists in the various domains involved. The technical guidelines of Chapters 3–7 aim at providing the accountants with a language for expressing their demands to the specialists. And ultimately, if some specialists default, the guidelines enable the accountants to make a start themselves, at least for a first try. In such a case, the initial results will need to be submitted to specialists for review and to help them understand the nature of the demand for data. Therefore, first choice as well as second-best choice (but easier to access) data will generally be required.

3.06 National versus international datasets. Ideally, SEEA-ENCA should be produced using national datasets, validated by national agencies and in use in the country. Access to such data may be a problem if they do not exist in the country or if they exist but are made available with restrictions and/or are disseminated on a commercial basis at prices beyond the budget of an experimental project. The first stage of putting in place an institutional partnership and governmental decisions may lead to solutions to these problems, albeit with some delays. Therefore, following the rationale of Quick Start implementation of experimental ecosystem accounts, access to data made freely available at the global level by many agencies should first be considered. In recent years, such access has been facilitated by programmes such as GEO-GEOSS (Figure 3.01).

REFERENCE GEOGRAPHICAL LAYERS

PRODUCING THE GEOGRAPHICAL LAYERS OF STATISTICAL UNITS

Spatial Integration of Environmental & Socio-Economic Data



4. THE LAND COVER ACCOUNT

4.1 LAND-COVER MAPS, STOCKS AND CHANGES

4.1.1 Specific role(s) of land-cover accounts in the ENCA framework

4.01 Land cover is an observable image of the many processes taking place on the land surface. It reflects land occupation by various natural, modified or artificial systems, and, to some extent, the way land is used by such systems. Land-cover cartographic and statistical information therefore plays a central role in the description and quantification of the interactions between the economy and nature by providing:

- **Statistical units**: observation of the bio-physical characteristics of land cover provides the basic variables which describe ecosystem composition and structure.
- **Data integration**: because land cover can be observed in many ways, including by satellite or airborne remote sensing, area sampling, and censuses and administrative data, it provides the foundation of more comprehensive descriptions combining land cover and land use, and land cover and biological data.
- **Localization**: land-cover data are generally geo-referenced with high accuracy for use in geographical systems together with other data. Land-cover data with lower spatial resolution are often used as a proxy or tool to model spatial distribution of less accurate data. An example is the reallocation of statistics to a regular grid, based on the assumed correlation between an observed phenomenon and a particular land-cover class (e.g. population and urban fabric, tree harvest and forested lands).
- **Change monitoring**: land-cover change is basic information about what has actually happened rather than about emerging issues, but it gives a fair and robust description of major processes such as urban development, extension of agriculture over marginal land, and change in forest tree-cover. The abundance of images provided by of Earth observation satellites, and progress in open dissemination and access to image-processing tools, make land-cover change or flow (in the sense of "other flows" in the System of National Accounts (SNA 2008), which describe the "other change in volume" of non-financial assets) one of the bases of ecosystem accounts.

4.02 If enough data and maps exist in various organizations in charge of cadastre, transport, agriculture, forestry, water management, and environment and in research centres, they can be used in a Quick Start of ecosystem natural capital accounting. Indications are given of possible methods of combining such maps into a first land-cover map. This can usefully be done for defining the statistical units (SELUs) needed to start accounting, as explained in Chapter 2. However, it might be more difficult to monitor land-cover change in that way. Even though thematic maps are updated, the frequency of these updates, the dates and the methodologies used may vary from one domain to another, making a synthesis and the production of reliable land-cover accounts difficult.

4.03 More broadly, the heterogeneity of dates poses the challenge of choosing a base or reference year for accounting. Since all ecosystem accounts are connected to some extent to land cover, the baseline land-cover map will play a very important role in structuring the whole information system.

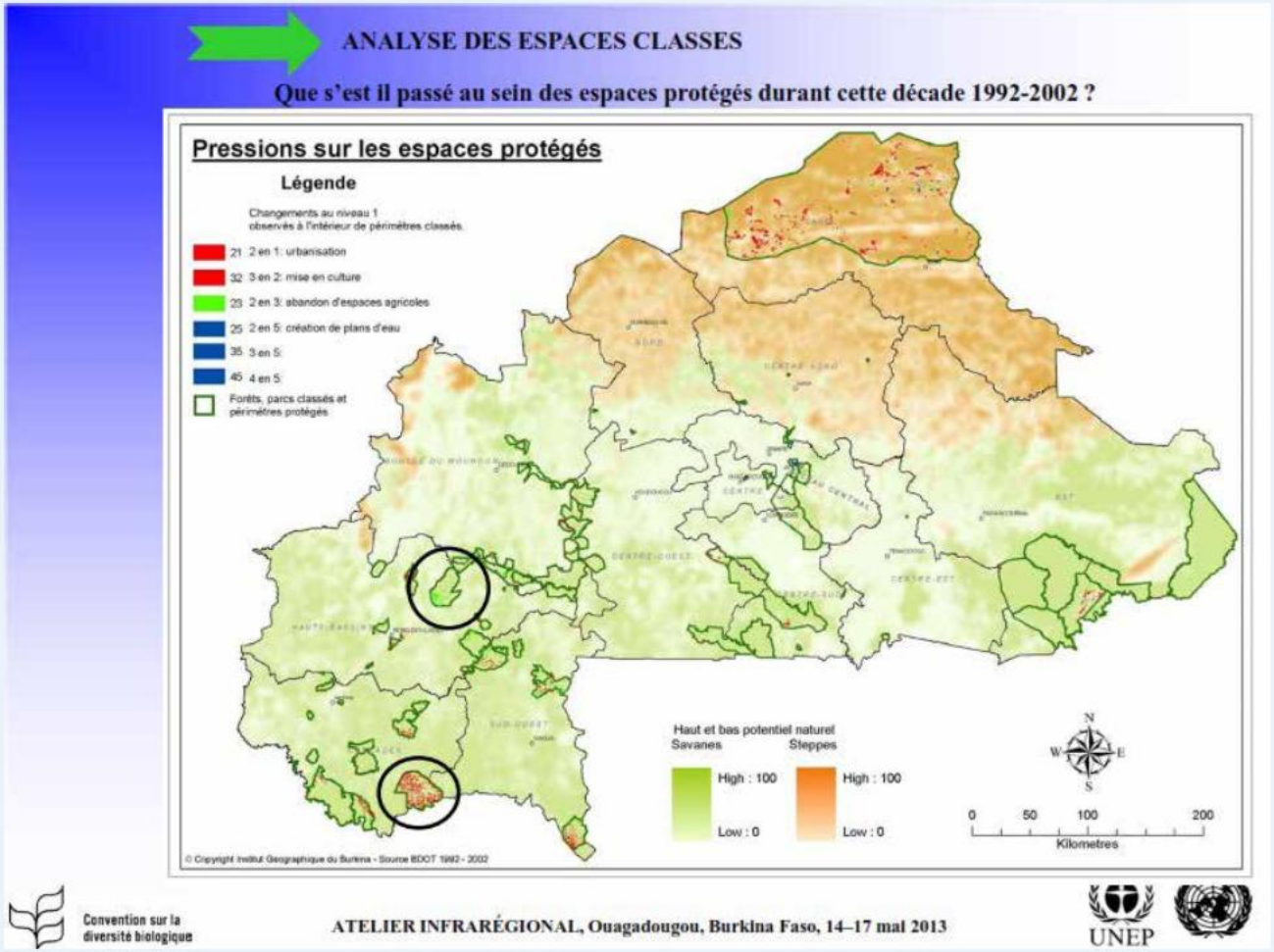
4.04 When it is necessary to produce new land-cover maps of stocks and change for accounting, this will be an investment not only for accounting but also for the national geographical system as a whole, requiring the involvement of the national mapping agency and other stakeholders. The discussion of land-cover mapping in this chapter will therefore go beyond the strict requirements of a Quick Start of ecosystem accounting and address the issue in a broader context.

LAND-COVER MAPS, STOCKS AND CHANGES

THE LAND-COVER ACCOUNTING FRAMEWORK

PRODUCING AND ANALYSING LAND-COVER ACCOUNTS

Land cover accounts of stocks and **change**



The map background shows the relative importance of savannahs (pale green) and steppes (pale brown), calculated with smoothed land-cover values. In the perimeters of protected areas, overlaid colours indicate land-cover flows: red for urban development, bright green for withdrawal of farming and blue for creation of water bodies.

Sources: Adama; Jaffrain and Adama, op. cit.

Simplified classifications of land cover types and land cover flows, to be detailed according to national/local conditions

Land cover types	
01	Urban and associated developed areas
02	Homogeneous herbaceous cropland
03	Agriculture plantations, permanent crops
04	Agriculture associations and mosaics
05	Pastures and natural grassland
06	Forest tree cover
07	Shrubland, bushland, heathland
08	Sparsely vegetated areas
09	Natural vegetation associations and mosaics
10	Barren land
11	Permanent snow and glaciers
12	Open wetlands
13	Inland water bodies
14	Coastal water bodies and inter-tidal areas
	Sea (interface with land)

Land cover flows	
lf1	Artificial development
lf2	Agriculture extension
lf3	Internal conversions, rotations
lf4	Management and alteration of forested land
lf5	Restoration and development of habitats
lf6	Changes of land-cover due to natural and multiple causes
lf7	Other land cover changes n.e.c. and reclassification
lf0	No observed land-cover change

Land cover flows regroup elementary changes according to land use and natural processes

5. ECOSYSTEM CARBON ACCOUNTS

5.01 Carbon accounting, in the sense in which it is addressed in the ENCA-QSP, is not new in terms of general knowledge and data collection. The greenhouse gas emission inventories and the carbon budgets established by countries and companies for reporting under the UNFCCC Kyoto Protocol are accounts[1] Not all the information collected in following IPCC Guidelines is directly usable but a large part of it is a valuable input to ecosystem accounting. The IPCC principles take into account a variety of situations and propose an incremental approach. Regarding carbon, data availability therefore varies from one place to another. Since ENCA-QSP recommends using the best available data in countries, there is no one-fits-all solution. This variety of conditions is taken into account in this chapter.

5.02 An ecosystem carbon account records an ecosystem's sustainable capacity to produce biomass, measured as biocarbon, and the way this is used by crops, harvest and tree removal, sterilized by artificial developments, and destroyed by soil erosion or forest fires. It also records the carbon that is assimilated by the atmosphere and oceans. The account records, in tonnes of carbon, the stocks available in soil, below- and above-ground vegetation, and in water (fish and vegetal species), the flow of gross primary production (GPP) of biomass by natural and cultivated vegetation, and its use by crops and timber harvests as well as by nature itself. The secondary production of animal biomass is added to the primary production.

5.03 In addition to inland ecosystems, the accounts cover seas – fisheries, sea grass and algae, plankton and net accumulation of calcium carbonate ($CaCO_3$) produced by corals and other calcifying organisms, and sea-regulating capacity. The atmosphere's climate regulation ecosystem service is also considered here. For this, the capacity of the system to sequester carbon (in biomass) or to assimilate greenhouse gases (measured in carbon dioxide (CO_2)-equivalents) up to the agreed UNFCCC target[2] of a maximum increase of temperature of 2 °C defines the limits of total carbon use without ecosystem degradation. However, the ENCA quick start package explicitly addresses only issues related to biocarbon (including emissions and sequestration), considering that the comprehensive gaseous carbon compounds account is covered in IPCC reporting.

5.04 Formally, the biocarbon account is a development of SEEA and connects accordingly to the SNA. This consistency is improved by the use of official statistics on agriculture, forestry and fisheries. It includes a link to a calculation of the total use of carbon of biological and fossil origin, which corresponds to a subset of the material flows accounts commonly used to support strategies such as resource efficiency (European Union) or green growth (OECD). At the same time, ecosystem biocarbon accounts seek the maximum consistency with IPCC reporting, in particular regarding the LULUCF sector and agriculture, forestry and other land use (AFOLU)[3]. The ecosystem perspective is very specific compared to the economic management of natural resources and the objectives of mitigating greenhouse gas emissions to the atmosphere; but the consistency of ecosystem carbon accounts with national accounts and with the climate-change programme makes them tools easy to integrate into decision-making processes.

5.05 Accounts are compiled using various data sources available within countries or at the international level. They include various kinds of monitoring data and statistics on the environment and natural resources, meteorology, and official statistics, particularly on agriculture, forestry and fisheries. Earth observation by satellite is an important data source used together with *in-situ* monitoring and statistics. National data compiled for international programmes such as IPCC-LULUCF/AFOLU, FAO SoilBase and Forest FRA2010[4] inventories and FishStat are convenient sources to start implementing ENCA-QSP, although their data need

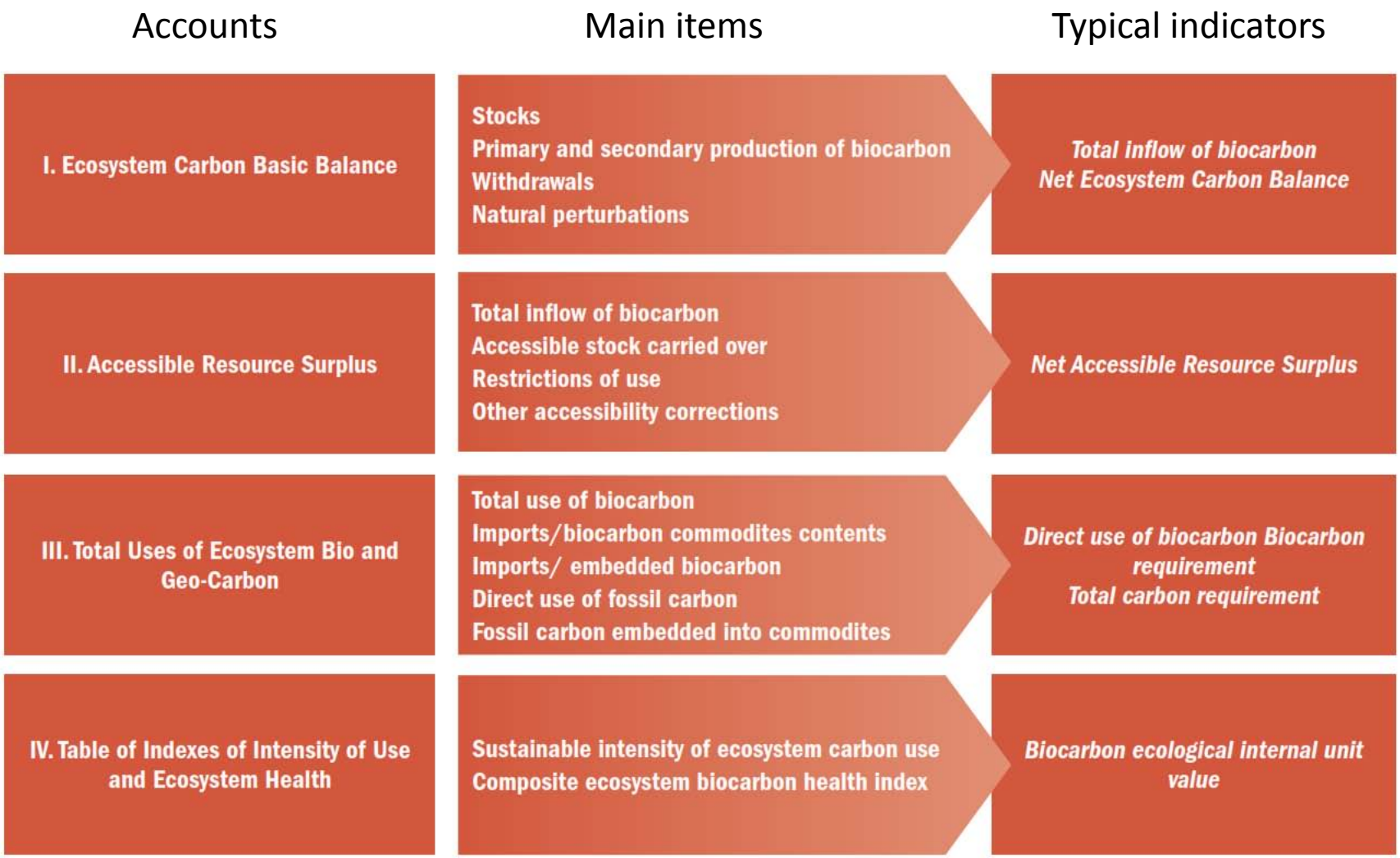
1 *Instead, the accounts established for the same convention relate to debits and credits established according to targets or commitments.*

2 *https://unfccc.int/essential_background/items/6031.php (accessed 14 July 2014)*

3 *Agriculture, forestry and other land use (AFOLU) is a term from the 2006 IPCC Guidelines describing a category of activities that contribute to anthropogenic greenhouse gas emissions. Used in national greenhouse gas inventories, the AFOLU category combines two previously distinct sectors – LULUCF and agriculture.*

4 *The Global Forest Resource Assessment (FRA) is carried out by FAO (with countries and other organizations) every five years.*

I. Ecosystem Carbon Basic Balance	**Stocks** **Primary and secondary production of biocarbon** **Withdrawals** **Natural perturbations**	***Total inflow of biocarbon*** ***Net Ecosystem Carbon Balance***
II. Accessible Resource Surplus	**Total inflow of biocarbon** **Accessible stock carried over** **Restrictions of use** **Other accessibility corrections**	***Net Accessible Resource Surplus***
III. Total Uses of Ecosystem Bio and Geo-Carbon	**Total use of biocarbon** **Imports/biocarbon commodites contents** **Imports/ embedded biocarbon** **Direct use of fossil carbon** **Fossil carbon embedded into commodites**	***Direct use of biocarbon Biocarbon requirement*** ***Total carbon requirement***
IV. Table of Indexes of Intensity of Use and Ecosystem Health	**Sustainable intensity of ecosystem carbon use** **Composite ecosystem biocarbon health index**	***Biocarbon ecological internal unit value***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Fossil carbon embedded into commodites
Direct use of biocarbon Biocarbon requirement
Total carbon requirement
IV. Table of Indexes of Intensity of Use and Ecosystem Health
Sustainable intensity of ecosystem carbon use
Composite ecosystem biocarbon health index
Biocarbon ecological internal unit value

6. THE ECOSYSTEM WATER ACCOUNT

6.01 Water accounting is a common practice in hydrology and agronomy where water budgets and water balances are commonly-used terms. Water, just like money, can be subject to double-entry accounting.

6.1 ACCOUNTING FOR WATER

6.1.1 Background

6.02 Water accounts have been produced in France[1] and in Spain[2] since the early 1980s, using largely similar and complementary methodologies. Both accounts covered water quantity at the river-basin level and were aggregated nationally; the relationships between stocks and flows were described on the basis of systems analysis of the interaction between the water system itself, which includes natural assets and flows as well as in-stream uses, and a use system, defined restrictively in relation to water abstraction, transport and returns. Both applications considered both water quantity and quality. On the quality issue, while the French accounts attempted to use quality indicators of rivers, the Spanish accounts developed an approach based on thermodynamic measurements of water exergy losses, integrating quantity and quality aspects into one number. Both programmes included accounts of water expenditure. The water accounting methodology has been used in Chile[3] and Moldova[4]. Development of exergy-based water accounts has continued in Spain at the University of Zaragoza in the context of an overall approach to environmental accounting based on the calculation of exergy physical costs, with several regional applications developed[5], and preliminary tests carried out jointly with the European Environment Agency.

6.03 Water accounts have been implemented by the Australian Bureau of Statistics (ABS) since the early 1990s with a focus on the use of water by economic sectors. The ABS methodology follows the SEEA – ABS contributed to its development – and in particular SEEA-Water (see below). Water Account Australia (WAA) "*presents information on the supply and use of water in the Australian economy in 2011–12 in both physical (i.e. volumetric) and monetary terms. The focus of Water Account Australia (WAA) is on the interactions between users within the economy and the environment. The economy extracts water for consumption and production activities. The infrastructure to mobilize, store, treat, distribute and return water back to the environment forms part of the economy*"[6]. Water Account Australia (WAA) has been available since 1993 and has been updated annually since 2008[7].

1 *In Les Comptes du Patrimoine Naturel, CICPN, 1986, Les Collections de l'INSEE : 535-536. Série C, 137-138.*

2 *Spanish accounts were presented to the OECD (Pilot Study on Inland Waters, OECD, ENV/EC/SE (90) 24) in 1990 and published later in Spanish Water Accounts, by Jose Manuel Naredo in Environmental Economics in the European Union, Mesonada, C.S-J. (ed.). 1997. Mundi Prensa, Madrid,*

3 *Meza F., Jiliberto R., Maldini F. et al. 1999. Cuentas Ambientales del Recurso Agua en Chile. Documento de Trabajo N° 11, Serie Economía Ambiental, Pontificia Universidad Católica de Chile, Facultad de Agronomía y Ciencias Forestales, Santiago, Chile*

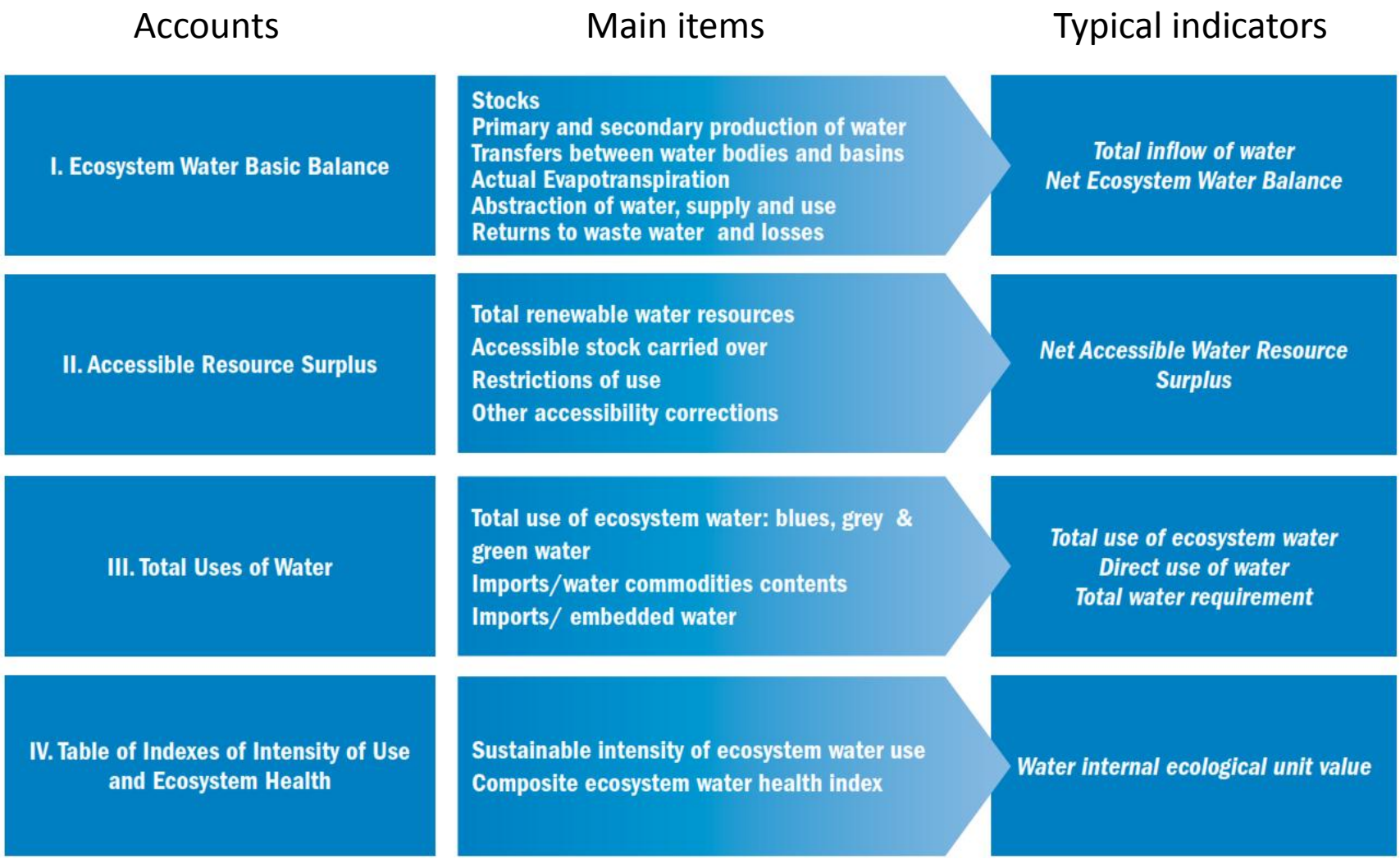
4 *Tafi J. and Weber J.-L. 2000. Inland Water Accounts of the Republic of Moldova - Preliminary Results of Resource Accounts in Raw Quantities, 1994 and 1998. Technical report, Eurostat.*

5 *Valero A. et al. 2006 Physical Hydronomics: application of the exergy analysis to the assessment of environmental costs of water bodies. The case of the Inland Basins of Catalonia. http://teide.cps.unizar.es:8080/pub/publicir.nsf/codigospub/0436/$FILE/cp0436.pdf (accessed 14 July 2014).*

6 *http://www.abs.gov.au/ausstats/abs@.nsf/mf/4610.0 (accessed 14 July 2014).*

7 *The Australian accounts from 1993 up to now are accessible at http://www.abs.gov.au/AUSSTATS/abs@.nsf/second+level+view?ReadForm&prodno=4610.0&viewtitle=~2011%9612~~&&tabname=Past%20Future%20Issues&prodno=4610.0&issue=2011%9612&num=&view=& (accessed 14 July 2014).*

I. Ecosystem Water Basic Balance	**Stocks** **Primary and secondary production of water** **Transfers between water bodies and basins** **Actual Evapotranspiration** **Abstraction of water, supply and use** **Returns to waste water and losses**	***Total inflow of water*** ***Net Ecosystem Water Balance***
II. Accessible Resource Surplus	**Total renewable water resources** **Accessible stock carried over** **Restrictions of use** **Other accessibility corrections**	***Net Accessible Water Resource Surplus***
III. Total Uses of Water	**Total use of ecosystem water: blues, grey & green water** **Imports/water commodities contents** **Imports/ embedded water**	***Total use of ecosystem water*** ***Direct use of water*** ***Total water requirement***
IV. Table of Indexes of Intensity of Use and Ecosystem Health	**Sustainable intensity of ecosystem water use** **Composite ecosystem water health index**	***Water internal ecological unit value***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IV. Table of Indexes of Intensity of Use and Ecosystem Health
Sustainable intensity of ecosystem water use
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Water internal ecological unit value

7. THE ECOSYSTEM INFRASTRUCTURE FUNCTIONAL SERVICES ACCOUNT

7.01 Accounts of ecosystem infrastructure and related functional services measure the sustainable capability of ecosystems to produce services such as biomass or water which are not directly measurable as material resources. These intangible services correspond to regulating and cultural services in the provisional Common International Classification of Ecosystem Services (CICES).

7.1 ACCOUNTING FOR ECOSYSTEM INFRASTRUCTURE FUNCTIONAL SERVICES

7.1.1 Physical flows of functional services cannot be measured directly because they are intangible.

7.02 Ecosystems are multifunctional and potentially deliver a bundle of material and intangible services which are used in various proportions according to the natural or socio-economic contexts. Services may be delivered directly to final users, protection from floods by forests, for example, or indirectly though intermediate inputs to services such as agricultural products or timber from managed forests. Uses can be either exclusive or synergetic. Uses can take place in the same ecosystem accounting unit (EAU: SELU, MCU or RSU[1]) as their generation, or in a different zone. In the absence of complete modelling of these interactions, including input-output analysis and imports-exports between EAUs, attempts to describe ecosystem capital capability by summing of ecosystem services would result in omissions and/or double counting.

7.03 The SEEA-EEA acknowledges the accounting issue in paragraph 3.45, "*if a choice is made to use an alternative boundary for the measurement of ecosystem services related to crops and other plants, then some adaptation of the CICES would be required. It is noted that if ecosystem services are measured using flows of harvested crops, then it is necessary to exclude flows relating to the growth of these plants such as pollination, abstraction of soil water, etc. Put differently, both pollination and harvested crops should not be combined in a measure of "final" ecosystem services. This would represent a "double count" in accounting terms*".

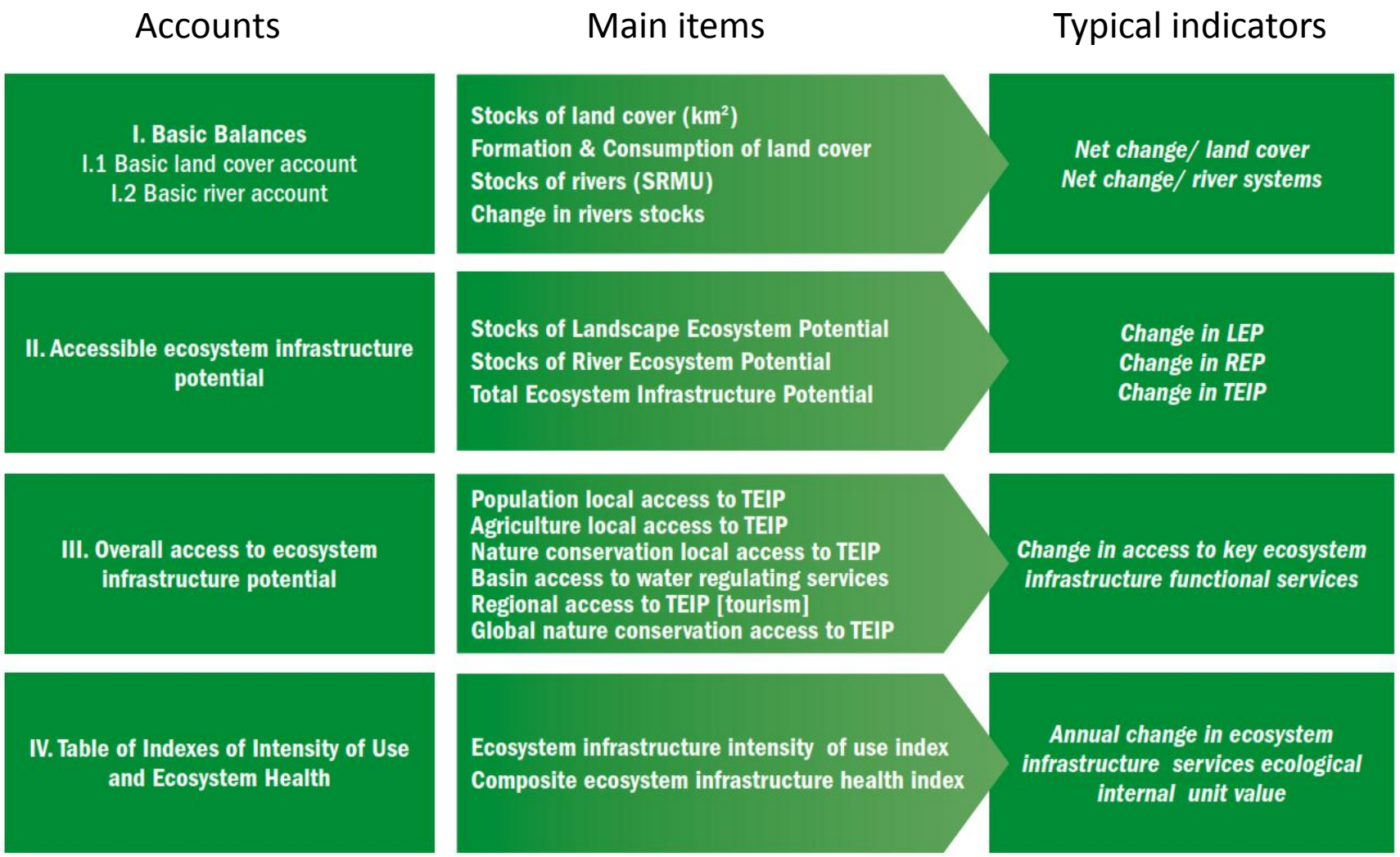
7.04 The ENCA-QSP approach to ecosystem services follows the option given in SEEA-EEA paragraph 3.45 where harvested crops are all included. This is done in the biocarbon account, where crops are considered as a joint economy-ecosystem outcome. This approach is consistent with the common definition of ecosystem services in the Millennium Ecosystem Assessment, in The Economics of Ecosystems and Biodiversity (TEEB)[2] or in the EU Mapping and Assessment of Ecosystems and their Services (MAES)[3] accounting project. As a consequence, no sum total of ecosystem services is presented – which would be difficult to achieve anyway in physical terms

1 *SELU: Socio-ecological landscape unit; MCU: Marine coastal unit; RSU: River system units.*

2 *The TEEB project is steered by UNEP. http://www.teebweb.org/ (accessed 14 July 2014)*

3 *MAES refers to the CICES 4.3 version. Provisioning services include "all material and biota-dependent energy outputs from ecosystems; they are tangible things that can be exchanged or traded, as well as consumed or used directly by people in manufacture". Mapping and Assessment of Ecosystems and their Services (MAES), an analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Discussion paper – Final, April 2013 http://biodiversity.europa.eu/maes/ (accessed 14 July 2014)*

I. Basic Balances I.1 Basic land cover account I.2 Basic river account	**Stocks of land cover (km²)** **Formation & Consumption of land cover** **Stocks of rivers (SRMU)** **Change in rivers stocks**	***Net change/ land cover*** ***Net change/ river systems***
II. Accessible ecosystem infrastructure potential	**Stocks of Landscape Ecosystem Potential** **Stocks of River Ecosystem Potential** **Total Ecosystem Infrastructure Potential**	***Change in LEP*** ***Change in REP*** ***Change in TEIP***
III. Overall access to ecosystem infrastructure potential	**Population local access to TEIP** **Agriculture local access to TEIP** **Nature conservation local access to TEIP** **Basin access to water regulating services** **Regional access to TEIP [tourism]** **Global nature conservation access to TEIP**	***Change in access to key ecosystem infrastructure functional services***
IV. Table of Indexes of Intensity of Use and Ecosystem Health	**Ecosystem infrastructure intensity of use index** **Composite ecosystem infrastructure health index**	***Annual change in ecosystem infrastructure services ecological internal unit value***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8. THE ECOSYSTEM CAPITAL CAPABILITY ACCOUNT

8.01 The ecosystem capital capability account aims at producing an aggregate summarizing the various changes recorded in the accounts of ecosystem carbon, ecosystem water and ecosystem ecological integrity and functional services. This aggregate measures the capacity of the ecosystems to deliver multiple services in a sustainable way. The aggregate has to reflect the real availability of each resource for use, and possible depletion or degradation, but accounting for each individual natural asset separately does not provide a full picture since they are part of systems: ecosystems. Natural assets interact with each other and what happens to one is generally of consequence to all. They also interact with human communities.

8.02 Regarding the services potentially supplied by the ecosystems, some can be appropriated, traded, and analysed using conventional market-based economic tools. Others are common or public goods which are more difficult to assess in this framework because of different value systems or because of consideration of long-term perspectives which are not all properly addressed by economic calculations: in other words ecological values should be distinguished from economic values. This distinction is clearly made in The Economics of Ecosystems and Biodiversity (TEEB) whose glossary of terms[1] states:

- **ecological value**: non-monetary assessment of ecosystem integrity, health, or resilience, all of which are important indicators to determine critical thresholds and minimum requirements for ecosystem service provision;
- **economic valuation**: the process of expressing a value for a particular good or service in a certain context (e.g. of decision-making) in monetary terms.

8.03 Nature conservation can bring short-term economic benefits, which are often neglected, but that is not the only motivation for conserving ecosystems. Other important motivations, which relate more to ecological values, include minimizing future risks to economies or humans, and the need to adapt to uncertain consequences of climate change and to secure food in the long term for an overcrowded planet. In the last resort, decisions have to be taken which will involve trade-offs between multiple options, opportunities, benefits and beneficiaries. Such decisions – at national as well as local, business or citizens levels – require comparisons between values and costs. To some extent, but not always, decision processes rely on data and, in that case, what is not measured risks not being taken into account.

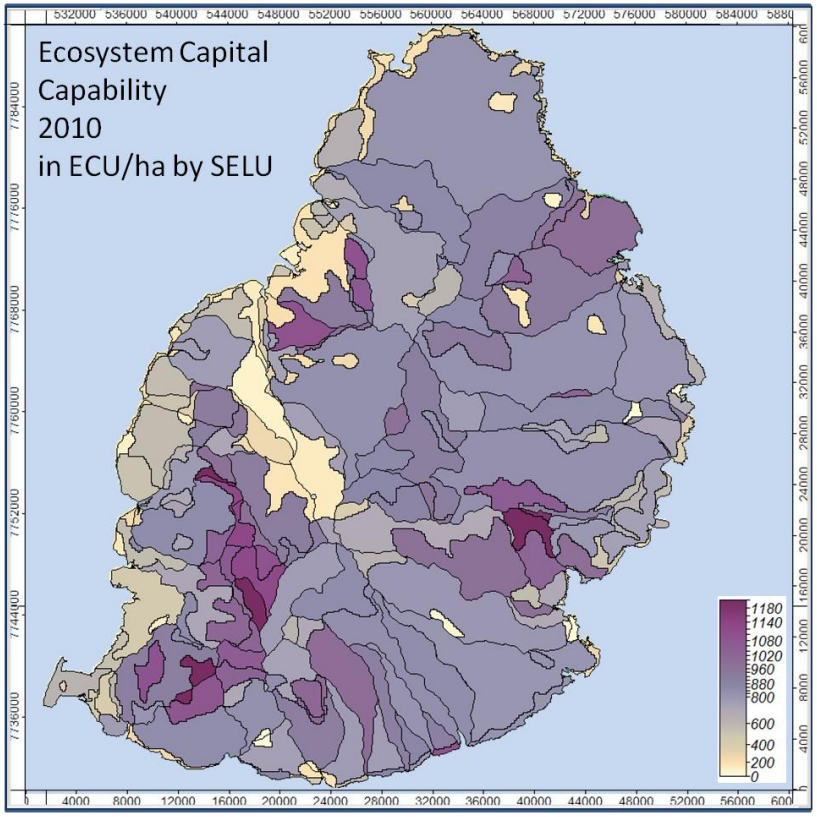
1 http://www.teebweb.org/resources/glossary-of-terms/ (accessed 14 July 2014).

ACCOUNTING FOR ECOLOGICAL VALUE

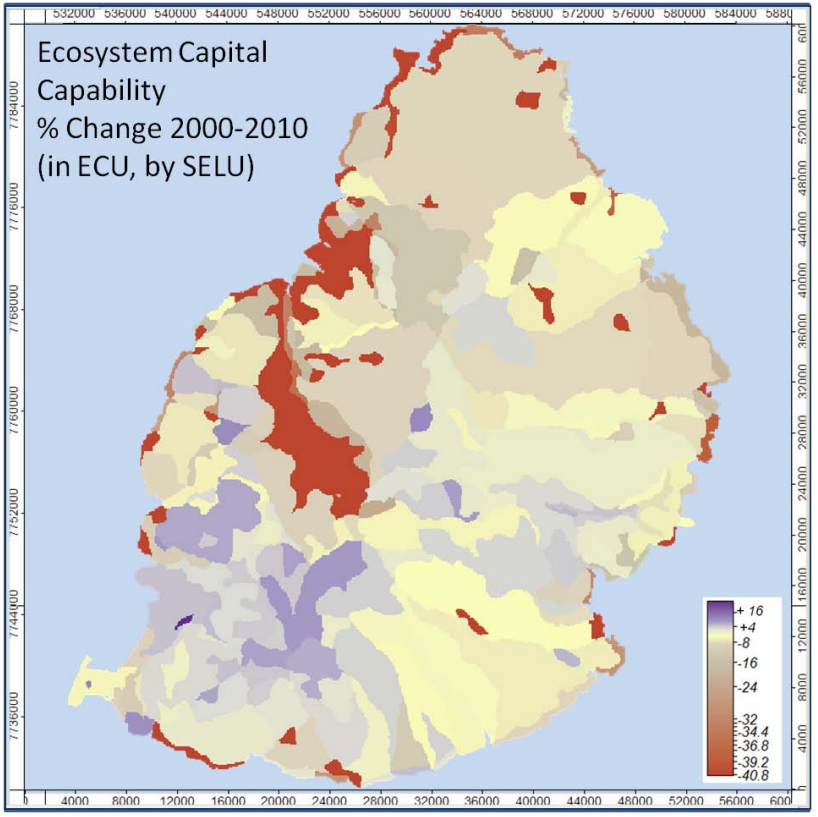
THE ECOSYSTEM CAPITAL CAPABILITY ACCOUNT

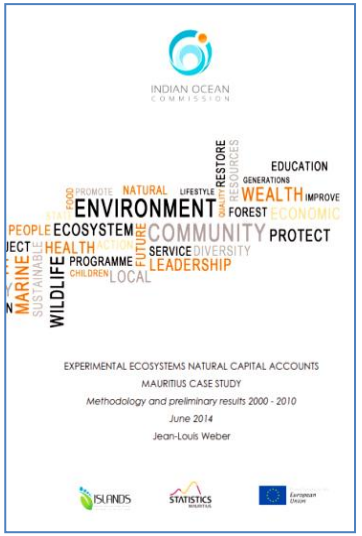
A first attempt to calculate Ecosystem Capital Capability (in ECU) for Mauritius

Ecosystem Capital Capability:
ECU value by Socio-Ecological Landscape Units, 2010



Ecosystem Capital Capability (inland):
Change in ECU value, % by Socio-Ecological Landscape Units, 2000-2010





Experimental ENCA, Mauritius Case Study (IOC, 2014)

Provisional results

9. THE ECOSYSTEM NATURAL CAPITAL ACCOUNTS QUICK START PACKAGE AND BEYOND

9.01 The scope of ENCA-QSP as initial implementation of the SEEA-EEA does not cover all possible accounts. Priority has been given to the measurement of ecosystems in terms of physical capital, productivity and resilience, for several reasons, the first being the aim to create a comprehensive database of all ecosystems. Although schematic to start with, such a database needs a minimum knowledge of general trends, and also needs to identify hotspots and specific issues, with some idea of their contexts and interactions.

9.02 This not to say that ENCA-QSP does not contain its own operational indicators. Indeed, its core accounts allow the production, at various scales including the macro level, of indicators of resource accessibility and sustainable use, and of ecosystem health and capability to deliver services, and consequently of degradation or enhancement by human activities. On some points, where a consensus could not be reached by the SEEA-EEA editorial board, ENCA-QSP will go one step further with the aim of allowing testing of the policy relevance of ecosystem capital accounts.

9.03 Future extensions of QSP towards (more) complete ecosystem natural capital accounting can be grouped into three broad types:

- assessment of the accountability of sectors for ecosystem degradation, and production of a balance sheet of ecological credits and debts;
- calculation of restoration costs and adjustments in relation to the SNA;
- assessment and valuation of ecosystem services and derived assessments of the economic wealth of ecosystem assets.

Not all these are novel. In the case of the third, important work has been carried out in recent years in various international and national programmes and the issue is more to link specific methodologies with the ENCA-QSP infrastructure, for example the land-cover map and accounts, and core accounts.

9.1 THE BALANCE SHEET OF ECOLOGICAL CREDITS AND DEBTS.

9.04 The ENCA-QSP core accounts include calculation of ecological values in order to assess the capability of ecosystems to deliver services and their degradation or enhancement by human activities (Chapter 8). This measure of ecological value in ECUs corresponds to two main aspects of the ecosystem: an asset which can be owned, exploited and managed in the economic sense, a natural resource; and a component of the broader ecosystem, the full bundle of services delivered to the owner as well as to others, its capacity to reproduce itself and continue delivering services in the future, and everything that corresponds to public-good functions. In accounting terms, degradation of an ecosystem will have to be recorded in two ways: as a decrease in the asset in terms of its use as a resource, and as an ecological debt in terms of the broader functions its fulfils. In the first case, degradation reduces assets; in the second, since ecosystem functions do not belong exclusively to the owner, their loss may affect not only him but also the community at large, in and around the ecosystem and elsewhere, and current and future generations.

9.05 Accounting for ecological debts is important for policies that aim at preventing such debt creation or at mitigating it through the payment of compensation, directly for restoration or indirectly as part of tax systems or insurance schemes. Such policies are being considered and several are being experimented with in several countries and/or companies. One factor limiting their implementation is the availability of relevant and verifiable information. Ecosystem natural capital accounts have the potential to deliver such information, and it is important to test this now.

9.06 A balance sheet of ecological credits and debts can be established as part of ENCA. Measuring credits and debts in physical units rather than monetary terms is not new, as shown by the well-known example of carbon credits and debits implemented to support the carbon management scheme in the context of UNFCCC, following the IPCC rules and national emission trading schemes. Another example is the EU Environmental Liability Directive of 2004[1].

1 http://ec.europa.eu/environment/legal/liability/ (accessed 14 July 2014).

THE BALANCE SHEET OF ECOLOGICAL CREDITS AND DEBTS

CALCULATION OF RESTORATION COSTS AND POSSIBLE ADJUSTMENTS IN RELATION TO THE SNA

ASSESSMENT AND VALUATION OF ECOSYSTEM SERVICES AND DERIVED ASSESSMENTS OF WEALTH:

Mapping and assessment of ecosystems services in Europe (MAES)

Guidelines for valuing ecosystem services by:

UNEP (Green Economy/ TEEB/ DEPI – Ecosystem Services Economics)
The World Bank / under WAVES
SCBD TS 4, 27, 71

Ecological Balance Sheet in ECU

	Domestic physical assets [a]	Ecological credits [b]	Ecological debts [c]	Net Ecological Worth = [b]-[c]
I - Short term assets and liabilities				
Opening balance sheet/ short term	**100**	**100**		**100**
Degradation by activities	-12		12	-12
Natural losses	-9	-9		-9
Restoration from previous degradation	2		-2	2
Ecosystem creation/ enhancement	7	7		7
Natural gains	4	4		4
Net change in short term assets and liabilities	**-8**	**2**	**10**	**-8**
Closing balance sheet/ short term	**92**	**102**	**10**	**92**
II - Long term assets and liabilities				
Ecosystem restoration commitments		50	50	0
Accumulated ecological credits/ allocations		13		13
Accumulated ecological debts			35	-35
Opening balance sheet/ long term		**63**	**85**	**-22**
Change in ecosystem restoration commitments		0	**0**	0
Change in accumulated ecological credits/ allocations		8		8
Change in accumulated ecological debts			11	-11
Net change in longterm assets and liabilities		**8**	**11**	**-3**
Ecosystem restoration commitments		50	50	0
Accumulated ecological credits/ allocations		21		21
Accumulated ecological debts			46	-46
Closing balance sheet/ long term		**71**	**96**	**-25**
III - International liabilities				
Opening balance sheet/ Embedded ecosystem degradation			**30**	**-30**
Accquisition of embedded ecosystem degradation			15	-15
Compensation of embedded ecosystem degradation			-5	5
Net change in ecosystem degradation embedded in trade			**10**	**-10**
Closing balance sheet/ Embedded ecosystem degradation			**40**	**-40**
Consolidated balance sheet (I + II + III)				
Opening balance sheet	100	163	115	48
Net change	-8	10	31	-21
Closing balance sheet	92	173	146	27

CONCLUSION

Ecosystem accounting is not a substitute for science, rather it is a way of bringing together the best available knowledge and presenting it in a form that may help decision makers. It is a way of bringing together and summarising often scattered information in a logical and transparent manner.

The development of ecosystem capital accounts is hampered by the state of our understanding of nature, natural systems and society, as well as by access to the data that does exist. This is not specific to this particular area, as climate change monitoring and national accounting face similar difficulties – although a longer tradition of developing socio-economic statistics results in more robust information in the latter case.

In practical terms, missing data has to be estimated with models, so that policy makers can have evidence that they can handle and interpret, alongside the usual macro-economic aggregates and social statistics.

As there is some urgency in incorporating ecosystems and biodiversity values into decision-making processes, as required by the CBD Aichi Target 2, and SDG Goal 15 proposed by the United Nations General Assembly Open Working Group, scientific issues and uncertainties can no longer be an argument for not producing ecosystem accounts now. Progress will only come by doing tests with what is available, rather than waiting for better scientific information, data and statistics – although all of these are highly desirable. This is the approach that has been adopted by the UN Statistical Commission for the SEEA Experimental Ecosystem Accounts, and although the first accounts in pioneer countries will certainly be less than perfect, the experience gained from producing them will provide the basis for further improvements.

The knowledge gap is, however, a strong argument for transparent methodologies and meta-data. The ambition to support evidence-based policy making puts great responsibility on the accountant. Stakeholders should be able to understand the uncertainties resulting from scientific and data issues and, more specifically should be fully aware of the underlying assumptions of the ecosystem accounting framework which, as for any model, cannot be neutral.

The ENCA framework is primarily a statistical one. It aims, in particular, to facilitate access to a wide range of data and statistics for ecosystem accounting, as well as for modelling or doing different types of analysis. One important aspect of accounting methodologies is that they contain systematic cross-checks, which is an important means of assessing data quality. It becomes particularly important whenever different data sources exist which propose different numbers for the same topics. For biodiversity data, this is frequently the case.

Another property of ENCA is the focus on change, particularly the measurement of degradation, which requires the establishment of time series, which are, themselves, a useful tool to assess data consistency and likelihood. The ENCA framework is not neutral in itself as priority is given to the measurement of ecological, as opposed to economic, values, which are based on ecosystem performance and resilience assessment. Ecosystem maintenance and restoration costs are, however, essential economic variables in ENCA – other frameworks favour an ecosystem services approach and the monetary valuation of benefits.

Although ENCA is open to the broadest range of applications, including ecosystem services accounting, its rationale is to start with core accounts of ecosystem capital, which is the purpose of the QSP.

The roadmap for implementing ENCA-QSP has been presented in 5 steps:

1. collection of reference geographical datasets and creation of a database of ecosystem accounting units (EAUs);
2. collection of basic datasets: monitoring data and statistics;
3. production of core accounts, measure total ecosystem capability, assess degradation or enhancement;
4. functional analysis of ecosystem capital and services in physical units;
5. functional analysis of ecosystem capital and services in monetary units: measurement of unpaid degradation costs; valuation of ecosystem services.

Steps 1 to 3 correspond to the QSP. Steps 4 and 5 are additional developments.

Data availability will determine the detail and accuracy of the first generation of accounts. The accounting tables will probably have to be simplified in practice, which means that, at a preliminary, stage, not all the details will

A roadmap and 5 steps:

1. collection of reference geographical datasets and creation of a database of ecosystem accounting units (EAUs);
2. collection of basic datasets: monitoring data and statistics;
3. production of core accounts: measurement of total ecosystem capability, assessment of degradation or enhancement;
4. functional analysis of ecosystem capital and services in physical units;
5. functional analysis of ecosystem capital and services in monetary units: measurement of unpaid degradation costs; valuation of ecosystem services.

Steps 1 to 3 correspond to the QSP. Steps 4 and 5 are additional developments.

Quick start with available data and progressive development.

Thank you for your attention!

여러분의 관심에 감사드립니다!

ENCA-QSP is downloadable from
*https://www.**cbd**.int/doc/publications/**cbd**-ts-77-en.pdf*

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Convention on
Biological Diversity