École Polytechnique Fédérale de Lausanne

Guest Conference

26 March 2015

Prendre le capital naturel écosystémique en compte(s): un test d'application de la compatibilité écosystémique pour le haut bassin du Rhône

Taking into account(s) the ecosystem natural capital: an experimental implementation for the Upper River Rhône catchment

Jean-Louis Weber

European Environment Agency Scientific Committee

Honorary Professor, School of Geography, University of Nottingham

Consultant on Ecosystem Natural Capital Accounting

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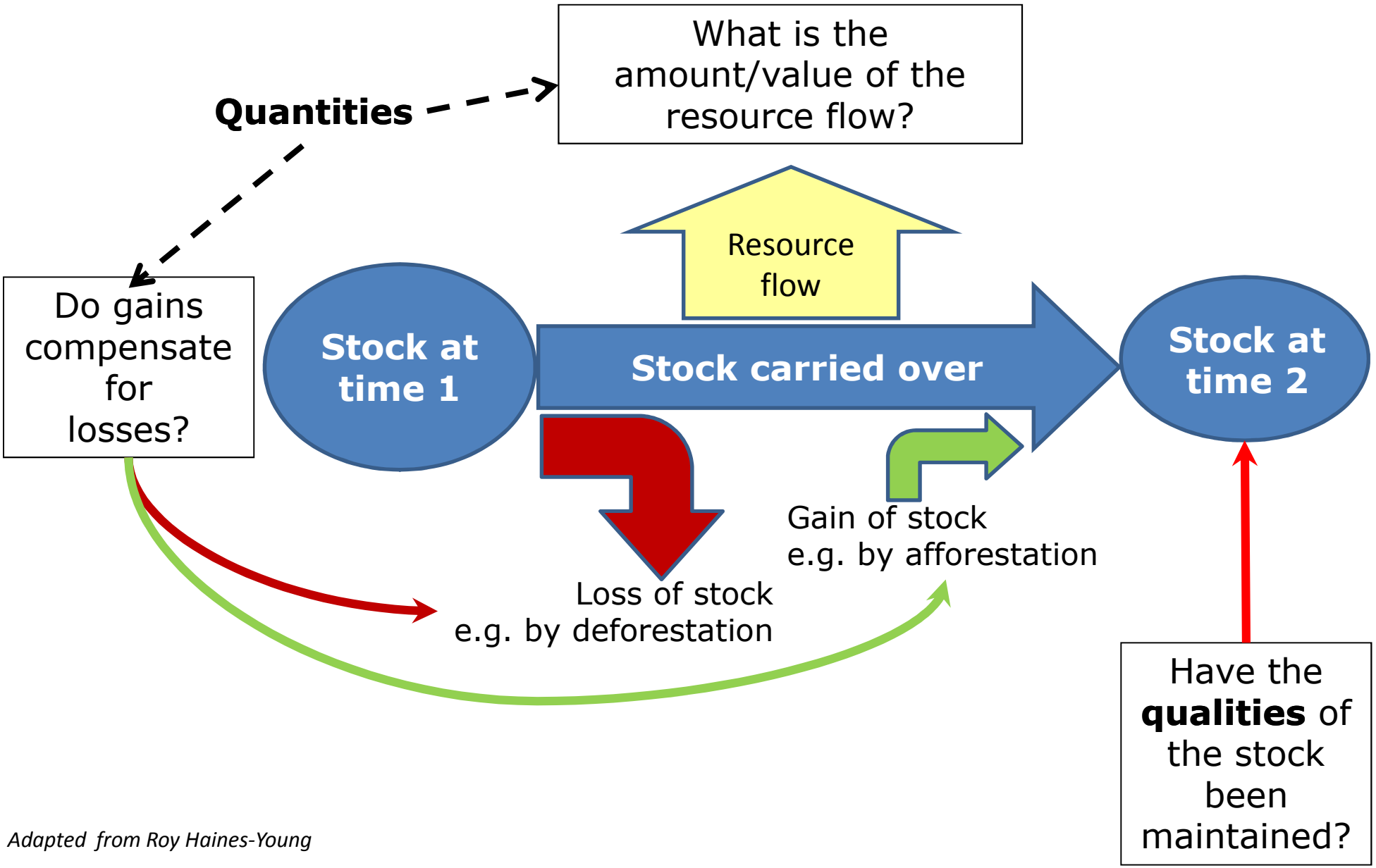
Ecosystem Natural Capital Account: attempt to respond to basic questions



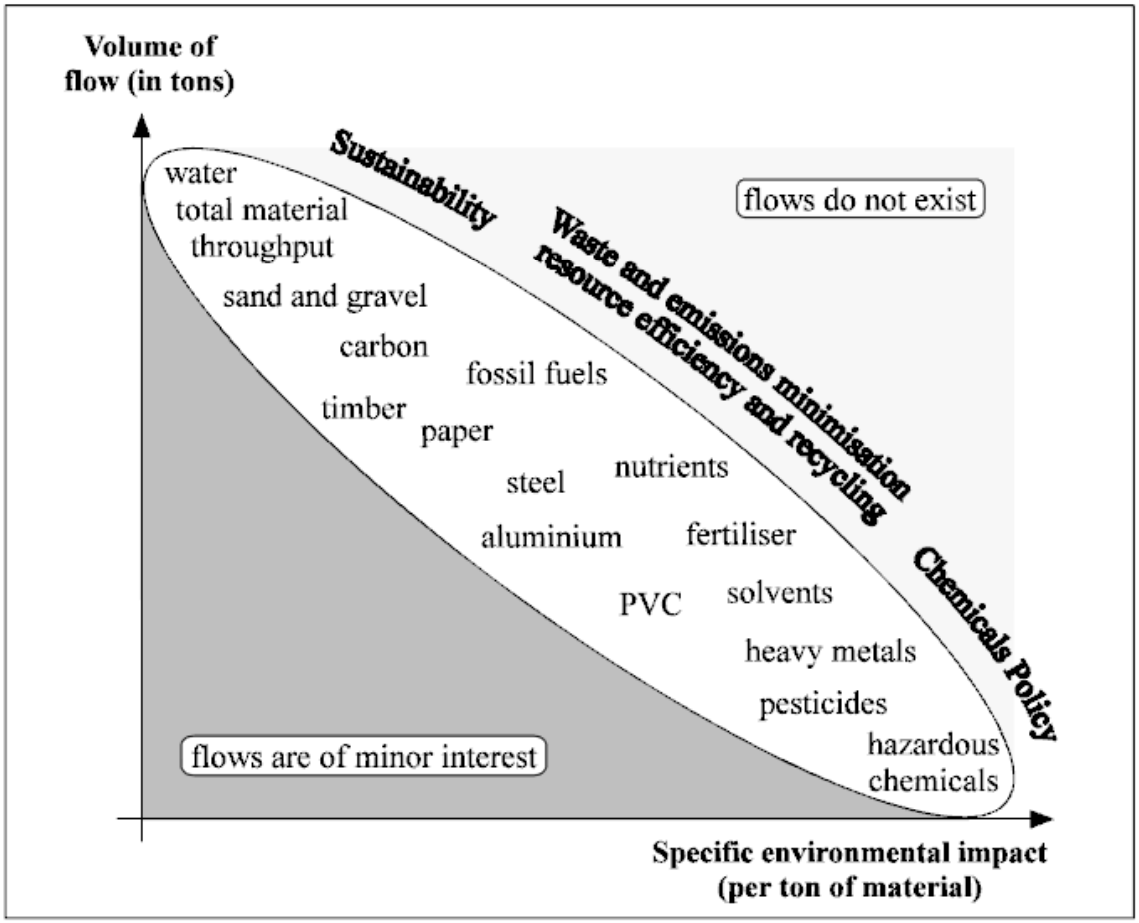
Adapted from Roy Haines-Young

Accounts are about recording and summarizing values...

- Counts, inventories are limited, standalone “accounts”, issues in aggregating measurements in physical units

SEEA Part1: Difficulty to Aggregate Physical Supply and Use Tables

- "Of note is that, unlike monetary flows which are measured in currency units, **physical flows are generally measured in different units depending on the material**. Thus, while it is conceptually possible to compile a complete PSUT for all material flows in an economy using a single measurement unit (e.g. tonnes), it is not usual practice". (SEEA2012 , 2.47)



Source: Steurer (1996),[11] as developed with W. Radermacher (StBA) in 1995

Accounts are about recording and summarizing values...

- Counts, inventories are limited, standalone “accounts”, issues in aggregating measurements in physical units

- Accounts or balances, integrated by double-entry rules are about values:
  - Assets value ➔ Wealth
  - Flows, receipts, expenditures ➔ Net Income

- Monetary value is important but it is not the only value that we acknowledge

Value is not just about money

…but maintaining an asset may have a cost

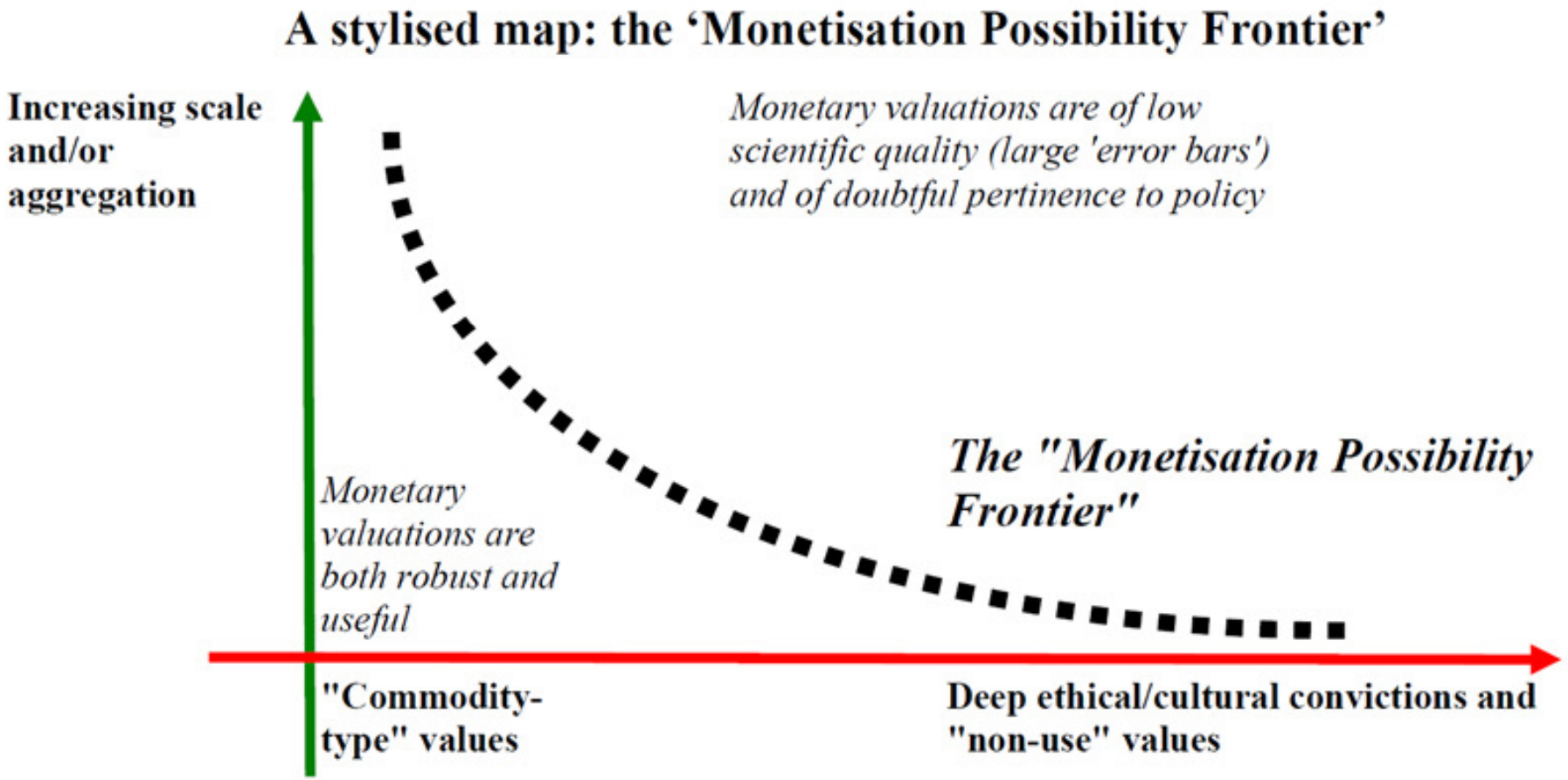
Paid maintenance/ restoration costs

Estimated cost of repairs (not yet paid) = <u>Measurement of asset depreciation</u>

<u>Invaluable</u> asset ➔ no monetary value…

<u>Cultural services</u>, may generate income

O'Connor and Steurer: The "Frontier of Monetisation" in Environmental Valuation, paper presented at the 6th meeting of the London Group on Environmental Accounting, Canberra November 1999



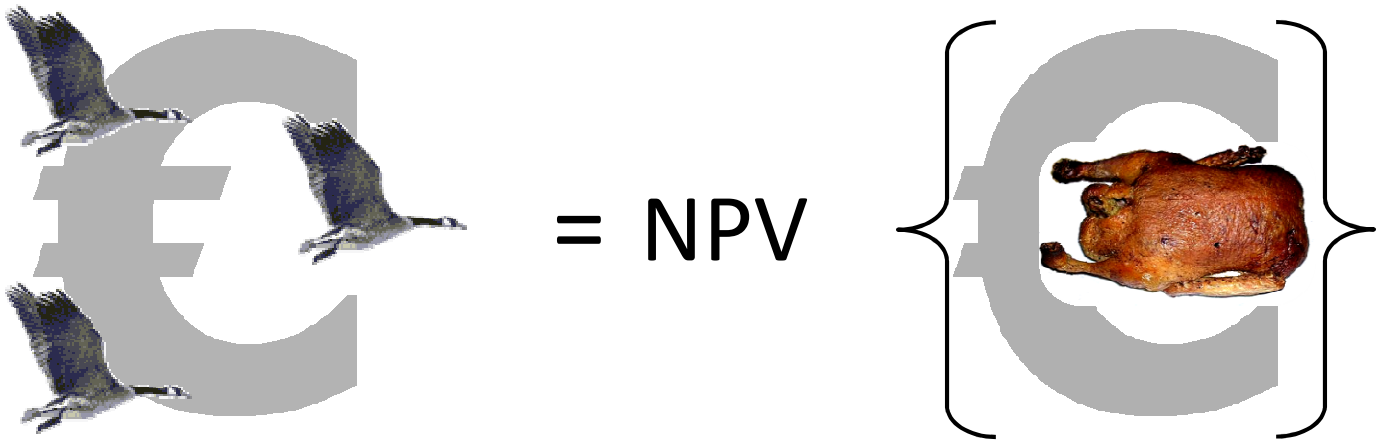
The conventional economic valuation of resource depletion is not appropriate for ecosystem degradation

Conventional economic theory:
asset depreciation =

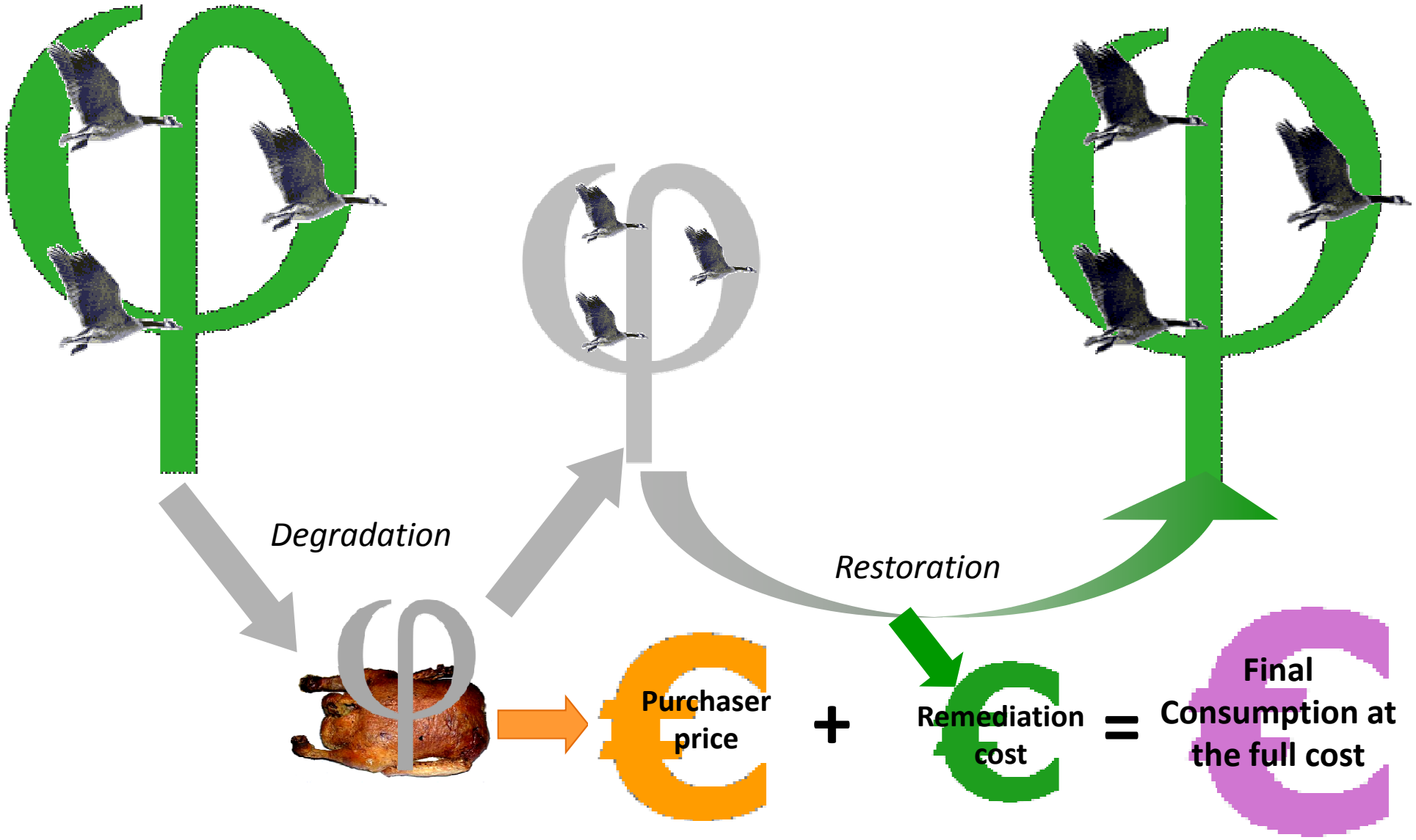
1. difference between asset values at two dates
2. cumulated loss of future benefits (financial approach, “Net Present Value”)

NB: 1. and 2. are assumed to be equivalent under the condition of “perfect market”

Financial value of natural assets = “Net Present Value” of expected future benefits



Ecosystem natural capital accounting: asset = “quantity*quality” (physical measurement)
only change is priced (imputed remediation costs)

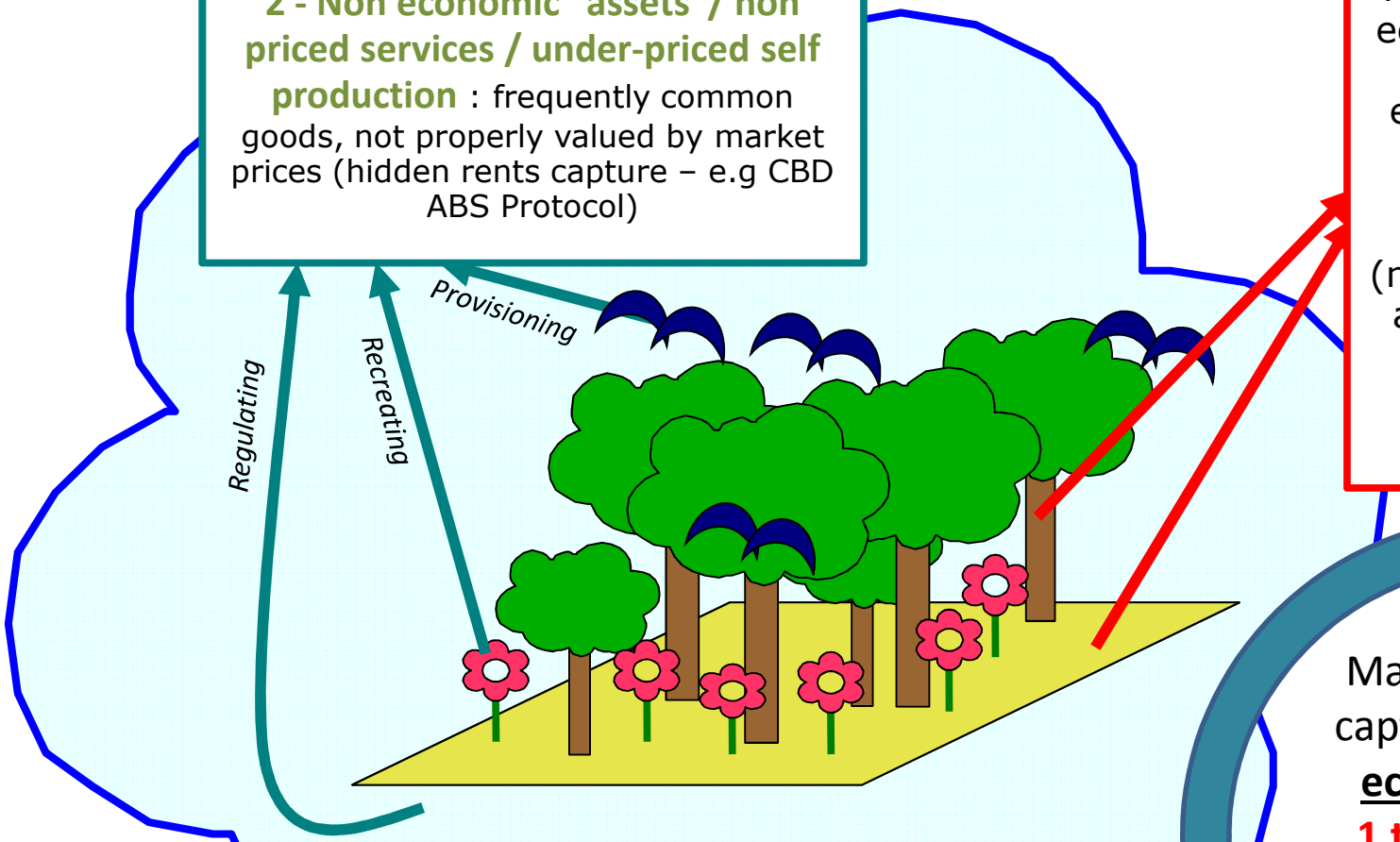


Ecosystems assets and services : 3 “values” in 1

1 – SNA commodities and assets:
The value of ecosystem economic assets, goods and services is entangled into market values…

It includes all goods (not all services) for self account recorded at a production price of similar goods

2 - Non economic “assets”/ non priced services / under-priced self production : frequently common goods, not properly valued by market prices (hidden rents capture – e.g CBD ABS Protocol)

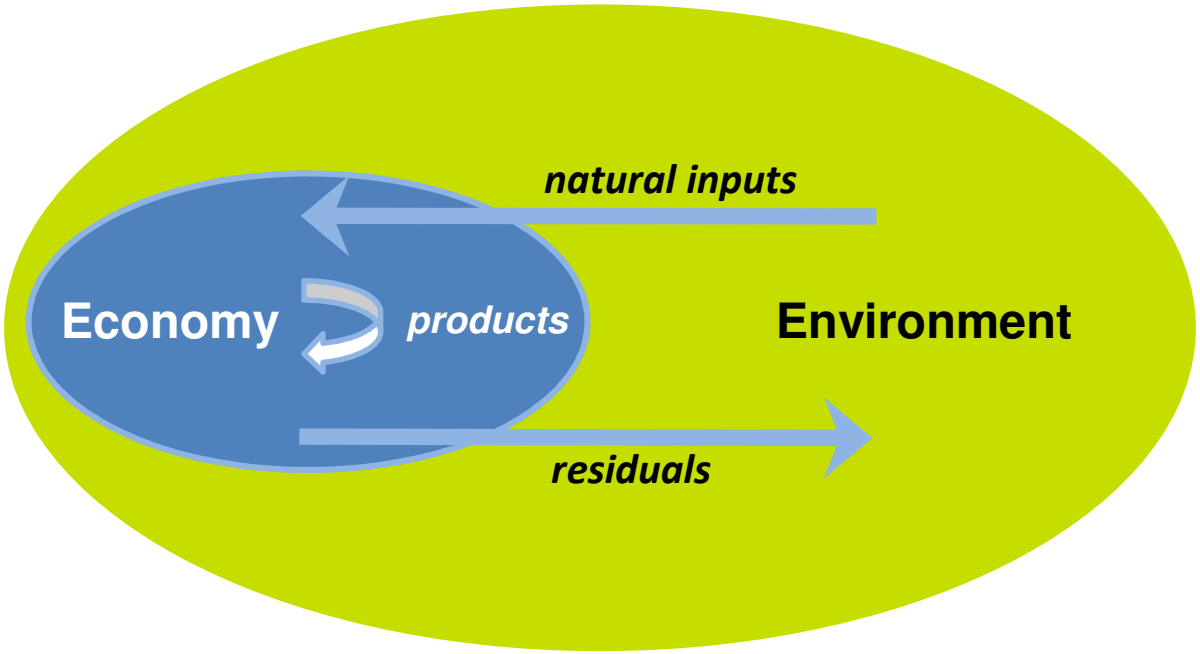


Market value don’t capture the genuine **ecosystem value**:
1 to some extent,
2 imperfectly and
3 very poorly ➔
need of a different currency

3 – Ecosystem health: public good, non-rival, non-exclusive use, long term “value”, non-transferable ownership rights. It can be maintained (environmental expenditures, green taxes, offset certificates, PES…) or degraded.
Degradation is an Unpaid Cost

Jean-Louis Weber, 19 July 2013

The current representation of the relation economy-nature in the SEEA and a mis-interpretation



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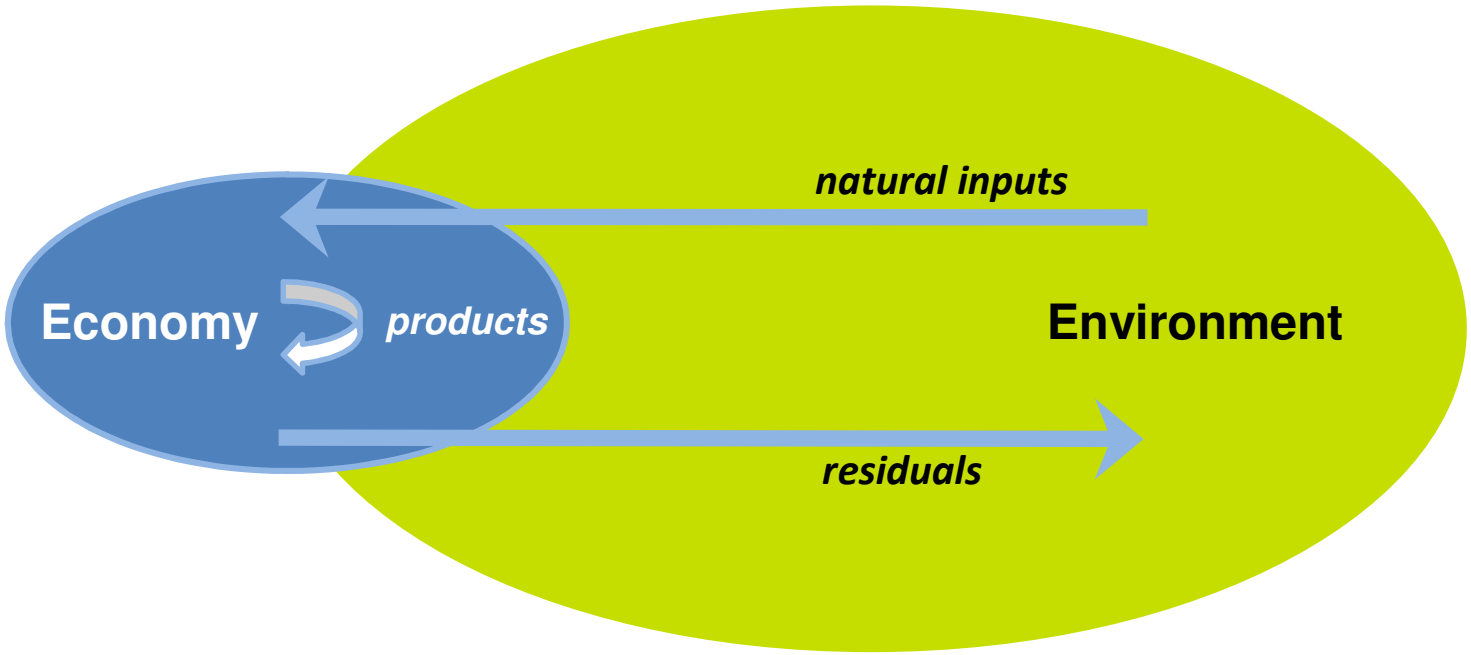

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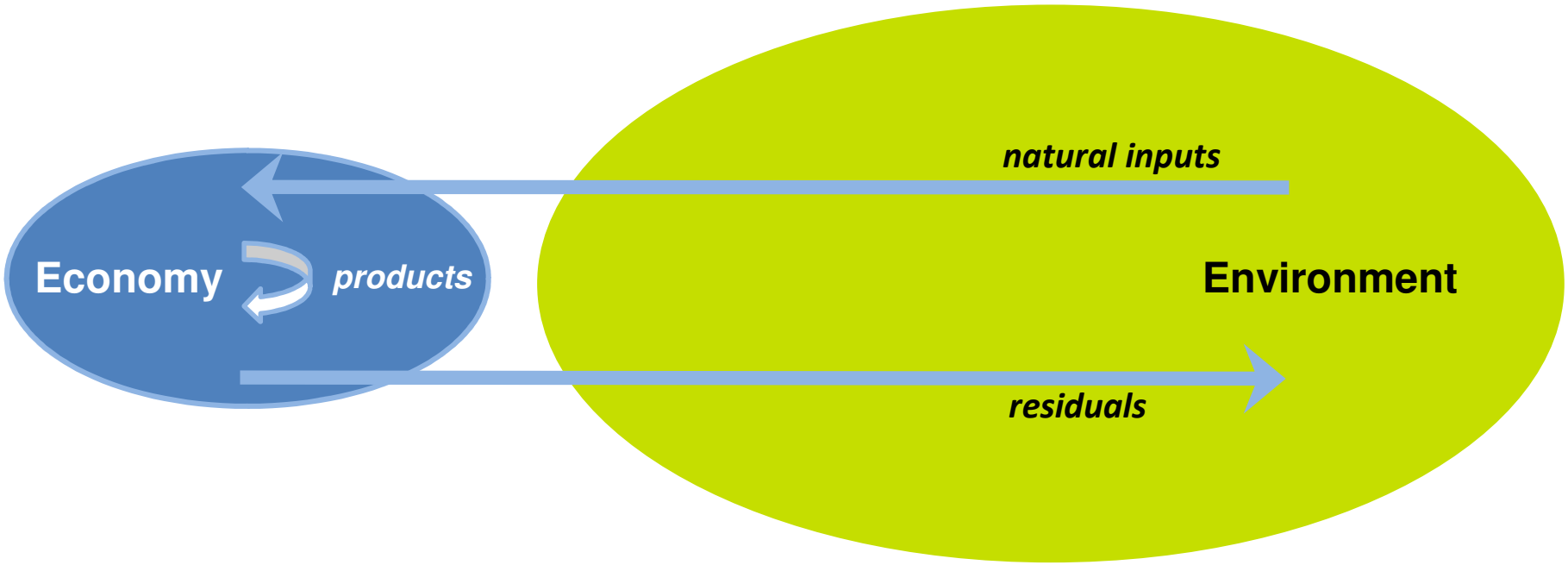
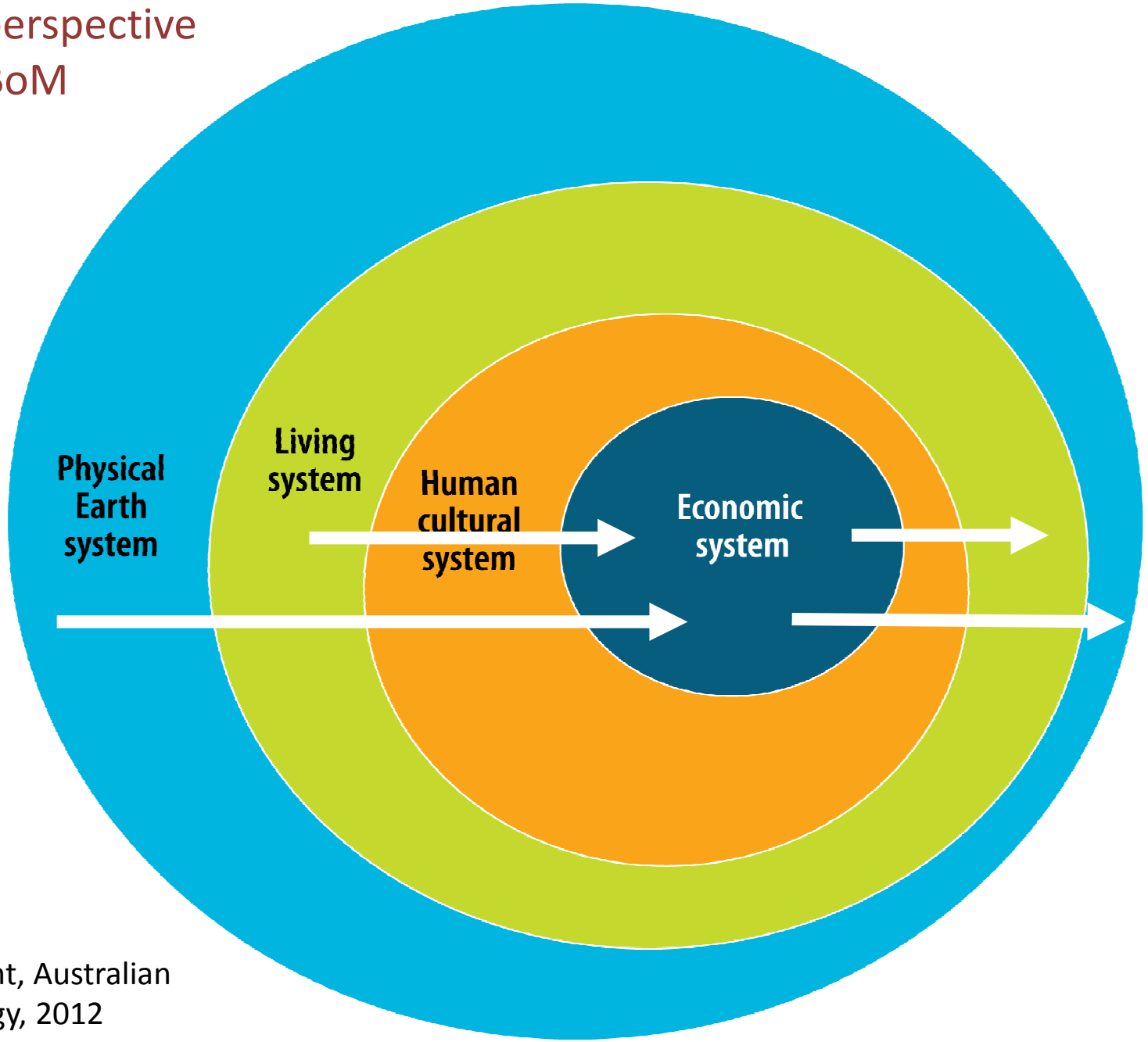


A products based approach

The “Joint perspective model” of BoM

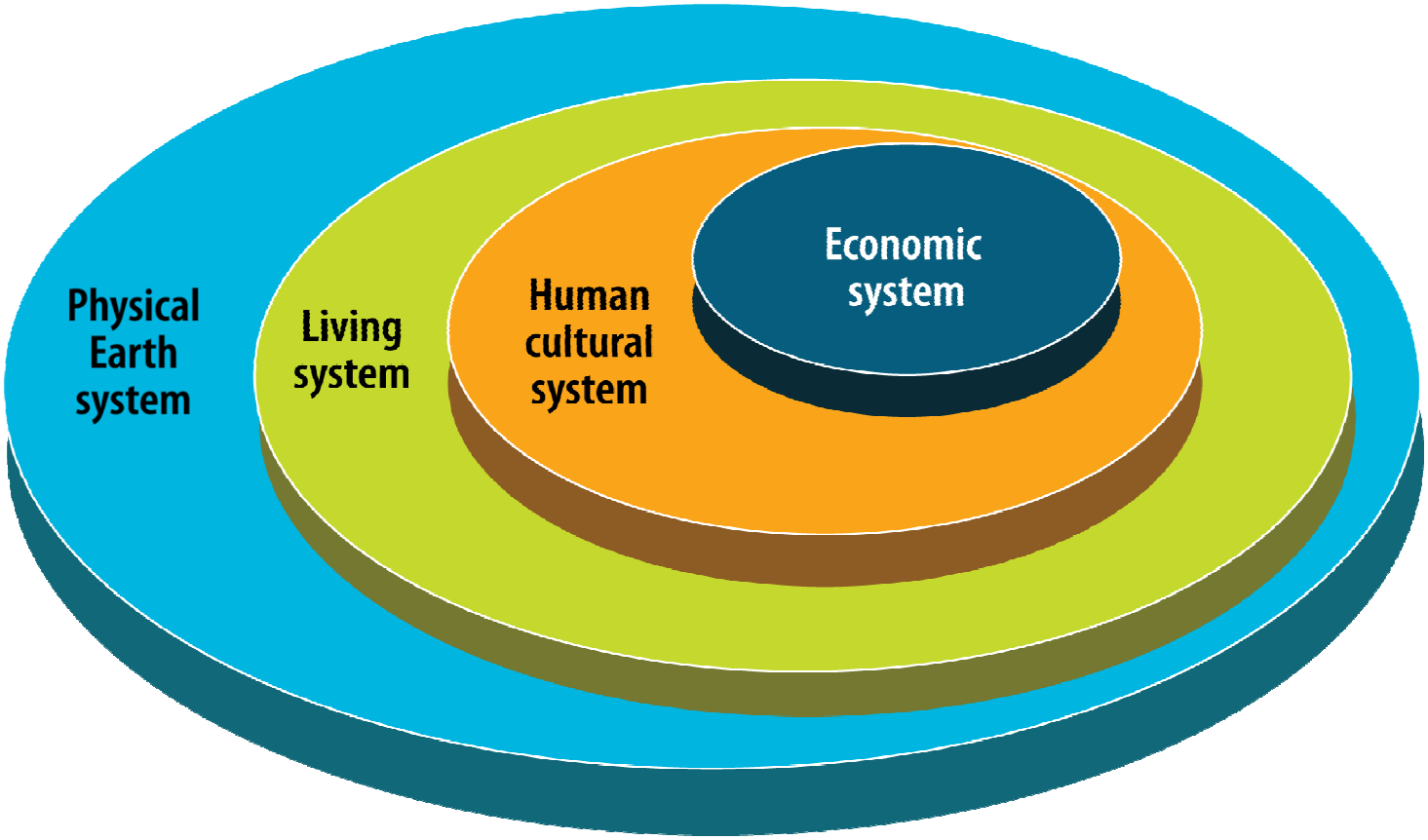
in 2D



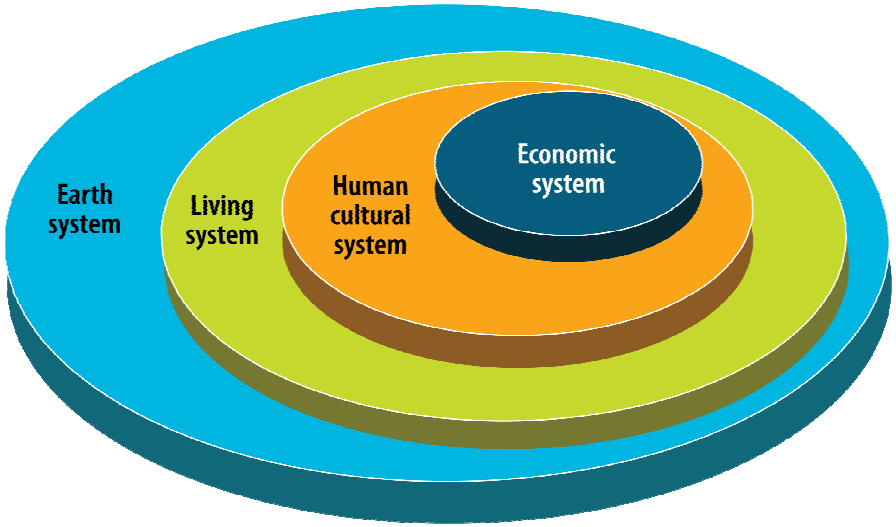
Source: Richard Mount, Australian Bureau of Meteorology, 2012

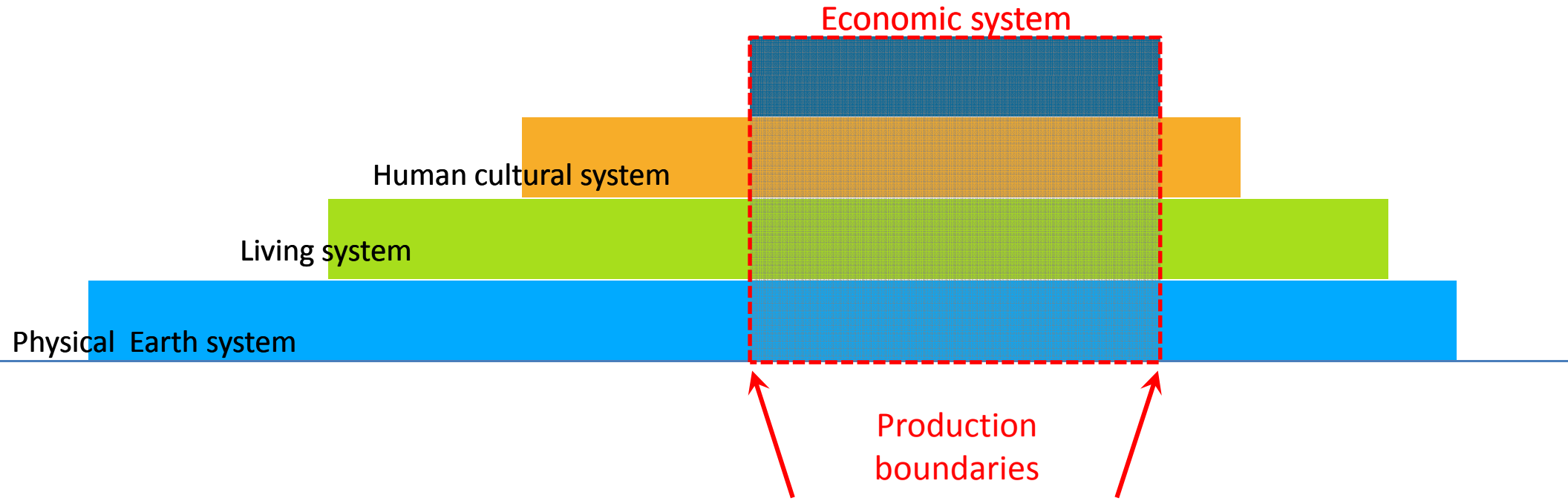
The “Joint perspective model” of BoM

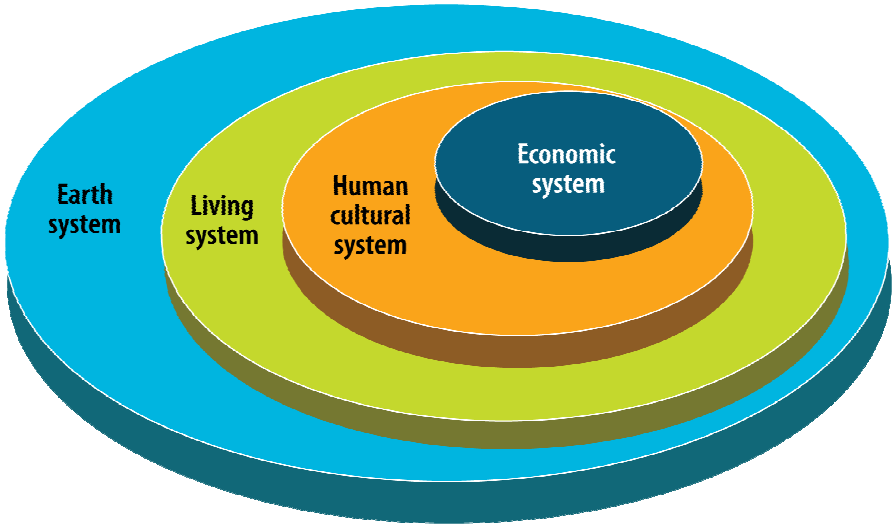
in 3D

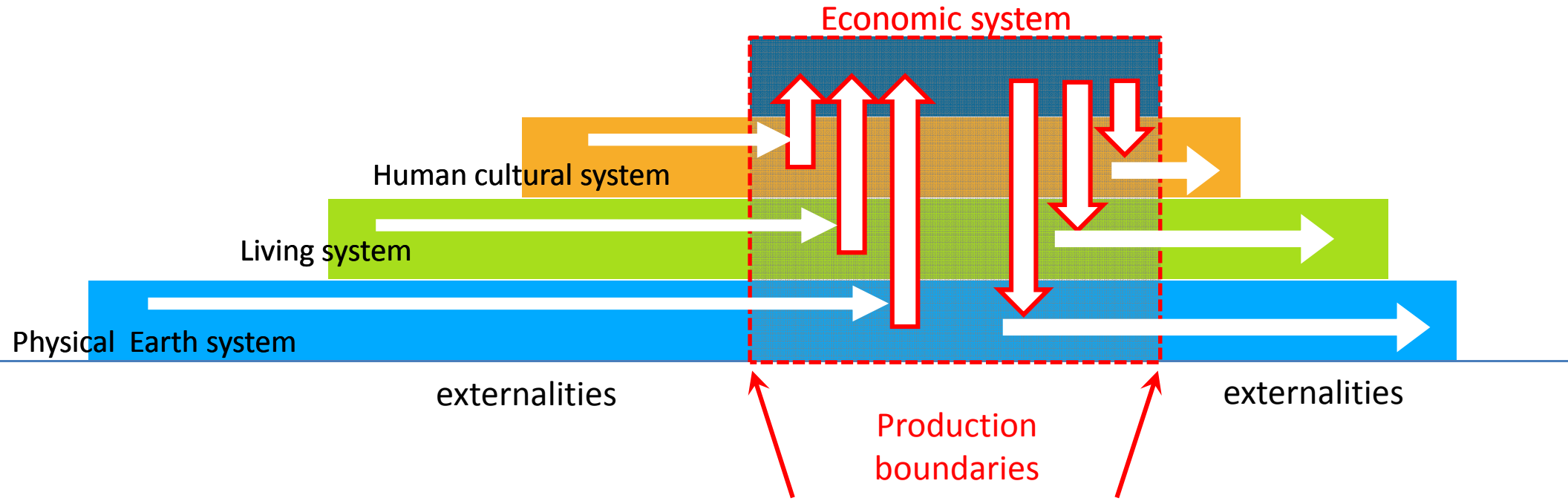


Source: Richard Mount, Australian Bureau of Meteorology, 2012


Earth system
Living system
Human cultural system
Economic system


Economic system
Human cultural system
Living system
Physical Earth system
Production boundaries

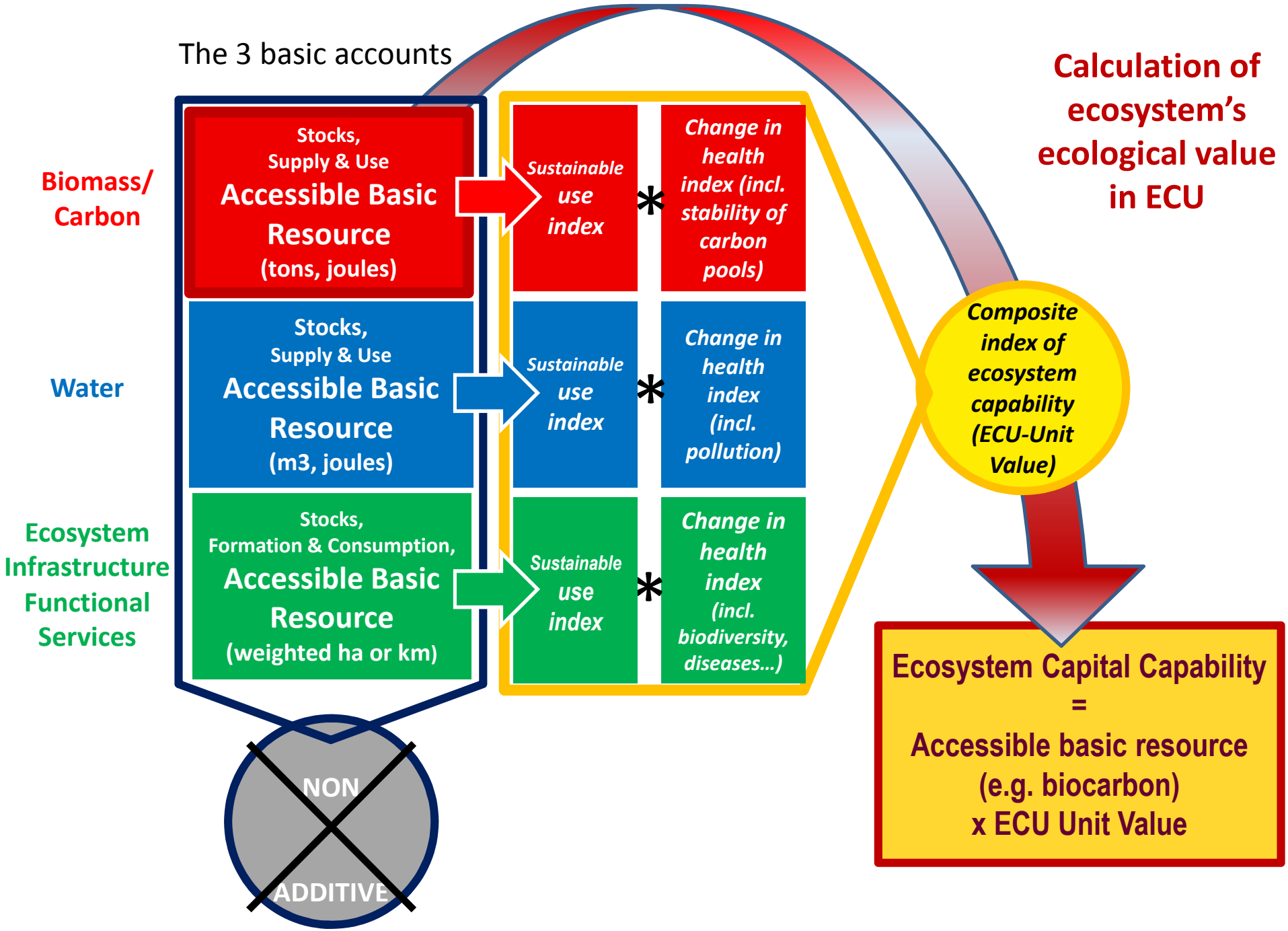

Earth system
Living system
Human cultural system
Economic system


Economic system
Human cultural system
Living system
Physical Earth system
externalities
externalities
Production boundaries

2.34 The coverage of assets is limited to those assets which are **subject to ownership rights** and **from which economic benefits may be derived by their owners** by **holding them or using them in an economic activity** as defined in the SNA. Consumer durables, human capital and those natural resources that are not capable of bringing economic benefits to their owners are outside the scope of assets in the SNA.

Need of a common unit for accounting

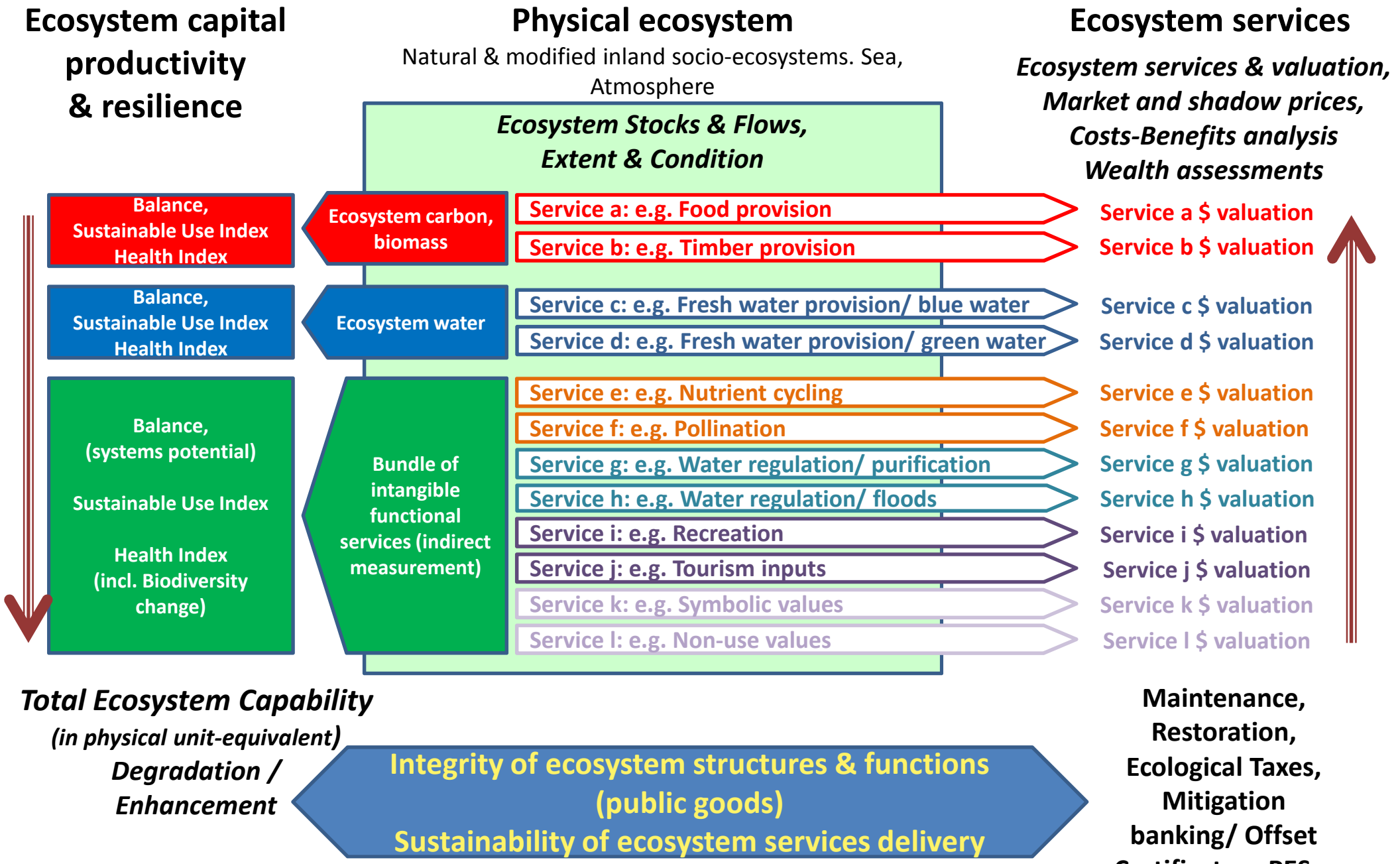
- Without a common unit, accounts aggregation is not possible.
- Simple physical units don't do the job...
- Climate change: CO_2-equivalents to measure contributions to global warming
- Green Growth: tons (-equivalents) to measure resource use efficiency
- Ecosystem/biodiversity: Ecosystem Capability 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 $)


The 3 basic accounts
Biomass/ Carbon
Water
Ecosystem Infrastructure Functional Services
Stocks, Supply & Use Accessible Basic Resource (tons, joules)
Stocks, Supply & Use Accessible Basic Resource (m3, joules)
Stocks, Formation & Consumption, Accessible Basic Resource (weighted ha or km)
Sustainable use index
Change in health index (incl. stability of carbon pools)
Sustainable use index
Change in health index (incl. pollution)
Sustainable use index
Change in health index (incl. biodiversity, diseases...)
NON
ADDITIVE
Composite index of ecosystem capability (ECU-Unit Value)
Calculation of ecosystem's ecological value in ECU
Ecosystem Capital Capability
=
Accessible basic resource
(e.g. biocarbon)
x ECU Unit Value

About the meaning of ECU values...

- A simplified model

Two possible approaches to ecosystem accounting



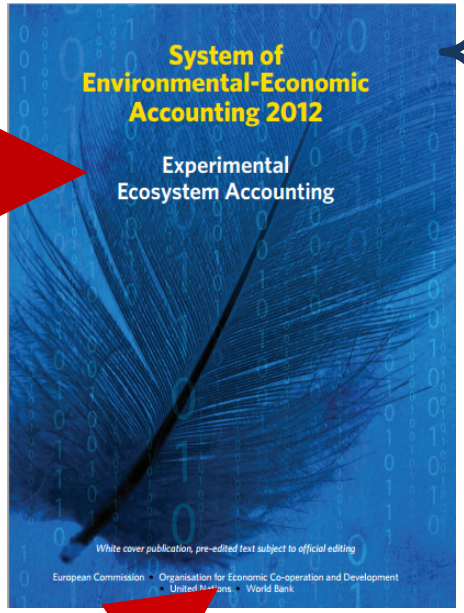
International statistical context: SNA and SEEA volumes 1 & 2

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

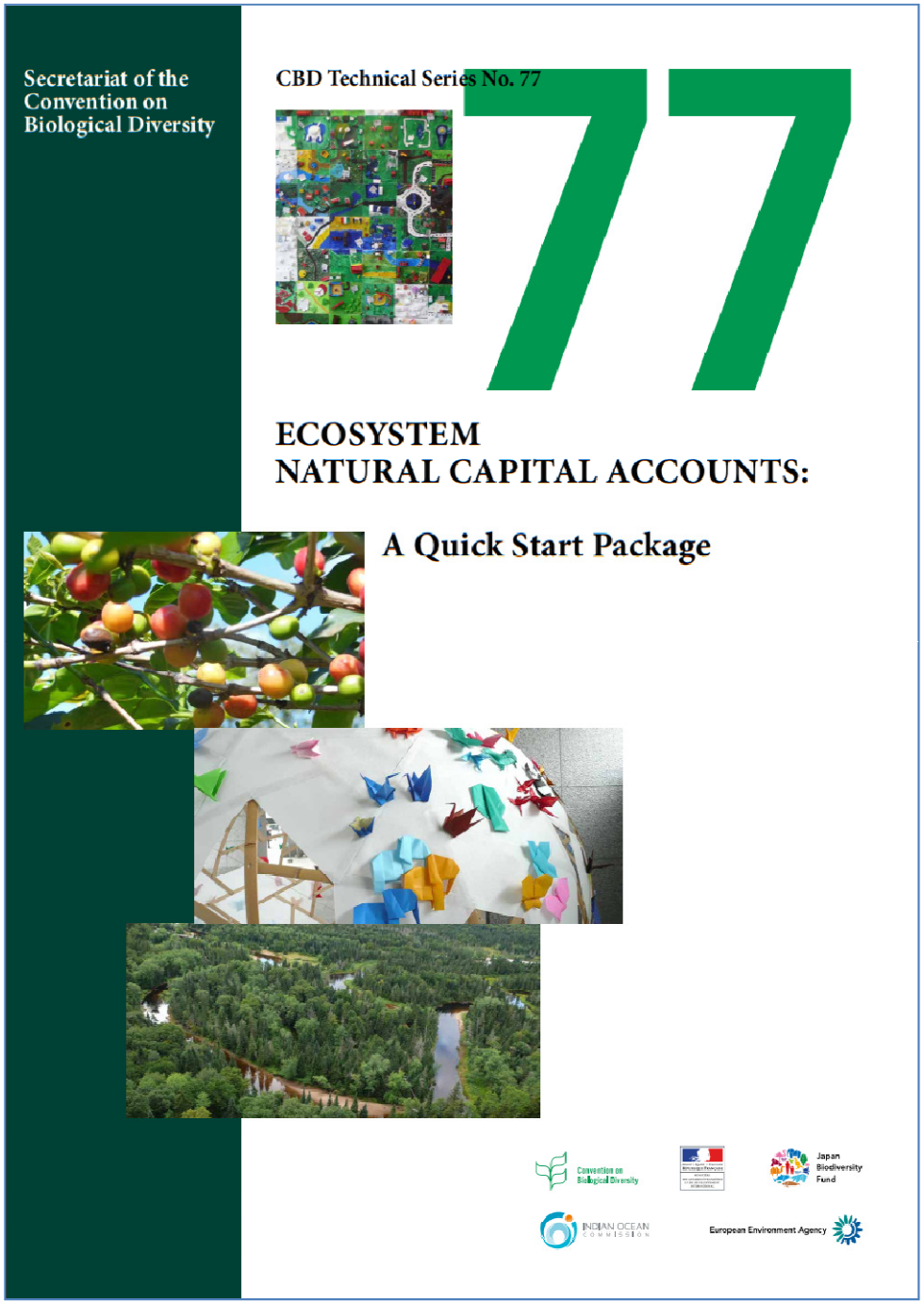
EU: ECA & MAES

Ecosystem Capital Accounts Mapping and Assessment of Ecosystem Services

SEEA-EEA Experiment

ENCA-Mauritius

Ecosystem/ Natural Capital Accounts

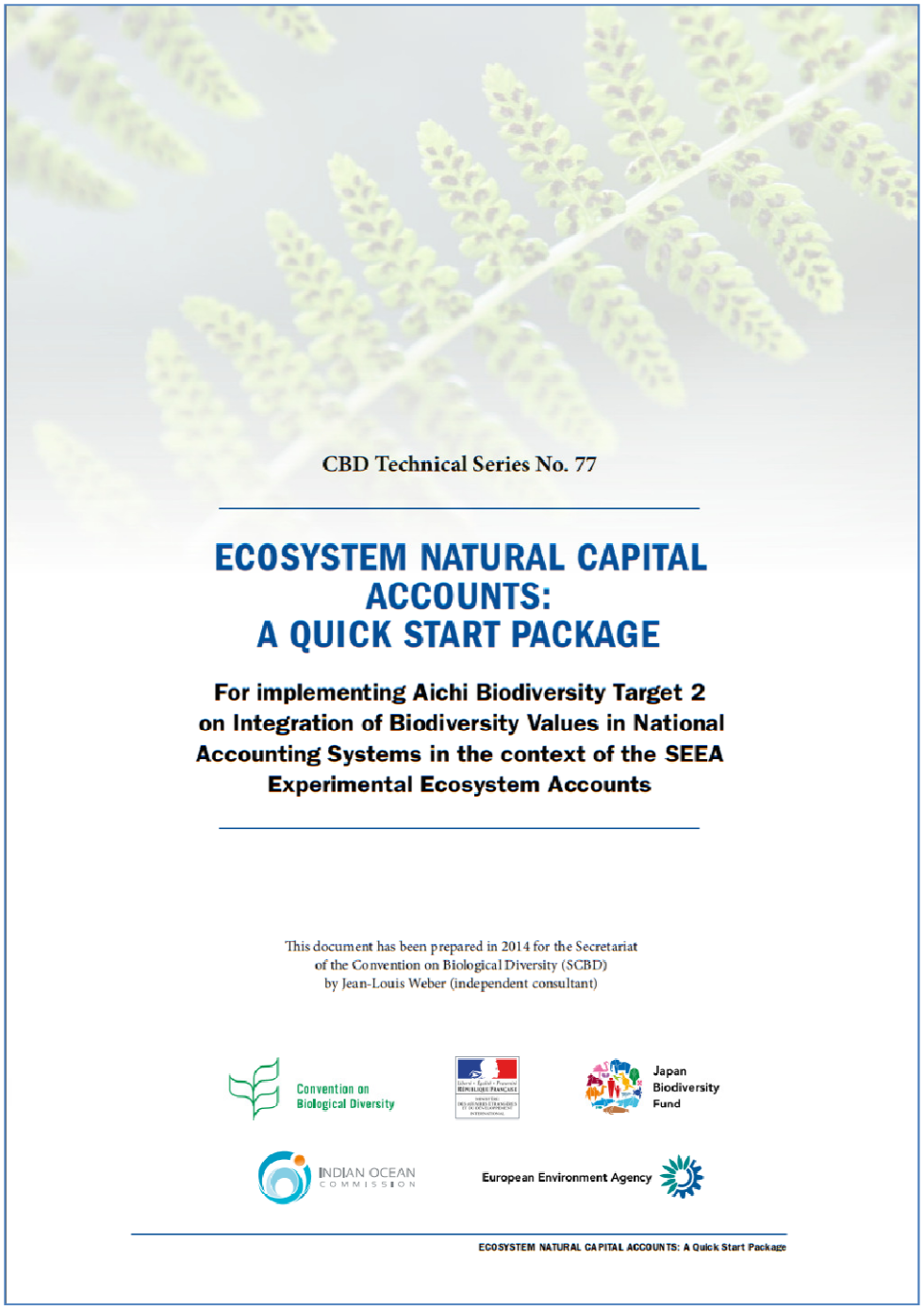


"In 2010, Parties to the CBD adopted Aichi Biodiversity Target 2, which calls for incorporating, as appropriate and by 2020 at the latest, biodiversity values into national accounting. This target is crucial to implementing the Strategic Plan for Biodiversity 2011-2020 and thereby addressing the underlying causes of biodiversity loss, in order to achieve its vision that "*by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people*".

This edition of the CBD Secretariat's Technical Series n°77 "*Ecosystem Natural Capital Accounts: A Quick Start Package*" provides the technical nuts and bolts for getting started in implementing this goal. Using existing data, countries can begin ecosystem accounting in accordance with the rules of national accounting and biodiversity data and indicators."

FOREWORD

Braulio Ferreira de Souza Dias
Executive Secretary,
Convention on Biological Diversity



ENCA: a Quick Start Package

- Meet an **urgency**
- **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...

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 bio diversity. 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*

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

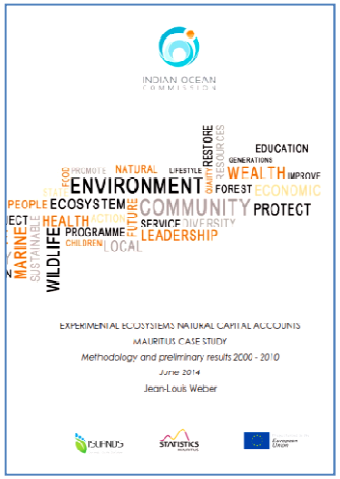
ENCA-QSP inherits from the SEEA & from other related accounting projects

Land accounts for Europe (2006)

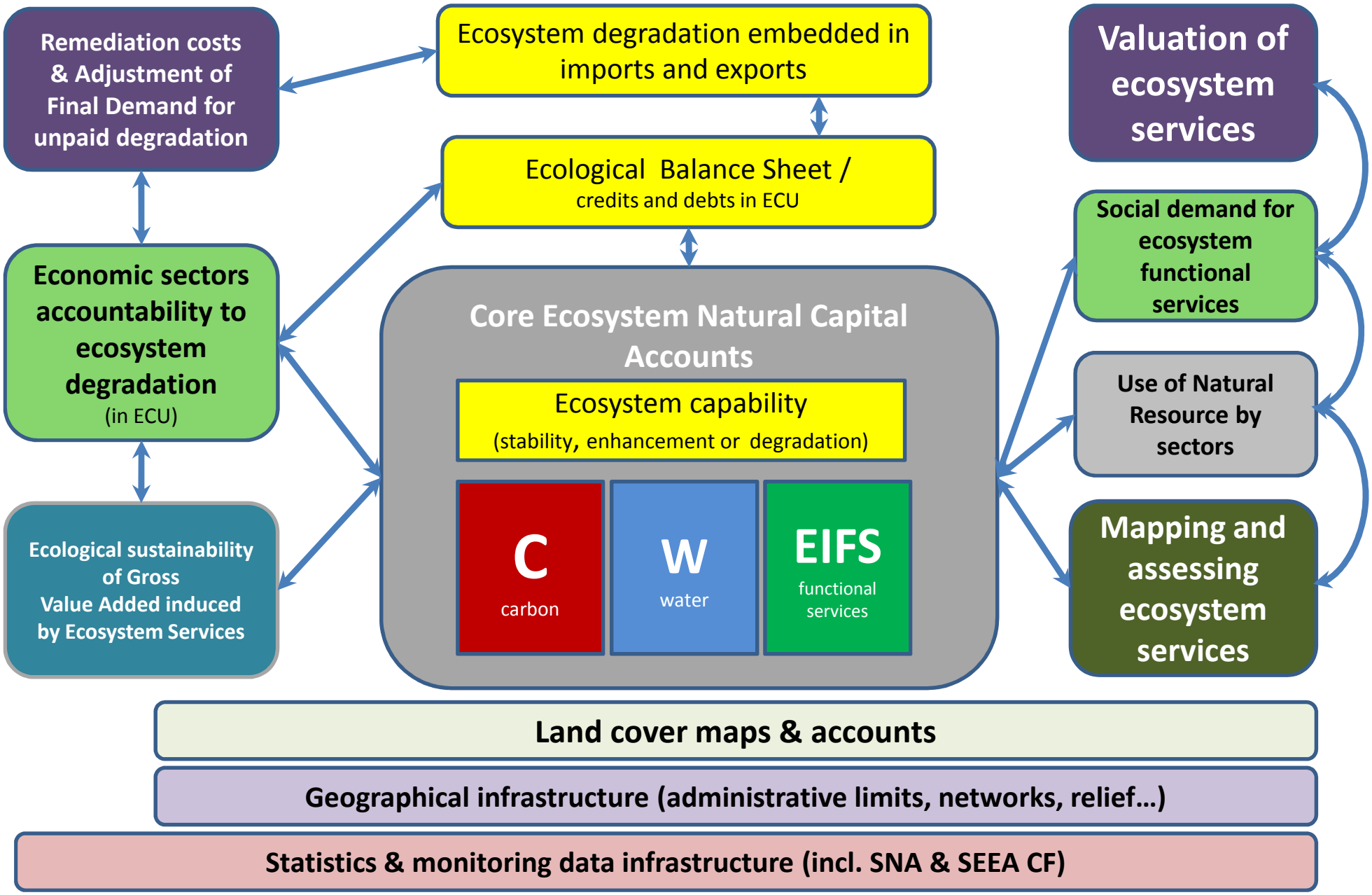
Ecosystem accounting and the cost of biodiversity losses — the case of coastal Mediterranean wetlands (2010)

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

Experimental ENCA, Mauritius Case Study (2014)



Structure of Ecosystem Natural Capital Accounts



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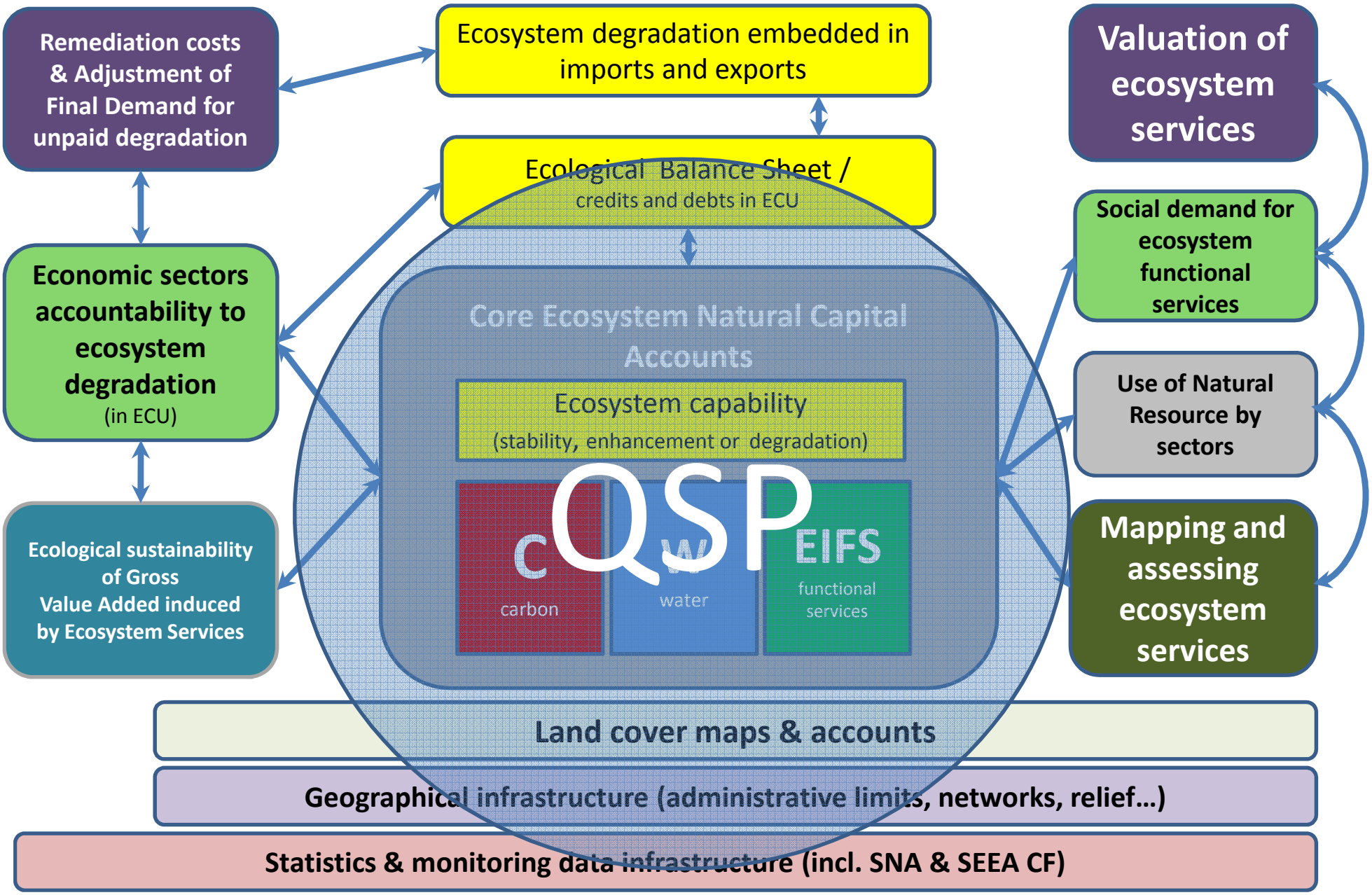


The land cover account

Land Cover Ecosystem Classes (LCEU) / *Land cover stocks and flows*	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)*	**TOTAL**
I. Opening Stock																
Opening stock																
II. Formation of land cover																
F_lf1 Artificial development																
F_lf2 Agriculture development																
F_lf3 Internal conversions, rotations																
F_lf4 Management and alteration of forested land																
F_lf5 Restoration and development of habitats																
F_lf6 Changes of land-cover due to natural and multiple causes																
F_lf7 Other land cover changes n.e.c. and reclassification																
Total formation of land cover																
III. Consumption of land cover																
C_lf1 Artificial development																
C_lf2 Agriculture development																
C_lf3 Internal conversions, rotations																
C_lf4 Management and alteration of forested land																
C_lf5 Restoration and development of habitats																
C_lf6 Changes of land-cover due to natural and multiple causes																
C_lf7 Other land cover changes n.e.c. and reclassification																
Total consumption of land cover																
Net change in land cover (formation - consumption)																
No change																
IV. Closing Stock																
Closing stock																

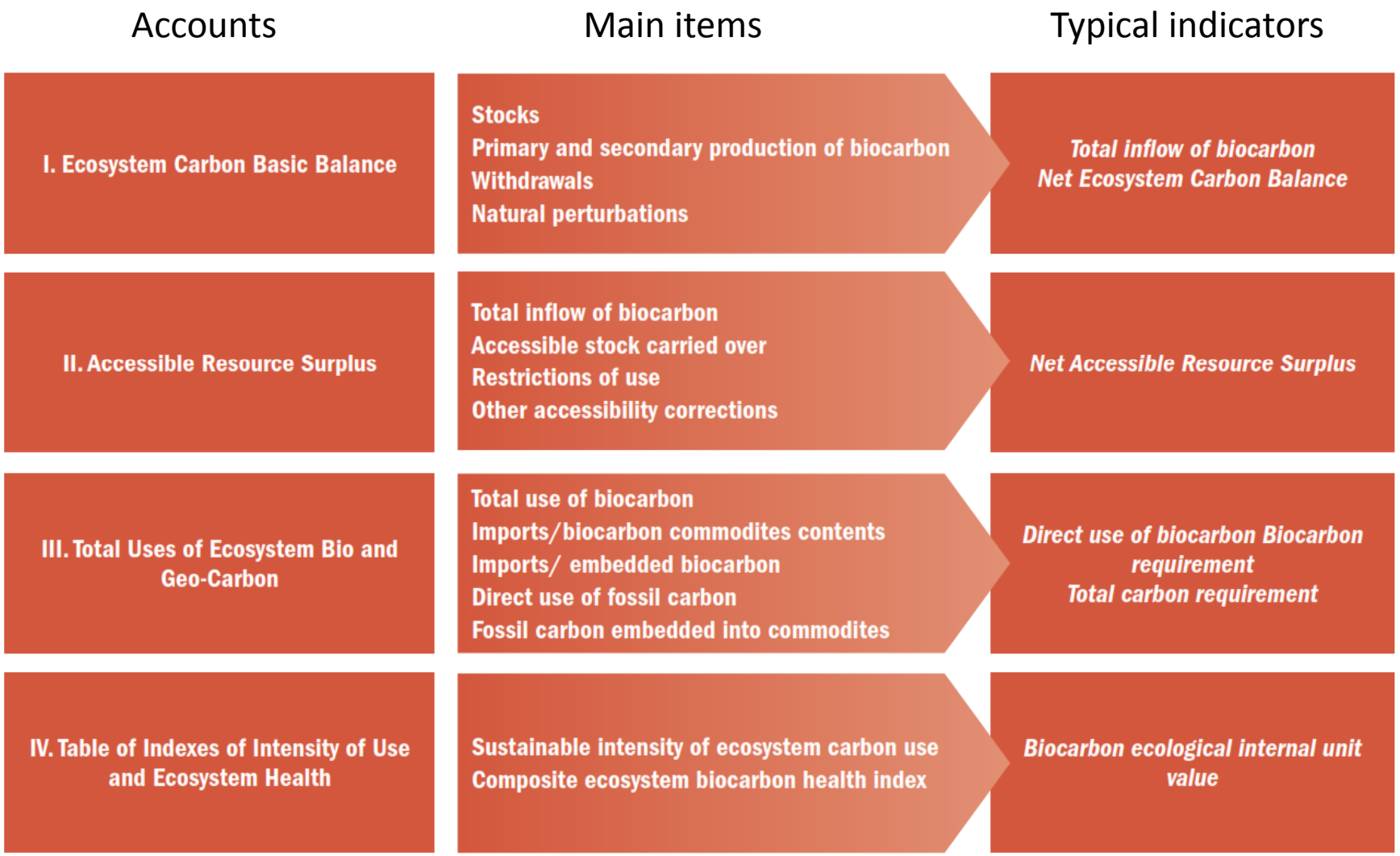
Simplified classifications of land cover types and land cover flows, to be detailed according to national/local conditions

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)

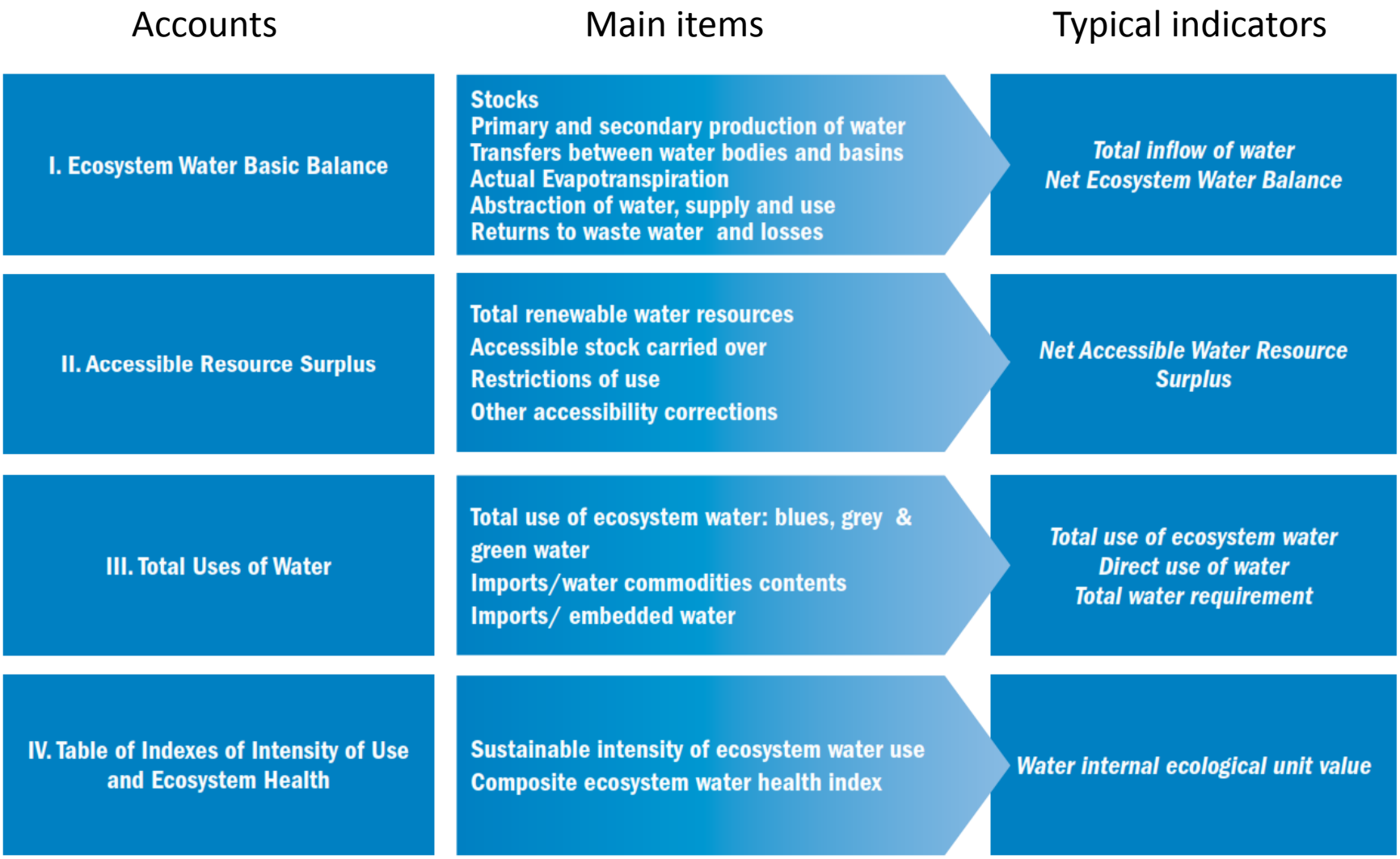
Land cover flows	
lf1	Artificial development
lf2	Agriculture extension
lf3	Internal conversions, rotations
lf4	Management and alteration of forested land
lf5	Restoration and development of habitats
lf6	Changes of land-cover due to natural and multiple causes
lf7	Other land cover changes n.e.c. and reclassification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

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

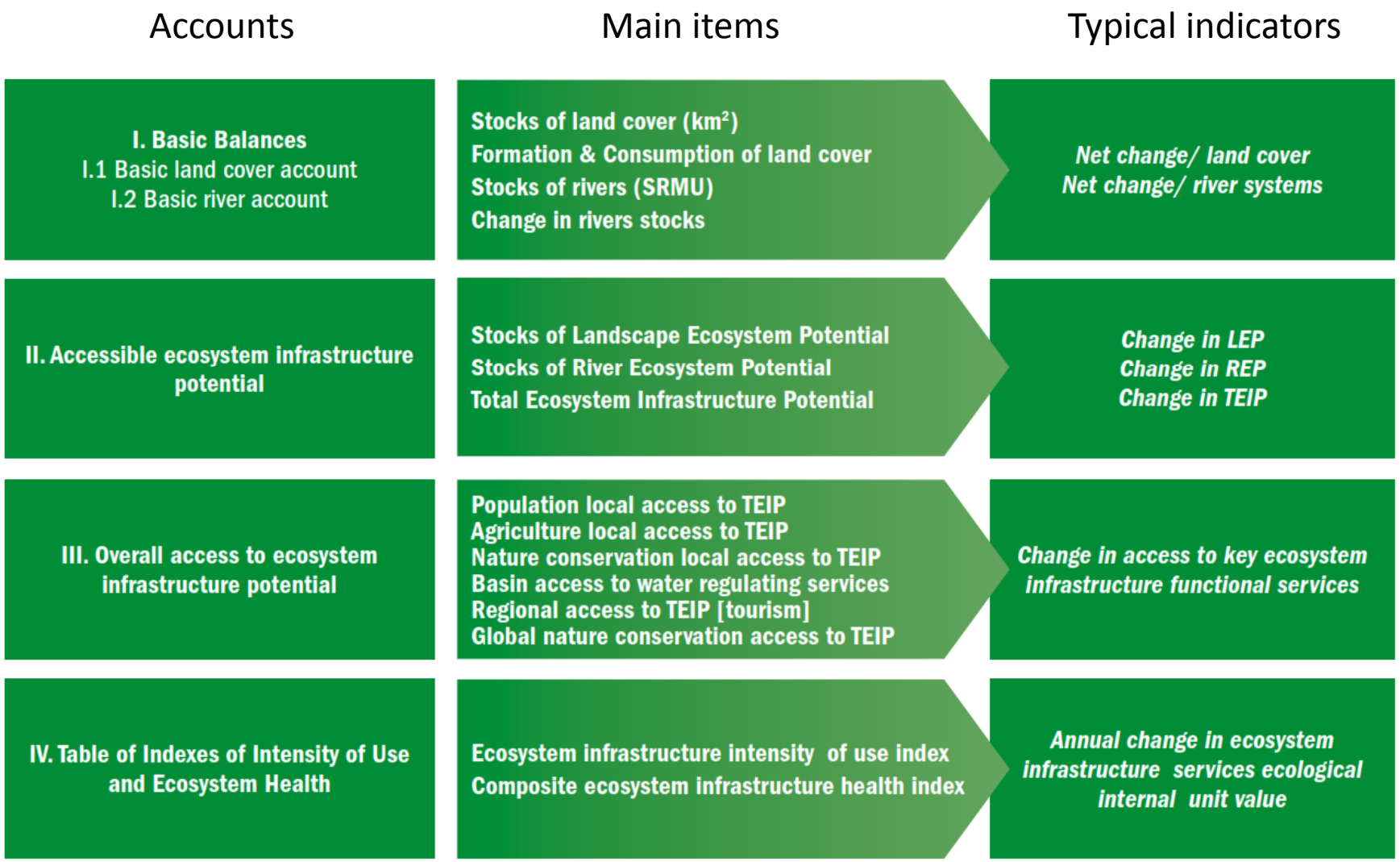
Ecosystem carbon account



Ecosystem water resource account



Ecosystem infrastructure functional services account



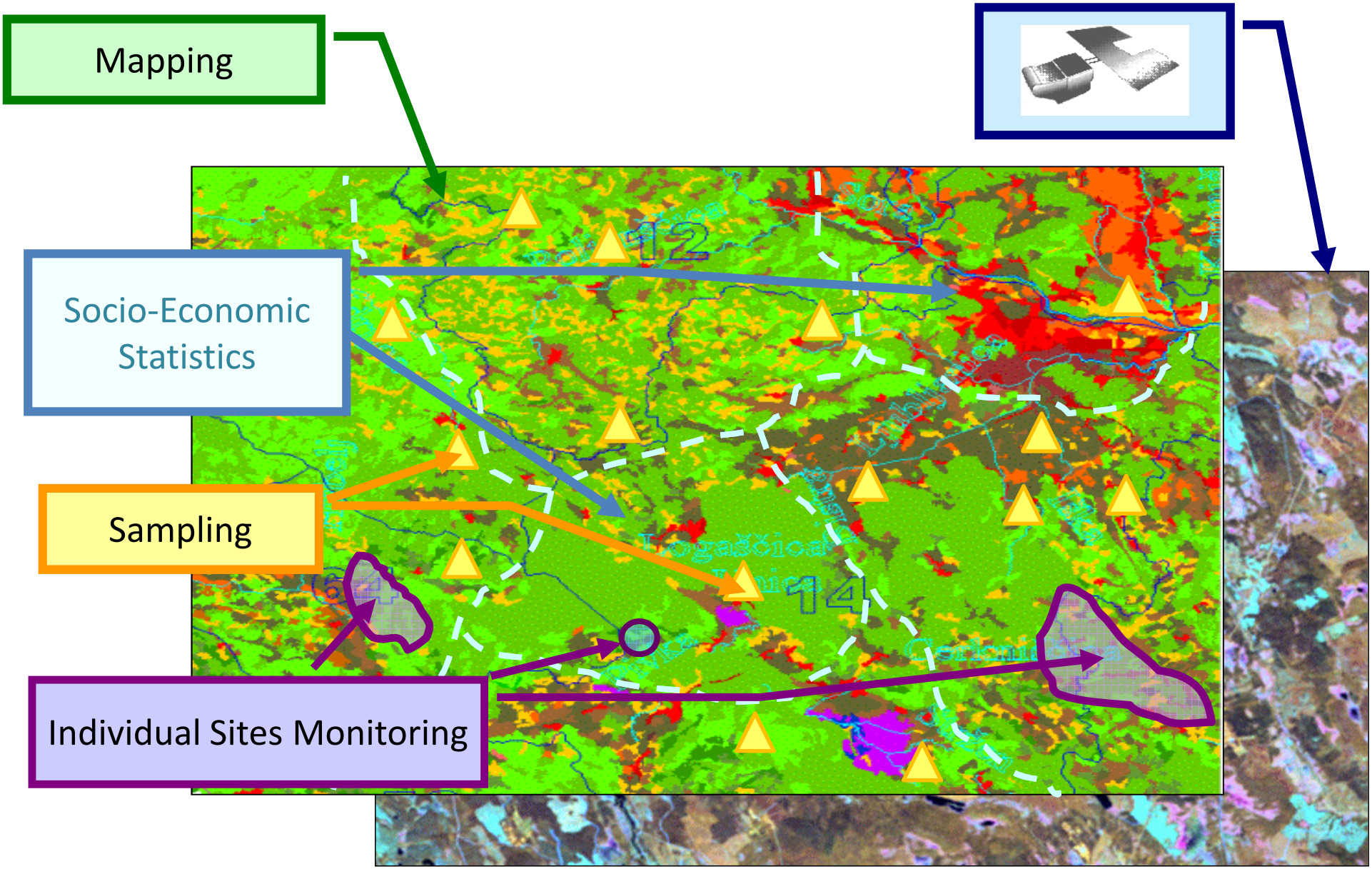
Ecosystem capability account, creation of ecological debts & credits

YEAR (2)			[C]	[W]	[EIP]	[ECC]
			Biomass/ Carbon	Water	Ecosystem infrastructure potential	Ecosystem Capital Capability
Accessible Ecosystem Resource and Use			t or j	m^3 or j	Weighted ha_or_km	*NA*
Accessible Basic Resources	**EC1**	**Net Accessible Ecosystem Resources, year (t-1) (NEACS, NEAWS & Net Ecosystem Infrastructure Potential)**	**1270**	1980	2331	
	EC211	Change due to Use of Accessible Basic Resources	90	-30	-11	NA
	EC212	Other Change due to Natural & Multiple Causes	-60	50	0	NA
	EC21	***Total Change in Basic Resource Accessibility***	30	20	-11	*NA*
	EC2	**Net Accessible Ecosystem Resources, year (t) (NEACS, NEAWS & Net Ecosystem Infrastructure Potential)**	**1300**	**2000**	**2320**	NA
Use of ecosystem resource	**EC3**	**Use of ecosystem resource**	**1210**	**2030**	**2331**	*NA*
Ecosystem Capability Account			**ECU**	ECU	ECU	**ECU**
Calculation of unit values in ECU	**EC4**	**Mean ECU unit value of Accessible Resources & Ecosystem Capital Capability in year (t-1)**	**0.963**			
	EC511	Indexes of sustainable intensity of resource use [IF<1, = overuse, dilapidation; IF>1, accumulation]	*1.074*	*0.985*	*0.995*	*NA*
	EC512	Indexes of change in ecosystem health [IF<1, = deterioration; IF>1, improvement]	*0.910*	*0.960*	*0.950*	*NA*
	EC51	***Annual change in accessible resources internal unit values & change of ECU unit value***	***0.992***	***0.973***	***0.973***	***0.979***
	EC5	**Mean ECU unit value of Accessible Resources & Ecosystem Capital Capability in year (t) [EC5 = EC4 x EC51_ECC]**	***0.943***			
Accessible Resources & Ecosystem Capital Capability	**EC6**	**Net Accessible Resources & Ecosystem Capital Capability, ecological value in ECU, year (t-1)**	**1222.7**	**1906.3**	**2244.2**	***1222.7***
	EC7	**Net Accessible Resources & Ecosystem Capital Capability, ecological value in ECU, year (t)**	**1225.5**	**1885.4**	**2187.0**	***1225.5***
	EC71	***Activities' Net Accumulation of Ecosystem Capital Capability, in ECU [IF<0, = degradation; IF>0, = renewal]***	0.8	-22.9	-59.2	***0.8***
	EC722	Global/continental/regional processes	***1.0***	*1.0*	*1.0*	***1.0***
	EC722	Change caused by neighbouring/interacting ecosystems	***1.0***	*1.0*	*1.0*	***1.0***
	EC72	***Change in Ecosystem Capital Capability Due to Natural and Multiple Causes, in ECU***	***2.0***	*2.0*	*2.0*	***2.0***
	EC73	***Total Change in Accessible Resources & Ecosystem Capital Capability, in ECU = EC7-EC6***	***2.8***	*-20.9*	*-57.2*	***2.8***
Creation of Ecological Debts & Credits	***EC81 = EC71***	***Activities' Net Accumulation of Ecosystem Capital Capability, in ECU [IF<0, = degradation; IF>0, = renewal]***	***0.8***	*-22.9*	*-57.2*	***0.8***
	EC821	Indirect change caused, Global/continental/regional processes	***-3.0***	*-2.0*	*-4.0*	***-3.0***
	EC822	Change caused to neighbouring/interacting ecosystems	***-1.0***	*-10.0*	*-15.0*	***-1.0***
	EC82	***Net Change Caused to Other Ecosystems' Capability, in ECU [degradation (-) or enhancement (+)]***	***-4.0***	*-12.0*	*-19.0*	***-4.0***
	EC8	**Creation of New Ecological Debts & Credits (in ECU) [direct & indirect ecosystem degradation or renewal]**	***-3.2***	*-34.9*	*-78.2*	***-3.2***
	EC9	**Cumulated Net Balance of Ecological Debts (-) & Credits (+) in ECU (from baseline year 0)**				***-16.5***
Indexes						
Indexes	***EC51***	***Annual change in accessible resources internal unit values & change of ECU unit value***	***0.992***	***0.505***	***0.498***	***0.665***
	EC5	***Mean ECU unit value of Accessible Resources & Ecosystem Capital Capability in year (t)***	***0.943***			
	EC22	***Index of Change in Volume of Basic Resource Accessibility = EC2/EC1***	***1.024***	**1.010**	**0.995**	NA
	EC23	***Index of Change in Ecological Value of Ecosystem Capital Capability =EC22xEC5***	**0.965**	**0.952**	**0.938**	**0.965**

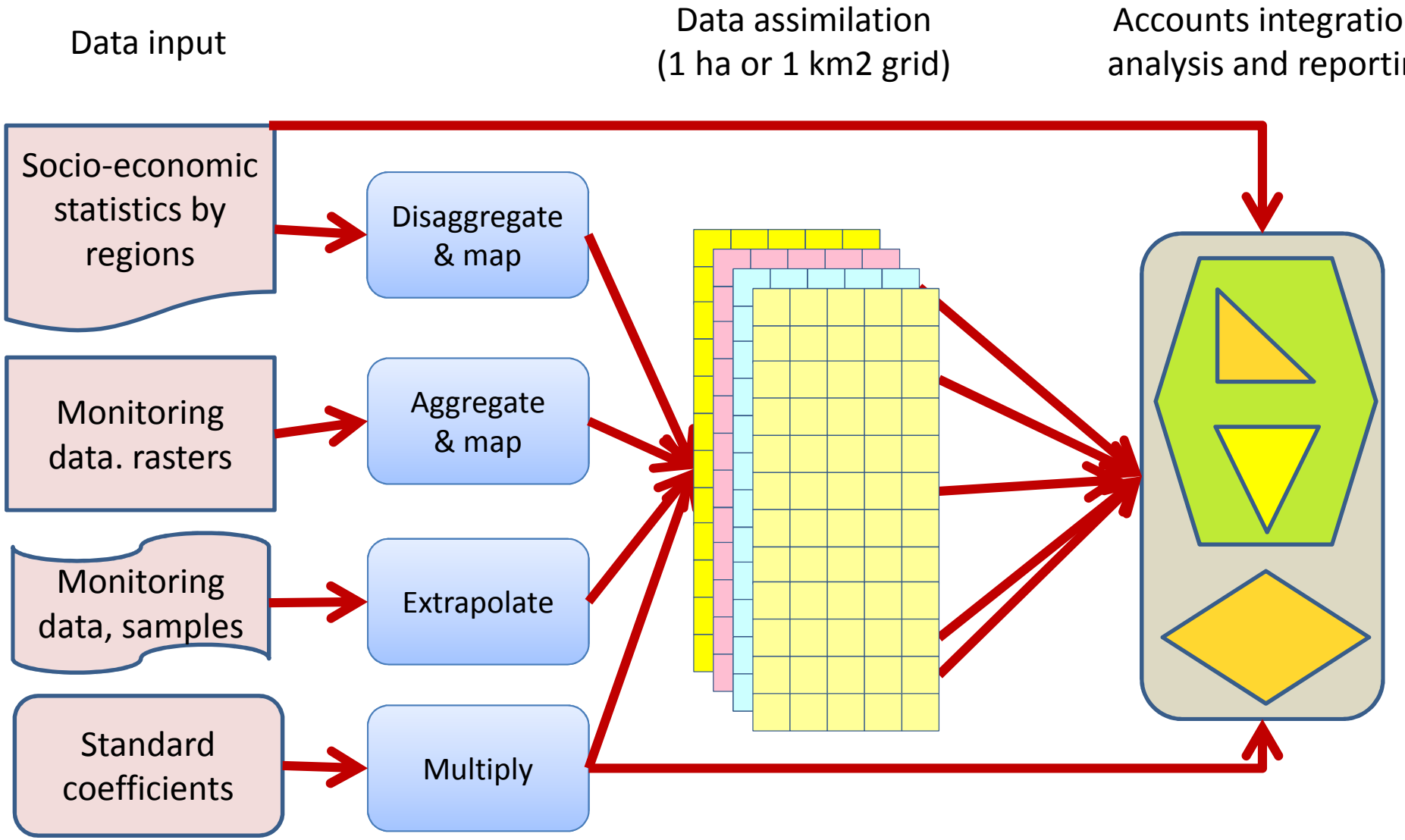
Ecological balance sheet in ECU

	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

Spatial Integration of Environmental & Socio-Economic Data



Main data flows to compile ecosystem capital accounts



Norgaard, 1998, about "THE" Constanza paper of 1997
in Ecological Economics 25 (1998) 37-39

- *As our title suggests, one response was certainly that some things perhaps should not be expressed in monetary terms. Will ecological economists bring us the value of God next? And will this be the end of history for economic valuation? Or, now that we know the exchange value of the earth, we wondered with whom we might exchange it and what we might be able to do with the money, sans Earth.*

- More technical arguments:
  - *First, there was concern that the specific services that were valued could not be separated from each other and valued individually. Such an atomistic approach defies our understanding of ecosystems as tightly interlocked systems, coevolving systems*
  - *Second, we were concerned about deriving values using prices from an economic system far from environmental sustainability.*
  - *Third, we pondered the broader significance of using partial equilibrium valuation techniques to look at a total system.*
  - *Fourth, we worried about using marginal values when the total collapse of some services seemed not only plausible but the driving concern.*
  - *And, fifth, we discussed the issues around whose values these were in a world of very rich and very poor; some powerful, most not; and dominated by western ideas yet also apparently reculturalizing.*

And ultimately, a discussion on how far scientists can go to attract the media's attention

Utilitarian vs. Systemic approaches of the capital(s)

- Shadow prices: substitutability of all capital assets
- Is the conservation of total or inclusive monetary value of all capitals a measurement of sustainability?
- Weak versus Strong sustainability

Ecosystem, economy & finance, two quotations and a few remarks…

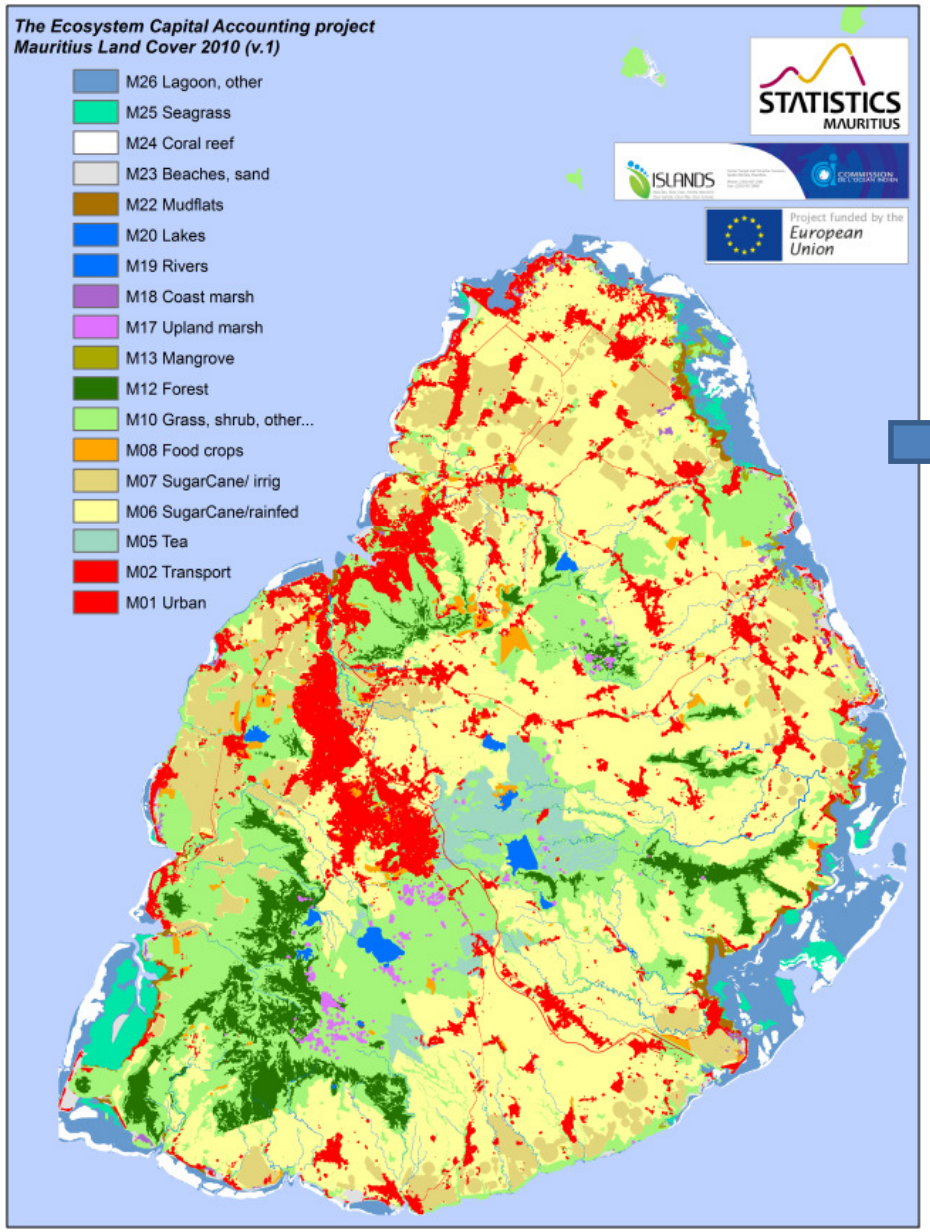
- Bertrand de Jouvenel, 1968: "Because National Accounts are based on financial transactions, they account nothing for Nature, to which we don't owe anything in terms of payments but to which we owe everything in terms of livelihood."
- Wikipedia: "Finance aims to price assets based on their risk level, and expected rate of return."

- We certainly owe nothing (in terms of payments) to Nature, but by degrading biodiversity and the ecosystem capability to produce ecosystem services, we create debts to Nature which are debts towards future generations who lose services or/and will have to restore the ecosystem…
- We create as well debts to the present (and future) generations of those who supply us with commodities obtained by degrading their ecosystem (altogether as the capability of their human capital; see the "fair trade" paradigm…).
- Unlike debts between human which can be repaid or cancelled by mutual agreement, debts to Nature can only be extinct or offset (if possible) by restoration of equivalent ecosystem functions, whatever the monetary cost...
- Ecosystem capital degradation is an unpaid depreciation cost = we don't pay the full cost of our consumption.
- Ecological debts increase the risk level of debtors, public and private; they should be part altogether with private and public conventional debts, of the overall portfolio…
- Ecological debts should be **taken into account(s)** in the international financial and monetary system

The ultimate goal of ecosystem capital accounts (ENCA) is to measure ecological debts (and credits, when ecosystems are enhanced) so that they can be taken into operational mechanisms…

SEEA-ENCA Mauritius preliminary results :

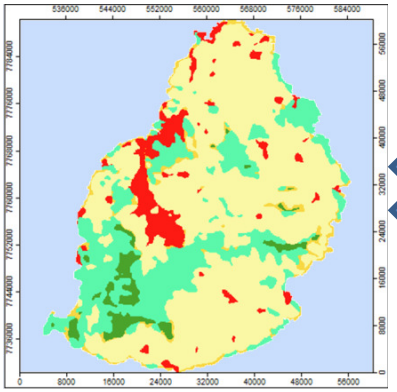
Creation of Ecosystem Accounting Units



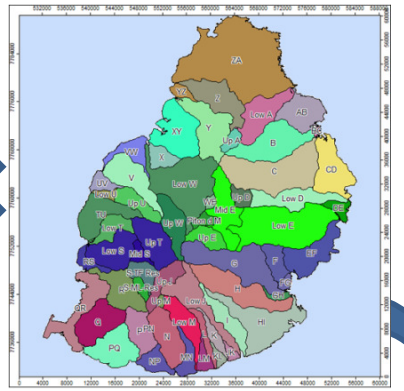
A land cover map has been produced from the start for:

1. **Defining statistical units for accounting (EAU) and**
2. **Computing the land cover account (next slide)**

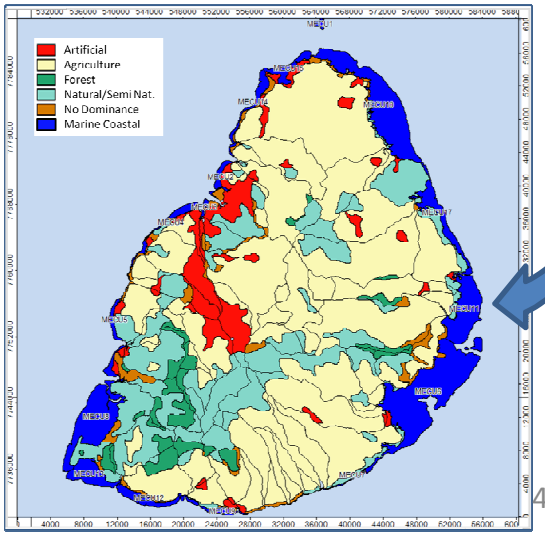
Dominant land cover types (>50%)



River sub-basins

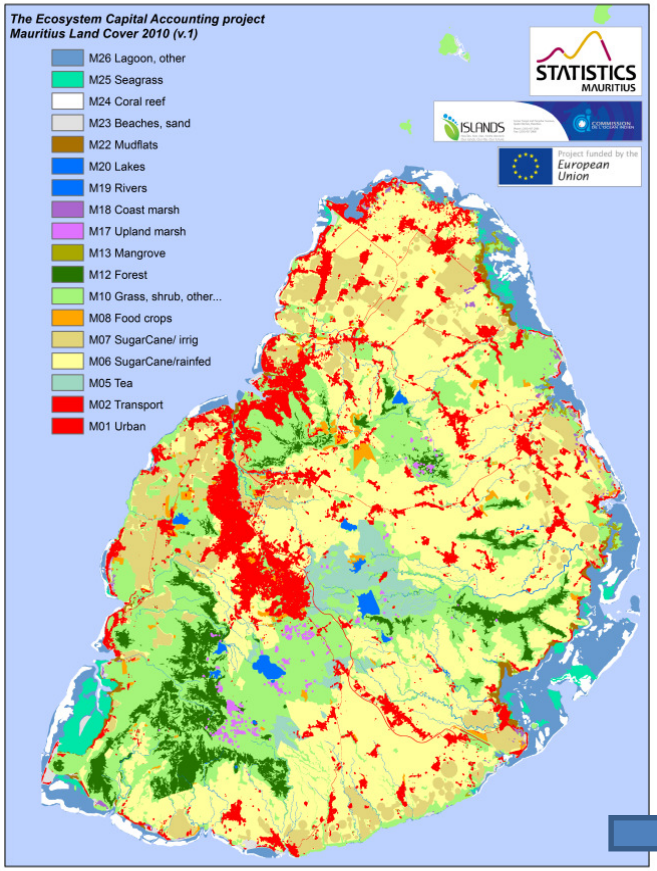


Socio-ecological landscape units (SELU) & Marine Coastal Units (MCU)



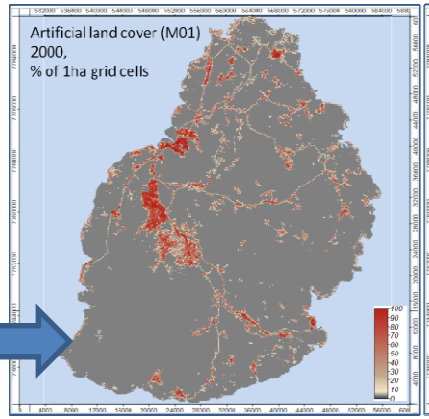
SEEA-ENCA Mauritius preliminary results :

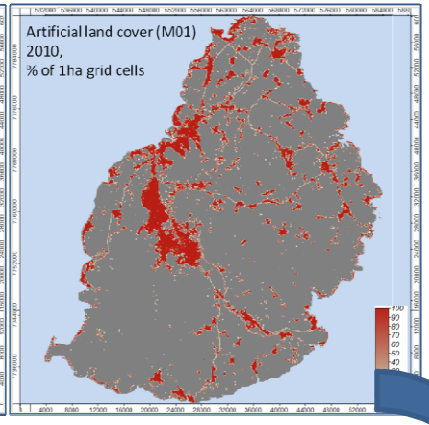
Land cover and change from 2000 to 2010



The land cover data are stored using geographical datasets which use grids (10m x 10m and 100m x 100m) at the most detailed level.

Urban land cover 2000 & 2010





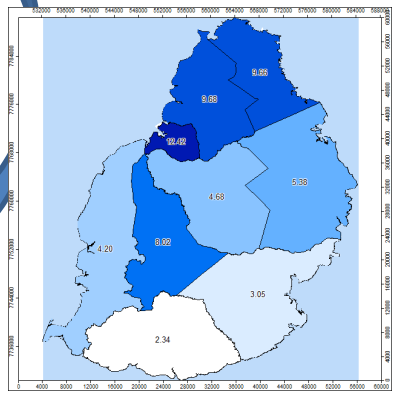
These grids allow computing statistics and producing ecosystems/natural capital accounts for various statistical units such as municipal and village council areas, districts, coastal zones, river basins, socio-ecological landscape units and any relevant zoning.

Land cover stock and change account/ urban sprawl **2000 2010 - km2**

Provisional

	Rivière du Rempart	Pamplemousses	Flacq	Moka	Grand Port	Plaines Wilhems	Black River	Savanne	Port Louis	TOTAL
District AREA SQKM	14703	18019	29826	23512	26134	19839	25558	24758	3976	186325
M01 Urban land cover 2000 v0	747	705	405	282	406	2060	334	266	2667	7872
M01 Urban land cover 2000 v1, adjusted	1225	1172	667	510	549	2456	542	379	3284	10782
lf1 Urban sprawl	478	467	263	228	143	396	208	112	616	2911
M01 Urban land cover 2010	1704	1639	930	738	691	2852	749	491	3900	13693

Urban sprawl 2000-2010 by Districts



SEEA-ENCA Mauritius preliminary results :

The biomass-carbon account

Carbon Accounts show the capacity of the ecosystems to produce biomass and the way it is used by crops harvests and trees removal or sometimes sterilised by artificial developments or destroyed by soil erosion or forest fires (in line with IPCC guidelines).

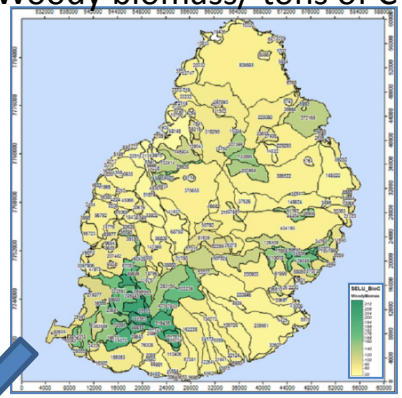
Accounts are compiled using various sources such as products based on earth observation by satellite (e.g. MODIS NPP), on in situ monitoring (for IPCC-LULUCF, FAO/soil, FRA2010) and official statistics .

Simplified bio-carbon accounts by districts, 2010 — **Tons of carbon**

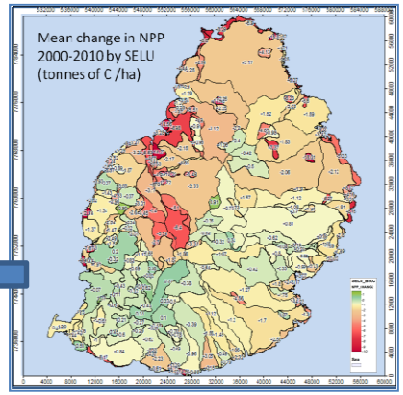
Provisional

2010	Rivière du Rempart	Pamplemousses	Flacq	Moka	Grand Port	Plaines Wilhems	Black River	Savanne	Port Louis	Tot
Initial stock 2010	**1457955**	**2101934**	**4135543**	**4165122**	**2855365**	**3327114**	**3173857**	**3196601**	**432317**	**24845808**
Woody biomass	873403	1137222	2068571	1744337	1796040	1643485	2224653	2409579	265193	**14162483**
Topsoil organic carbon	584551	964712	2066972	2420785	1059325	1683629	949204	787022	167124	**10683324**
Flows/inputs	**335582**	**417954**	**819601**	**675923**	**736068**	**454057**	**642970**	**739278**	**68922**	**4890354**
Net Primary Production	335582	417954	819601	675923	736068	454057	642970	739278	68922	**4890354**
Flows/outputs and decrease	**349143**	**448659**	**870542**	**708508**	**725853**	**481532**	**650835**	**744290**	**74976**	**5054339**
Removals, harvests	65446	90345	108405	56498	90172	35596	87914	81900	1698	**617974**
Wood removals										**0**
Sugarcane	*63718*	*86585*	*104230*	*52531*	*87208*	*31984*	*83773*	*80223*	*912*	**591165**
Food crops	*1727*	*3759*	*4175*	*3656*	*2918*	*3565*	*4141*	*1633*	*786*	**263**
Other cops	*0*	*0*	*0*	*311*	*46*	*46*	*0*	*44*	*0*	**447**
Decrease due to land use change	4102	4761	5762	3629	3240	5216	2881	2290	1388	**33269**
Other decrease (fire, erosion…)	14580	21019	41355	41651	28554	33271	31739	31966	4323	**248458**
Soil/decomposers respiration v2	265016	332534	715020	606730	603888	407449	528301	628133	67567	**4154638**
Net Ecosystem Carbon Balance 1 (flows)	***-13562***	***-30705***	***-50941***	***-32585***	***10215***	***-27475***	***-7865***	***-5012***	***-6054***	**-163985**
Statistical adjustment	16597	28379	33235	15034	-29421	11163	-19714	-15632	6178	**45819**
Net Ecosystem Carbon Balance 2 (stocks)	***3035***	***-2326***	***-17706***	***-17551***	***-19206***	***-16312***	***-27579***	***-20644***	***123***	**-118166**
Final Stock 2010	**1460990**	**2099608**	**4117837**	**4147571**	**2836159**	**3310802**	**3146278**	**3175957**	**432440**	**24727642**
Woody biomass	876438	1134896	2050865	1726786	1776835	1627173	2197074	2388935	265316	**14044318**
Topsoil organic carbon	584551	964712	2066972	2420785	1059325	1683629	949204	787022	167124	**10683324**
Net accessible bio-carbon resource 2010	**73600**	**83094**	**86875**	**51642**	**112974**	**30296**	**87089**	**90500**	**1479**	**617550**
Change in stocks in the previous year	3035	-2326	-17706	-17551	-19206	-16312	-27579	-20644	123	**-118166**
Flows/inputs (+)	335582	417954	819601	675923	736068	454057	642970	739278	68922	**4890354**
Soil/decomposers respiration v2 (-)	265016	332534	715020	606730	603888	407449	528301	628133	67567	**4154638**
Index of intensity of use of bio-carbon 2010	**112**	**92**	**80**	**91**	**125**	**85**	**99**	**111**	**87**	**100**

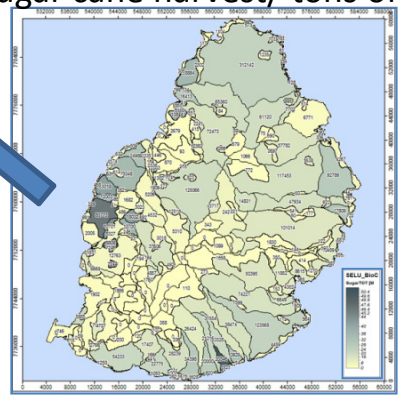
Woody biomass/ tons of C



Change in NPP/ tons of C



Sugar cane harvest/ tons of C

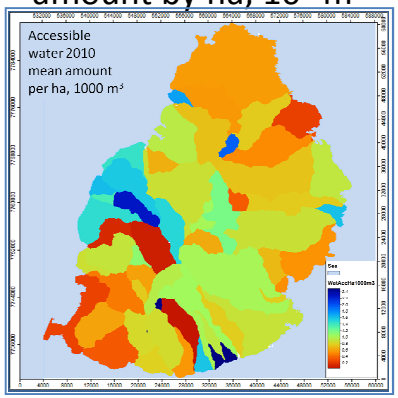


SEEA-ENCA Mauritius preliminary results :

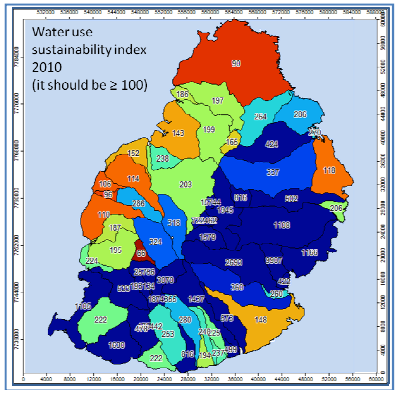
The ecosystem water account

The ecosystem water accounts follows the SEEA Water methodology and use preliminary results of the national water accounts. They are detailed by river basins and sub-basins where the hydrological system can be described consistently. Stocks of water are mainly aquifers and lakes/reservoirs, which play important role in Mauritius. Data have provided by the meteorological and water agencies. Water use by sub-basins is estimated from population census data and irrigation map. Satellite products have been used for evapotranspiration. The outcome is the calculation of the water really accessible for use and of an index of stress from water use intensity.

Accessible water, mean amount by ha, 10^3 m^3



Water use intensity stress index (stress when <100)



Simplified water accounts by Districts, 2010 — **Mm3**

Provisional

2010	Rivière du Rempart	Pamplemousses	Riviere	Moka	Grand Port	Plaines Wilhems	Black River	Savanne	Port Louis	Total
AREA_ha	*14703*	*18019*	*29826*	*23512*	*26134*	*19839*	*25558*	*24758*	*3976*	*186325*
Boreholes_nb	*105*	*164*	*100*	*83*	*110*	*146*	*131*	*30*	*12*	*881*
River runoff districts coeff	*35*	*20*	*150*	*150*	*100*	*100*	*80*	*100*	*20*	*755*
Lake 2010 ha	*0*	*103*	*0*	*468*	*41*	*511*	*109*	*19*	*0*	*1251*
Stocks	**3345**	**5231**	**3189**	**2681**	**3510**	**4687**	**4183**	**961**	**383**	**28170**
Aquifers	3343	5222	3184	2643	3503	4649	4171	955	382	28052
Lakes/reservoirs	0	7	0	32	3	35	7	1	0	86
Rivers	2	2	5	6	5	3	4	4	1	32
Soil/vegetation										
Net Inflows	**75**	**176**	**292**	**342**	**355**	**293**	**155**	**353**	**12**	**2052**
Rainfall	173	236	579	633	629	484	302	603	49	3688
EvapoTranspitation (actual), total	155	199	367	290	338	224	308	326	40	2247
EvapoTranspitation (actual), spontaneous	109	115	310	268	294	207	167	269	40	1779
Net transfers surface - groundwater	11	14	23	18	20	15	20	19	3	143
Transfers between basins		41		-41						0
Abstraction and Uses	**63**	**109**	**80**	**36**	**63**	**83**	**152**	**69**	**23**	**678**
Municipal Water Production	17	23	23	13	18	64	11	11	22	202
Use of water	*8*	*12*	*11*	*7*	*9*	*32*	*5*	*6*	*11*	*101*
Loss of water in distribution	*8*	*12*	*11*	*7*	*9*	*32*	*5*	*6*	*11*	*101*
Irrigation	46	85	57	22	44	17	141	57	0	468
Other	1	1	1	1	1	3	0	0	1	8
Waste water to rivers	**6**	**8**	**8**	**5**	**6**	**22**	**4**	**4**	**8**	**70**
Outflow to the sea	**78**	**46**	**324**	**318**	**217**	**212**	**172**	**213**	**50**	**1632**
Rivers runoff	74	42	318	318	212	212	170	212	42	1602
Waste water to the sea	4	4	6	0	5	0	2	1	8	30
Induced ETA, Evaporation	**46**	**85**	**57**	**22**	**44**	**17**	**141**	**57**	**0**	**468**
Net Flows	-103	-52	-156	-29	41	2	-304	19	-46	-626
Closing stocks	**3242**	**5179**	**3034**	**2652**	**3551**	**4690**	**3879**	**980**	**337**	**27544**
Accessible renewable water	**83**	**124**	**217**	**200**	**219**	**187**	**228**	**213**	**36**	**1507**
Water use intensity (1): Average/ha	**132**	**114**	**270**	**561**	**345**	**224**	**150**	**310**	**155**	
Water use intensity (2): 1st decile	**90**	**90**	**118**	**203**	**148**	**114**	**110**	**222**	**143**	

SEEA-ENCA Mauritius preliminary results :

The functional services account (depending from integrity and biodiversity)

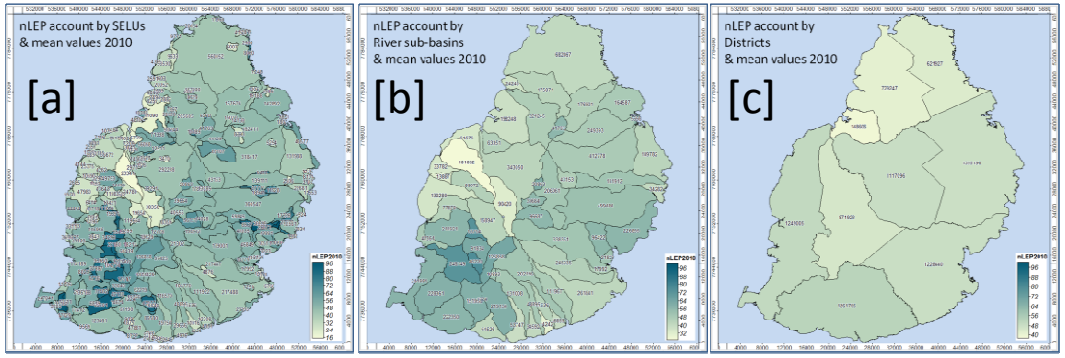
The biodiversity of systems and species account is made of two accounts which describe the state of ecosystems green infrastructure (landscapes, rivers and sea coastal zones) on the one hand and changes in species biodiversity on the other hand.

The NLEP index combines the green character of ecosystems and their fragmentation by roads which may alter their good functioning. Land cover is then weighted with NLEP.
Highest NLEP values can be found where forests, shrubs, grass and natural habitats are predominant, in particular in mountainous and land coastal areas. Low NLEP values correspond to urbanised areas and intermediate score reflect agriculture dominated catchments.

Green Infrastructure Accounts

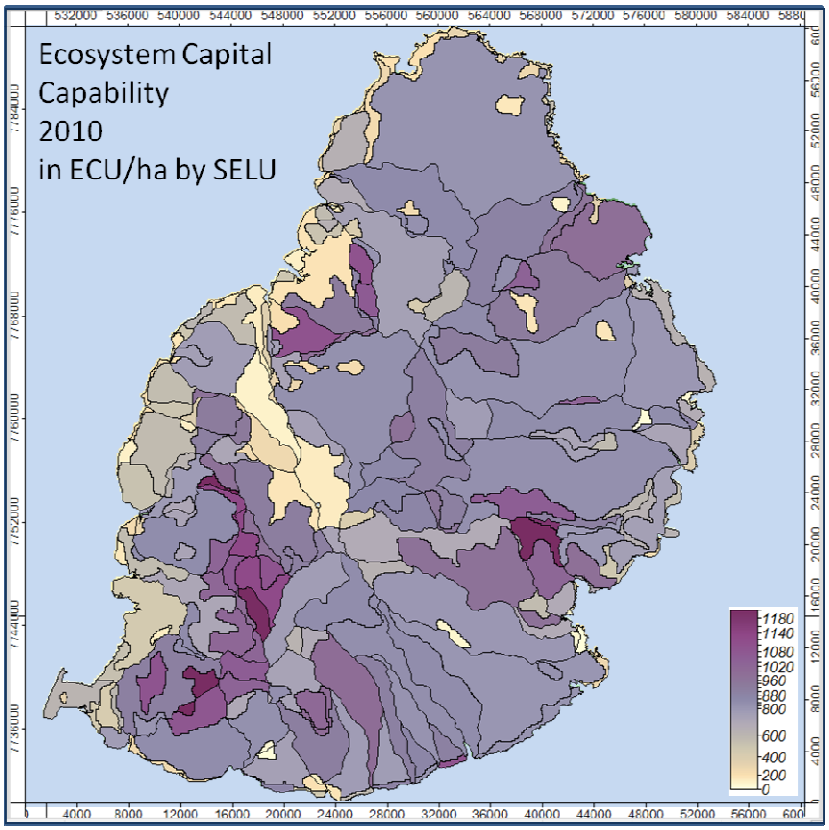
Provisional	*Riviere du Rempart*	*Pamplemousses*	*Flacq*	*Moka*	*Grand Port*	*Plaines Wilhems*	*Black River*	*Savanne*	*Port Louis*	**Total** */ Mean values*
AREA_ha	14703	18019	29826	23512	26134	19839	25558	24758	3976	186325
Indexes (0-100 value per ha)										
GBL 2000 index	*43.4*	*41.7*	*49.7*	*55.6*	*50.1*	*53.4*	*61.0*	*53.7*	*58.6*	*51.9*
Fragmentation index	*8.6*	*9.8*	*7.3*	*6.2*	*6.9*	*7.9*	*5.1*	*5.1*	*6.9*	*6.9*
nLEP 2000 index	*39.7*	*37.6*	*46.0*	*52.1*	*46.6*	*49.2*	*57.9*	*51.0*	*54.5*	*48.4*
Green Infrastructure Account										
GBL 2000 / weighted ha	638105	751152	1481482	1307506	1309039	1060139	1559660	1330151	232911	9670145
nLEP 2000 / weighted ha	583021	677761	1373059	1226033	1218167	976061	1479992	1262700	216727	9013521
Indexes (0-100 value per ha)										
GBL 2010 index	*42.0*	*40.6*	*49.2*	*55.1*	*49.8*	*52.4*	*60.5*	*53.5*	*50.7*	*51.1*
Fragmentation index	*8.6*	*9.8*	*7.3*	*6.2*	*6.9*	*7.9*	*5.1*	*5.1*	*6.9*	*6.9*
nLEP 2010 index	*38.4*	*36.7*	*45.6*	*51.6*	*46.4*	*48.2*	*57.4*	*50.8*	*47.2*	*47.7*
Green Infrastructure Account										
GBL 2010 / weighted ha	617999	732184	1468542	1294945	1301938	1039397	1547086	1324150	201660	9527900
nLEP 2010 / weighted ha	564651	660647	1361066	1214254	1211558	956963	1468060	1257003	187648	8881851
Change in nLEP 2000-2010	**-18370**	**-17114**	**-11993**	**-11779**	**-6608**	**-19097**	**-11932**	**-5697**	**-29079**	**-131670**
Change in nLEP index % 2000-2011	**-3.2**	**-2.5**	**-0.9**	**-1.0**	**-0.5**	**-2.0**	**-0.8**	**-0.5**	**-13.4**	**-1.5**

Net Landscape Ecosystem Potential (NLEP) 2010 by SELU [a], River basins [b] and Districts [c]

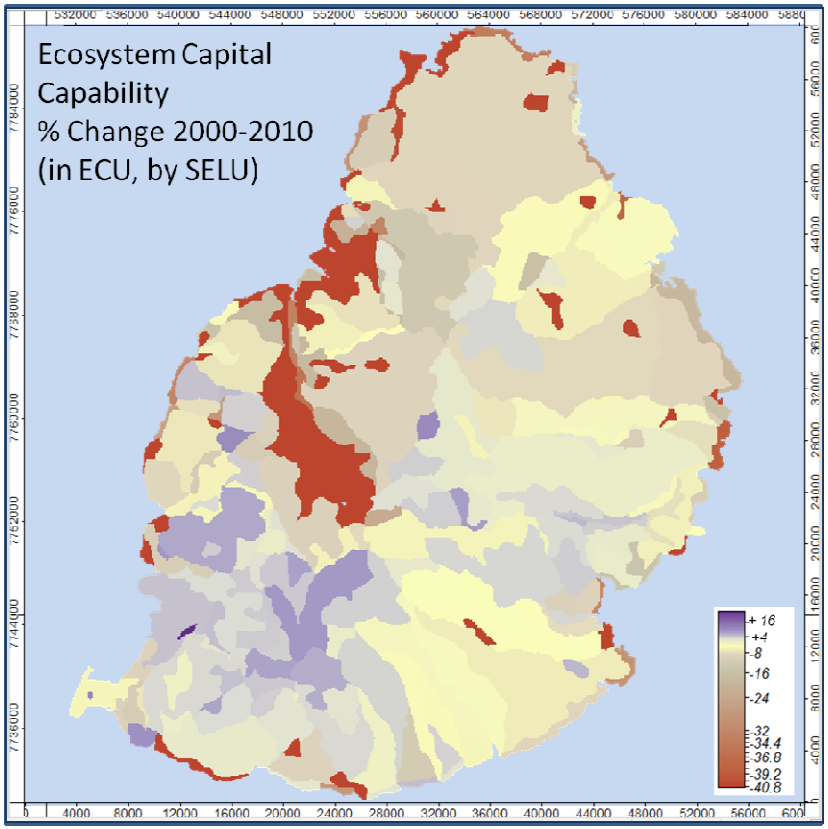


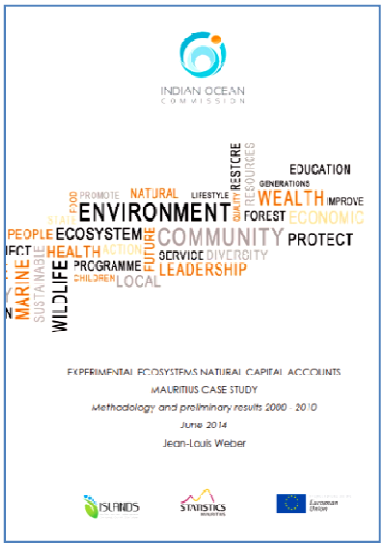
A first attempt to calculate Ecosystem Capital Capability (in ECU) for Mauritius

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

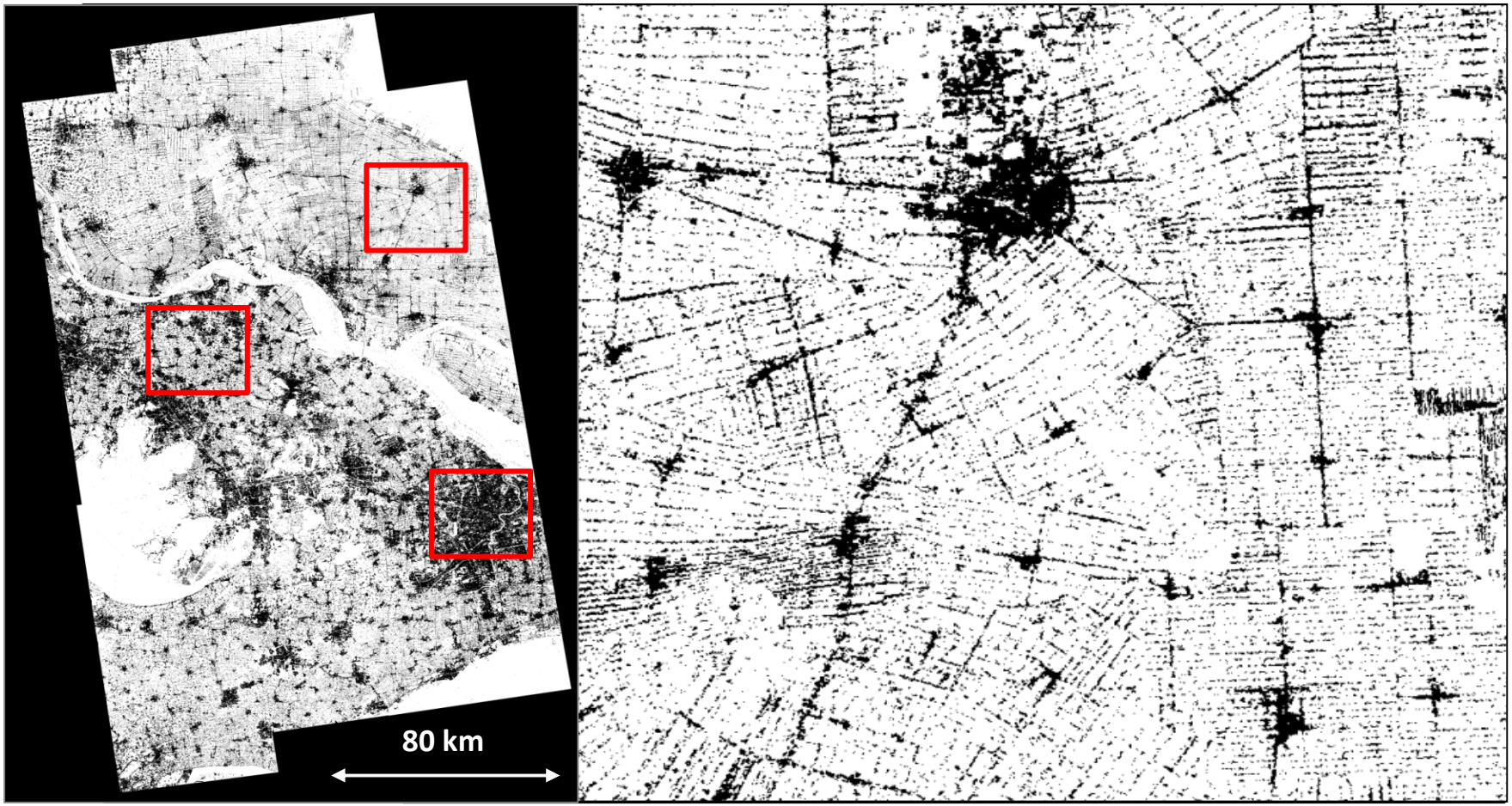




Provisional results

Experimental ENCA,
Mauritius Case Study (IOC, 2014)

Global Urban Footprint – Shanghai (China)



Urban Footprint