DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
STATISTICS DIVISION
UNITED NATIONS

Ninth Meeting of the UN Committee of Experts on Environmental-Economic Accounting
New York, 25-27 June 2014

8. Towards a medium-term programme of work for the SEEA-Experimental Ecosystem Accounting

Panel discussion on country experiences in ecosystem accounting

Presentation of Mauritius pilot study 2013 on experimental ecosystem natural capital accounts

Jean-Louis Weber

Consultant

The project partners

Indian Ocean Commission

Islands Project on the implementation of the 2005 Mauritius Strategy (MS) for the Sustainable Development of Small Island Developing States (SIDS). Funded by EU/ EuropAid

Maurice **I**le **D**urable
Mauritius Sustainable Island Commission
(Prime Minister Office)

Supervision of tests + data supply + future implementation

The project background

- **Clear policy demand:**
  - **International:** The Programme of Action for the Sustainable Development of Small Island Developing States adopted in Mauritius, 2005 (the Mauritius SD Strategy) and its implementation by the Indian Ocean Commission
  - **National**: well identified SD issues, "green growth", "blue growth", "green economy", fast change in sugar cane agriculture, tourism, urban sprawl, degradation of lagoon fisheries and coral reefs...
  - **Natural Capital/Ecosystem Accounting**: a demand by the Ministry of Finance and Economic Development and MID, the "Maurice Ile Durable" Commission, to the Indian Ocean Commission (Islands Project, EU/EuropAid funding).

- **UNFCCC/IPCC reporting** (Meteo Services, with SM), National GHG inventory report of the Republic of Mauritius 2000-2006 (2010).

- **Tradition in environmental statistics** (a statistician based in the Ministry of Environment, a statistician member of the FDES revision group...)

- **Environment-Economic Accounts, 2002 – 2009, Statistics Mauritius (SM),** covering 'Energy Use and Atmospheric Emissions' for the period 2002 to 2009, 'Water Use' for years 2002 and 2007 and 'Economy-wide Material Flow Accounts (MFA)' covering period 2005 to 2009 (UNDP + support). Update of SEEA-water accounts in 2013 (UNSD mission).

The project implementation

- **First phase (2013):** Inception (with MID, IOC and SM), visit to 12 organisations, collection of data and statistics (with strong support from SM), two "training" sessions (presentation of the methodology), two stakeholders meetings (data requirements, the way forward...), creation of the database for accounting, production of preliminary accounts, production of a first detailed action plan.

- **Intermediate period:** presentation of results at the UNEP VANTAGE Conference in Nairobi Dec. 2013, at UNEP Workshop on the draft guidelines for ecosystem services valuation and accounting in SIDS (New York, Feb. 2014); policy meetings in Mauritius and decision to create a special unit for environment accounting within SM.

- **Second phase (May-June 2014):** Installation of the Steering Committee (Chaired by MID), preparation of a specific action on land cover mapping (MID, Ministry of Finance, Ministry of Environment and Agence Française de Développement), data transfer and (first) technical training of staff in the SM new unit, revision of the 2013 draft report in view of publication by IOC of a report on preliminary ecosystem natural capital accounts for Mauritius; drafting of ToR for land cover mapping and accounts; and...
- **revision of the 2013 action plan** for Mauritius 3rd phase: consolidation and completion of first core accounts, development of cases studies for coastal zones/ tourism/ recreation/ fisheries; medium term capacity development, technical training of staff (ecosystem accounting, GIS, database management etc...); preparation of the extension to other IOC countries.

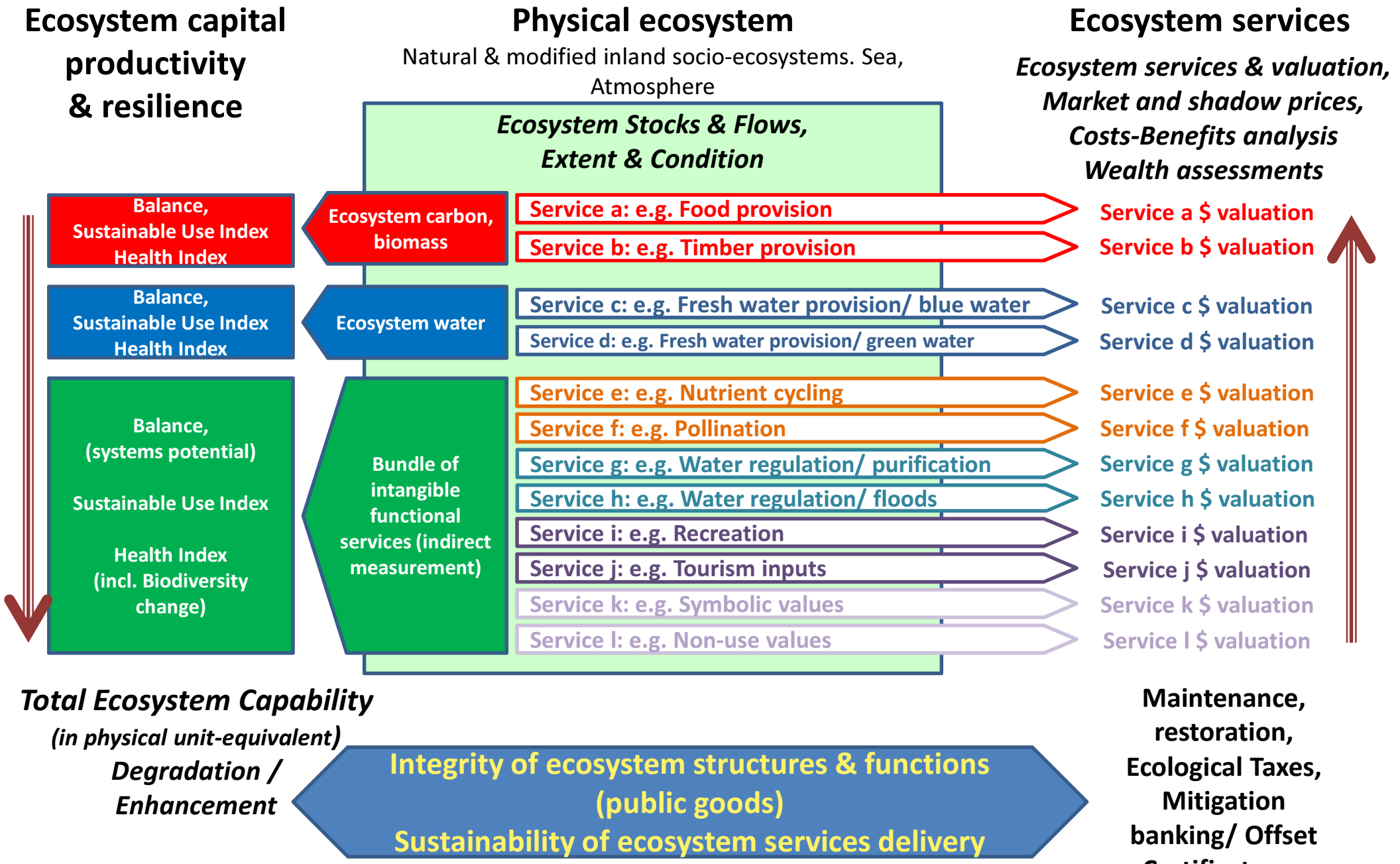
Conclusions

- **Integrated ecosystem natural capital accounts are feasible** in Mauritius with existing data which are available in the country or/and from international programmes. NB Land cover change requires specific investment at early stage. Simplified accounts can be produced (rather) quickly and deliver relevant results; their accuracy can be improved in subsequent steps on the basis of the data gaps identified in the first test – and additional data collection.
- **The cost of IT investments is no more an issue**; performing freeware can be used as well as commercial software packages – and cloud computing has started to propose solutions and deliver products from the web.
- **Staffing & training (in statistics and accounting, data management, GIS applications) are the main capacity building issues (need 2 to 3 staff in the central unit + correspondents in partner organisations). External technical support to implementing agencies is needed for the creation of the first database (typically annual accounts 2000-2012)**
- Institutional cooperation between the various agencies holding data and knowledge is essential. Creation of a **shared environmental information system** is recommended.
- **The implementation of integrated physical accounts should facilitate further work on assessment, modelling and valuation of ecosystem services** (*today, data collection alone represents up to 80% of the cost of most environmental studies*)

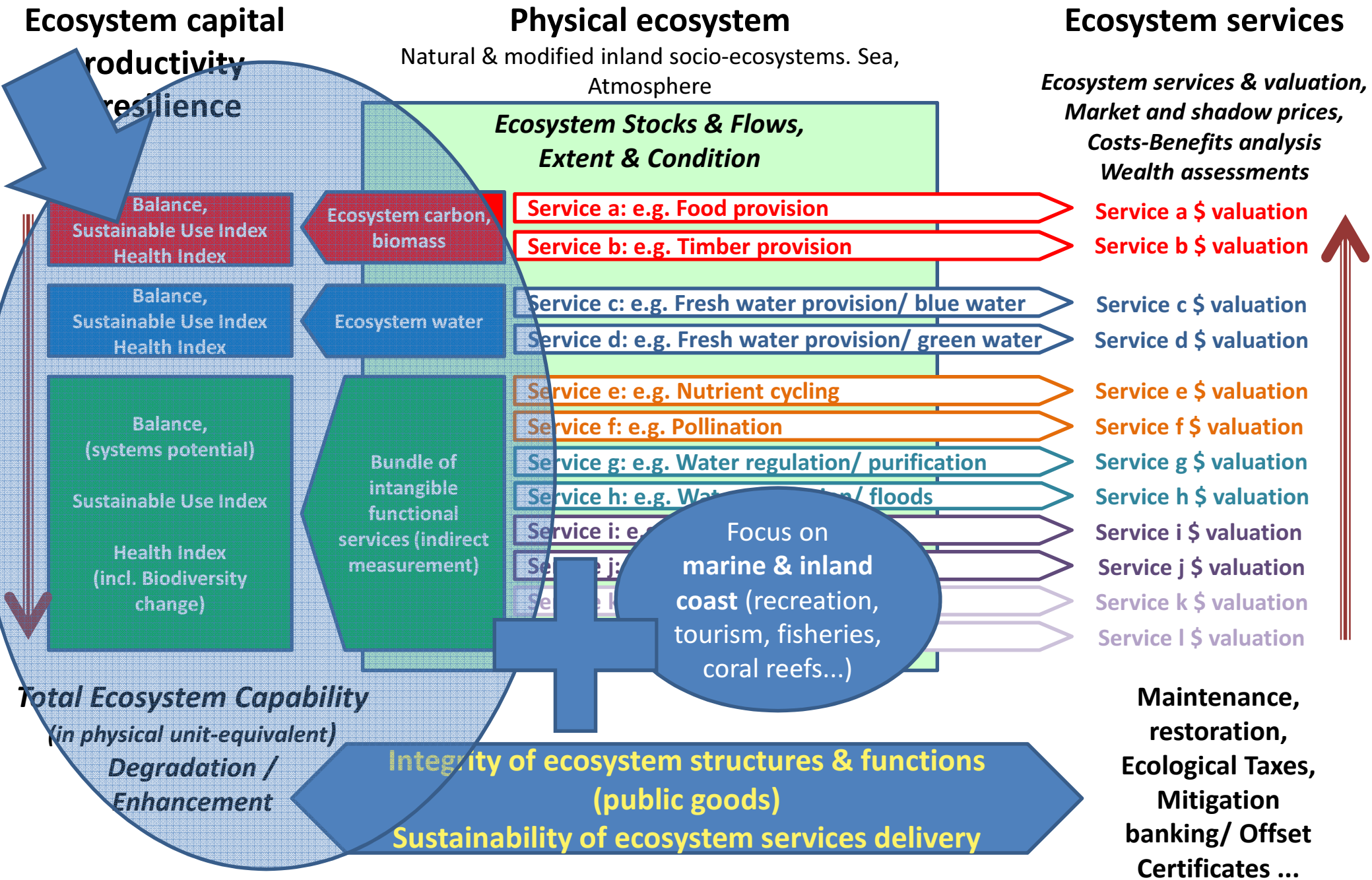
Ecosystems/Natural Capital Accounts of Mauritius: Results of the Pilot Study 2013

- Context: Mauritius Sustainable Development Strategy, “Maurice Ile Durable”
- Support: Indian Ocean Commission, European Union
- An experimentation of SEEA-Experimental Ecosystem Accounting
- Operator: Statistics Mauritius
- Contributors: more than 10 public organisations
- Duration: over a 7 months period, the equivalent of 5 man-months all in all (consultant + national statistician)
- Preliminary results…

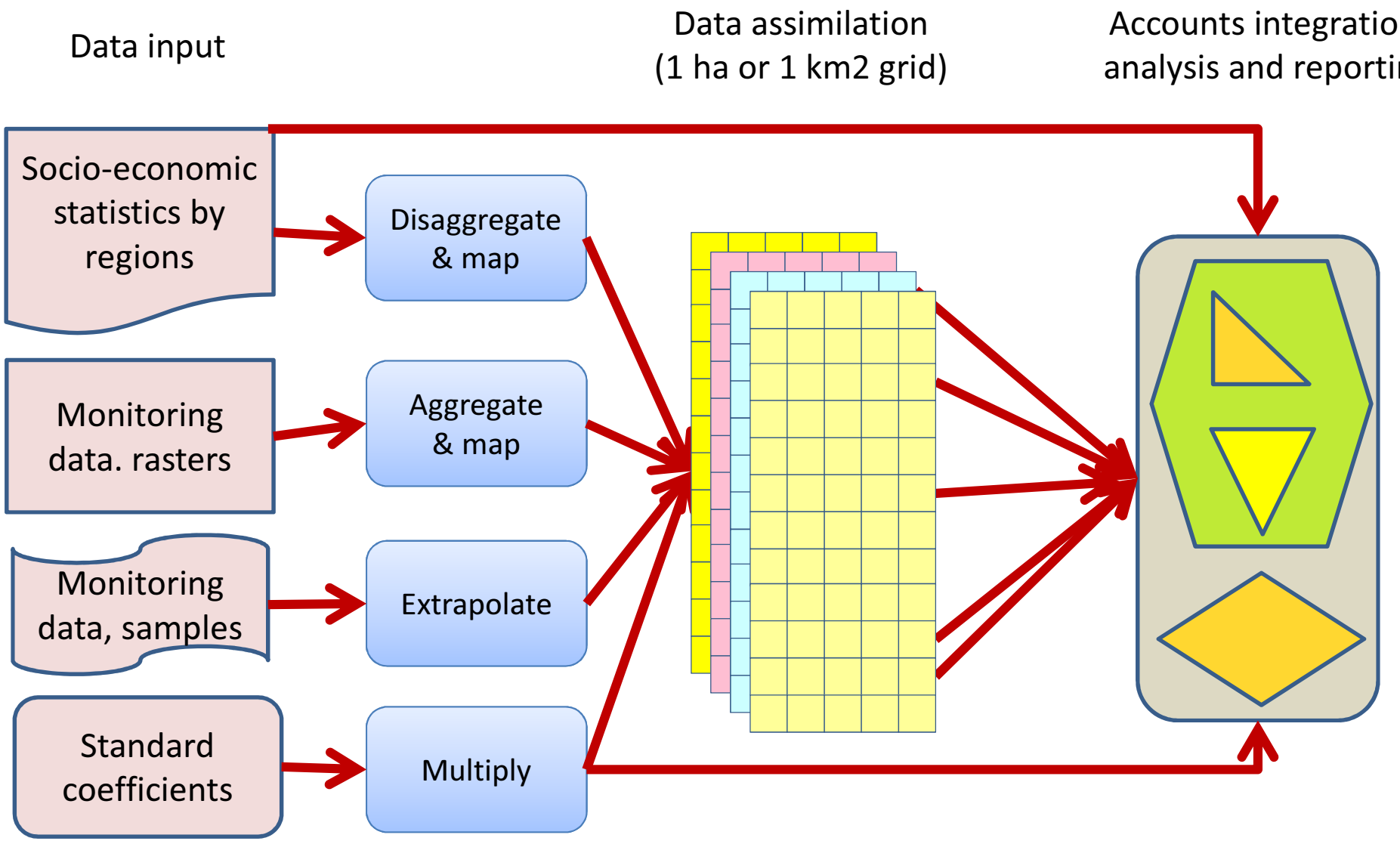
Two possible approaches to ecosystem accounting



Two possible approaches to ecosystem accounting



Main data flows to compile ecosystem natural capital accounts

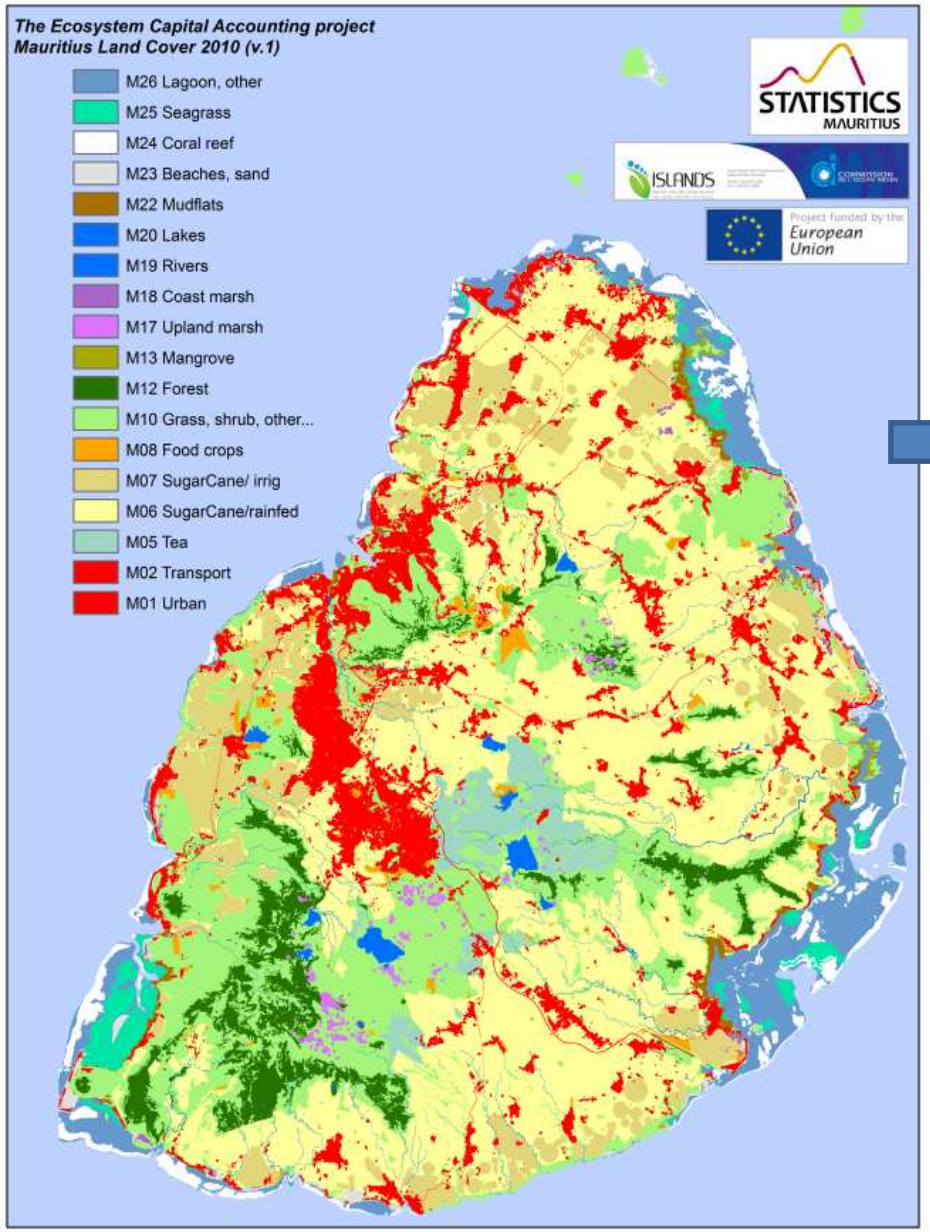


SEEA-ENCA Mauritius preliminary results :

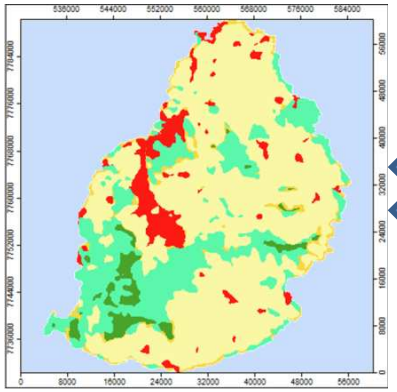
Creation of Ecosystem Accounting Units

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

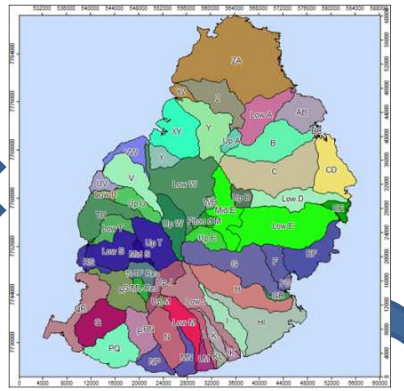
1. **Defining statistical units for accounting (EAU) and**
2. **Computing the land cover account (next slide)**



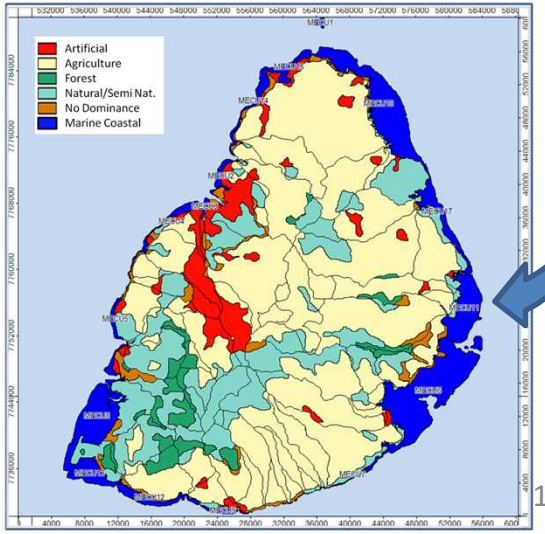
Dominant land cover types (>50%)



River sub-basins

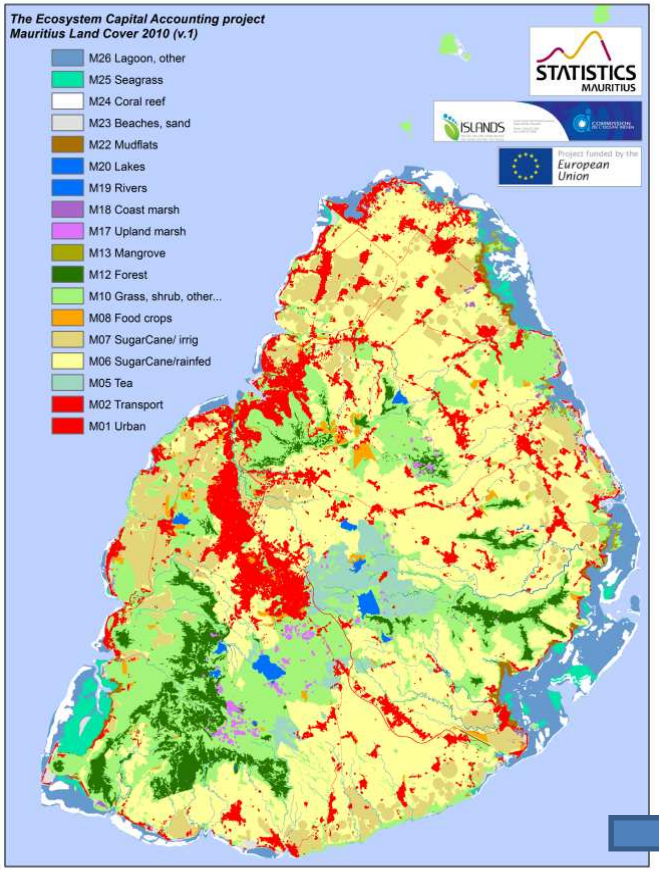


Socio-ecological
landscape units (SELU)
&
Marine Coastal Units (MCU)



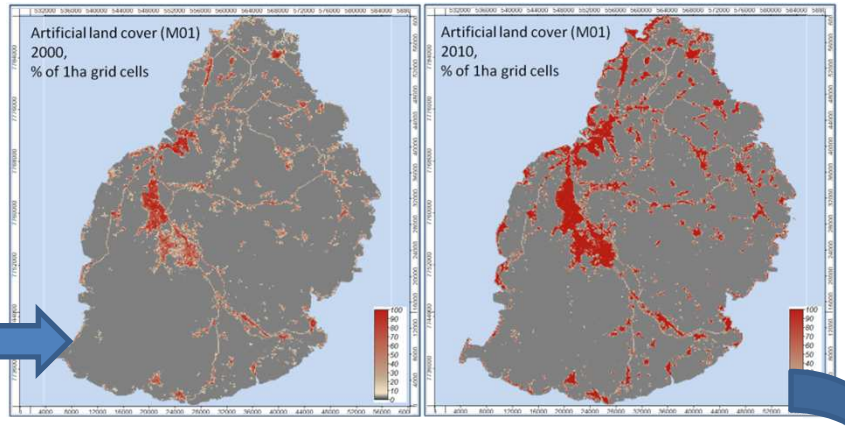
SEEA-ENCA Mauritius preliminary results :

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

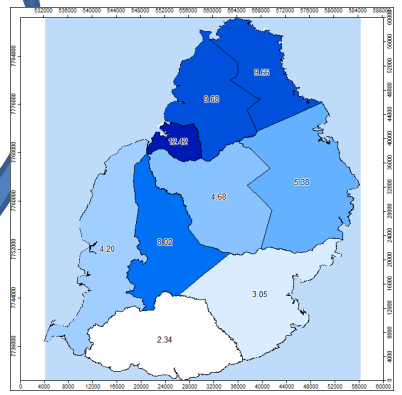


These grids allow computing statistics and producing ecosystems/natural capital accounts for various statistical units such as municipal and village council areas, districts, coastal zones, river basins, socio-ecological landscape units and any relevant zoning.

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).

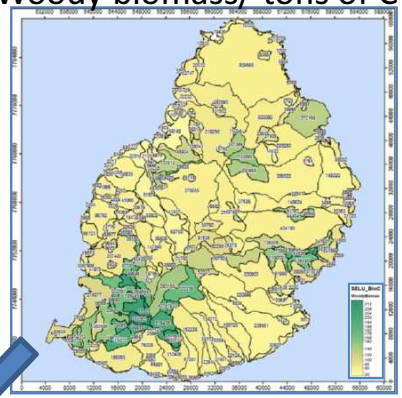
Accounts are compiled using various sources such as products based on earth observation by satellite (e.g. MODIS NPP), on in situ monitoring (for IPCC-LULUCF, FAO/soil, FRA2010) and official statistics .

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

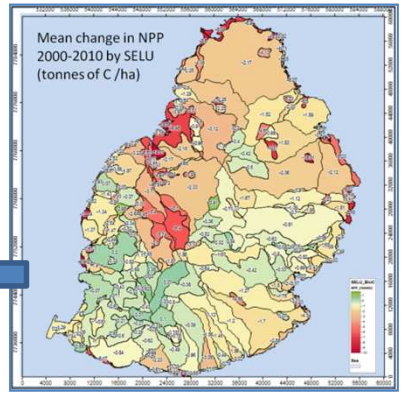
Provisional

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**	**24845**
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**

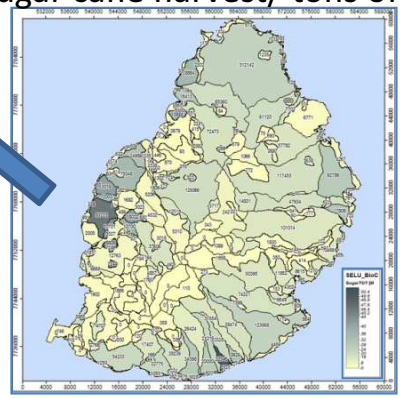
Woody biomass/ tons of C



Change in NPP/ tons of C



Sugar cane harvest/ tons of C

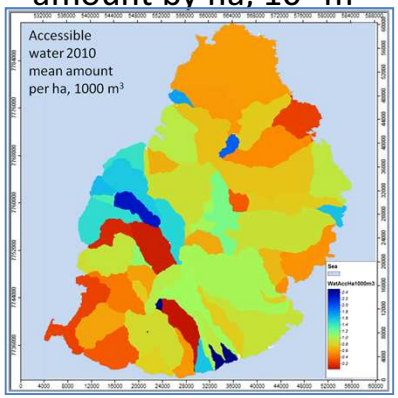


SEEA-ENCA Mauritius preliminary results :

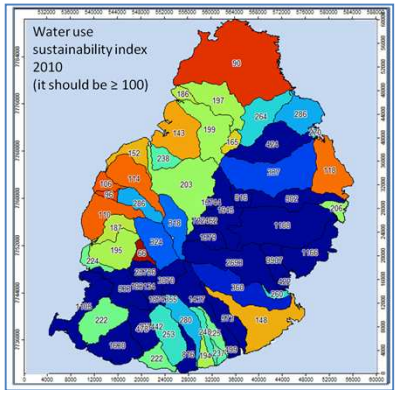
The ecosystem water account

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	Flacq	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)

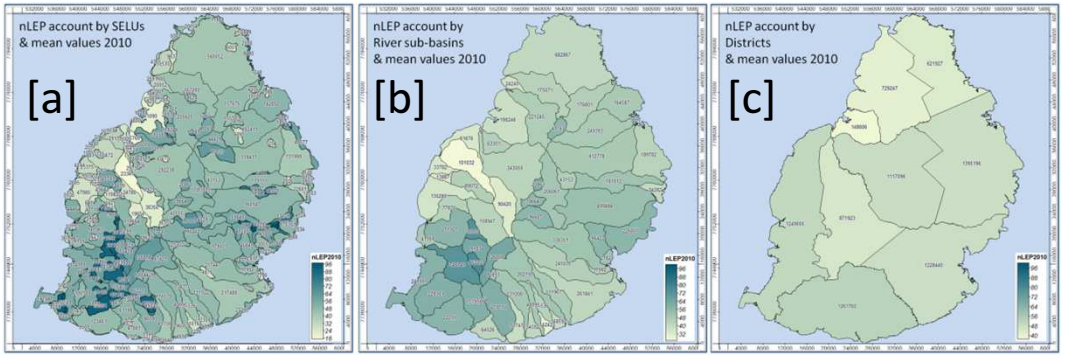
The biodiversity of systems and species account is made of two accounts which describe the state of ecosystems green infrastructure (landscapes, rivers and sea coastal zones) on the one hand and changes in species biodiversity on the other hand.

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

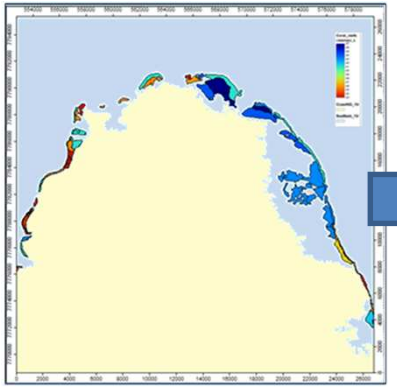
Provisional	*Riviere du Rempart*	*Pamplemousses*	*Flacq*	*Moka*	*Grand Port*	*Plaines Wilhems*	*Black River*	*Savanne*	*Port Louis*	**Total** / *Mean values*
AREA_ha	14703	18019	29826	23512	26134	19839	25558	24758	3976	186325
Indexes (0-100 value per ha)										
GBL 2000 index	*43.4*	*41.7*	*49.7*	*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]

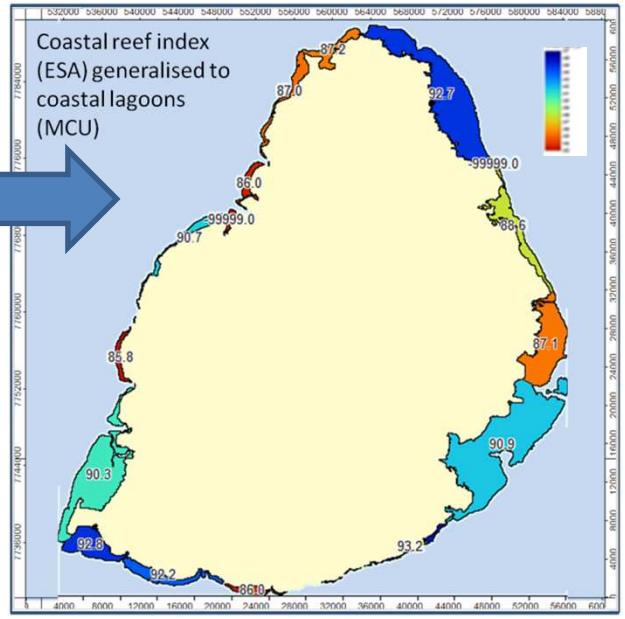


SEEA-ENCA Mauritius preliminary results :
the Sea Coastal Ecosystems test account

Coastal ecosystems play important role in Mauritius and a test has been done in a domain where little practical accounting experience exists. The methodology for land ecosystems has been extended to the lagoons for which ecosystem accounting units (EAU) have been defined and mapped . A test account of been produced using the inventory of "Environmentally Sensitive Areas", using the indicator of coral reefs vulnerability, on the one hand and urban pressure on coastal ecosystems on the other hand .The conclusion is that the SEEA-ENCA methodology can be implemented in full.



Coral reefs vulnerability index (ESA project)



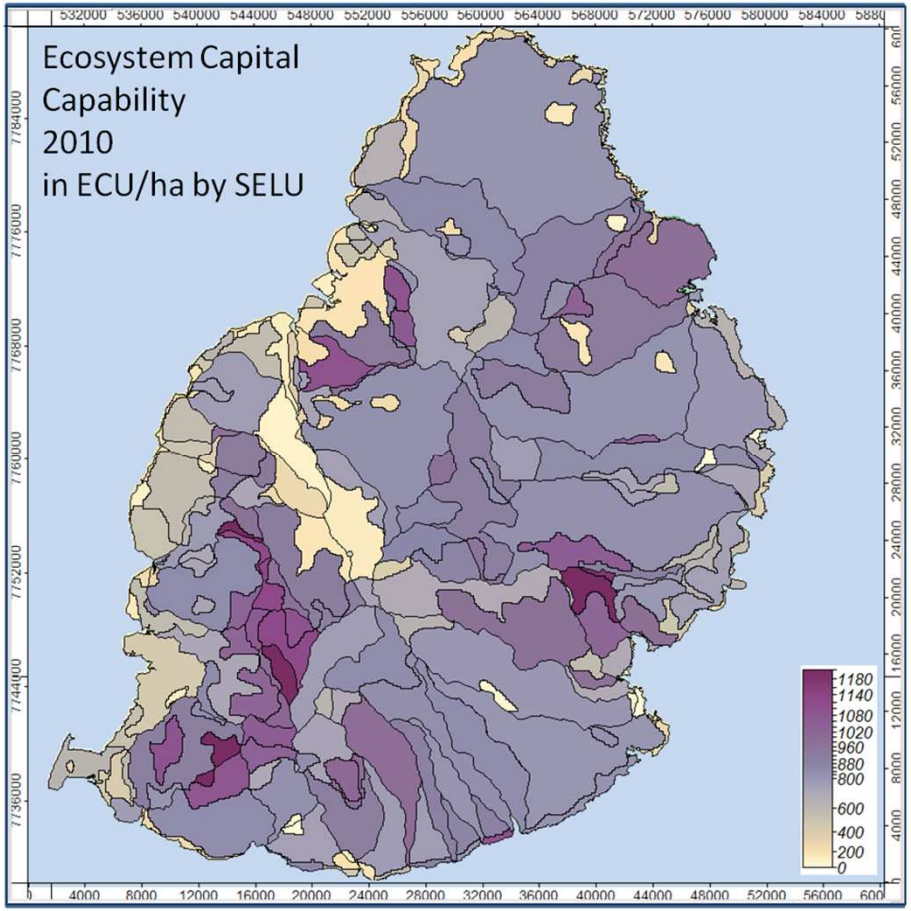
Sea Coastal Units
Biodiversity test account, stock 2010

Provisional

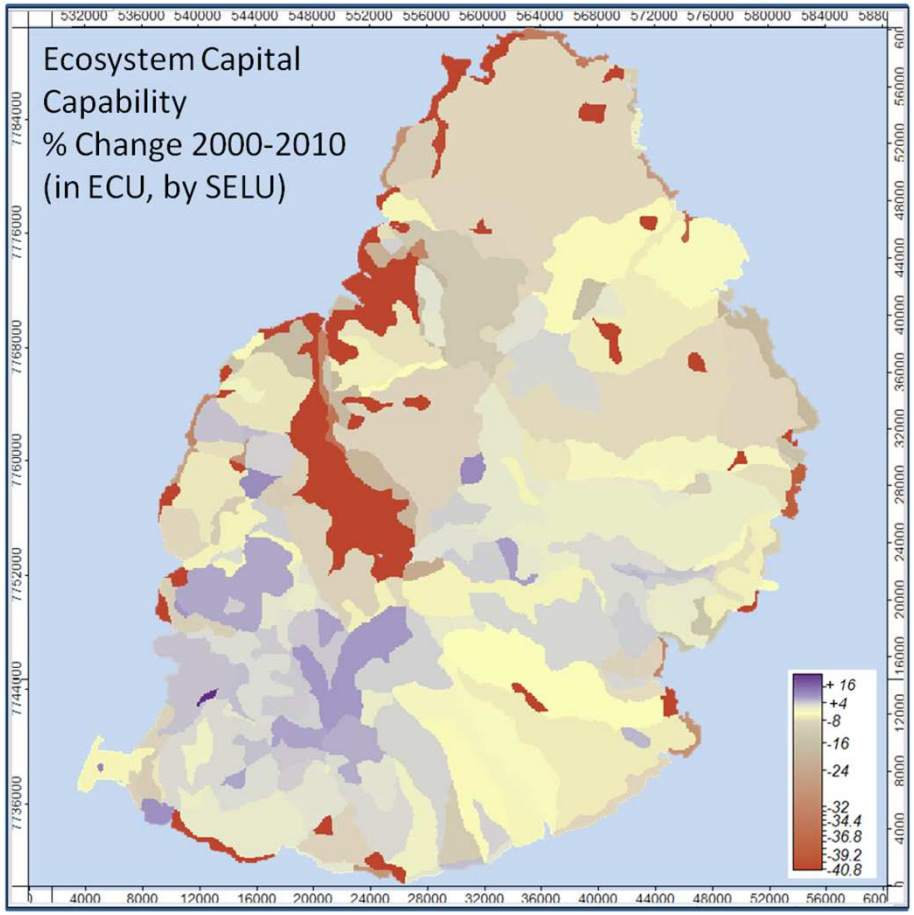
B - Sea Ecosystem Coastal Units / Only for test with coaral reefs vulnerability index; 2000 = 100.										
Coral_reefs area ha	2222	658	1472	No coast	2167	No coast	1821	814	No reef	9154
Conventional coral reef stock (bio-carbon not available)= ha x 10	22220	6580	14720	No coast	21667	No coast	18210	8143	No reef	91540
SECU/ Lagoons area ha	61009	13244	45083	No coast	46136	No coast	45952	14540	537	226501
Coral_reefs Index 2000	100	100	100	No coast	100	No coast	100	100	100	
Coral_reefs Index 2010	92	87	88	No coast	91	No coast	91	94	100	
SECU/ Lagoons capability/coral reefs, 2000	2222000	658000	1472000		2166700		1821000	814300		9154000
SECU/ Lagoons capability, coral reefs 2010	2050327	570745.8	1291775.3		1975381.6		1653196.5	766500.99		8307927
Net change in Laggos Ecosystem Capability 2000-2010, in ECU, v0	-171673	-87254	-180225	0	-191318	0	-167803	-47799	0	-846073
Net change in lagoons Ecosystem Capability 2000-2010, in ECU, % v0	**-7.7**	**-13.3**	**-12.2**		**-8.8**		**-9.2**	**-5.9**		**-9.2**

Ecosystem capital capability and change

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

Summary: 5 steps for implementing ecosystem natural capital accounts

Objective	*Datasets/ Accounts*	*Tasks to the accountant*
Step 1: Create the data infrastructure needed for accounting		
Collect reference geographical datasets and create the database of Ecosystem Accounting Units	Geographical features/zonings • Physical boundaries (coastline, river basins & sub-basins limits, climate zoning, elevation classes) • Administrative boundaries (municipalities, districts, regions) • Transport network • Hydrological network, rivers, aquifers • Sea/fisheries zoning(s) Regular grid(s) for accounting (1 ha and 1 km^2)	*Collect from relevant organisations the basic geographical layers which will structure the physical accounts. Check their consistency (geometry, projection). Produce a set of regular grids (based on official geographical standards).* *Create the database of **Ecosystem Accounting Units** for terrestrial ecosystems, rivers, marine coastal units and other sea accounting units* *(NB: requires land cover map for the baseline year)*
Step 2: Collect the basic datasets		
Collect the basic datasets for ecosystem natural capital accounting: monitoring data and statistics	• Land cover change (including marine coastal areas) • Meteorological data • Hydrological data • Soil data • Data on forest stocks and growth • Population data • Regular agriculture, forestry and fishery statistics • Data/statistics on water use • Indicators on species and systems biodiversity	*Produce a consistent multi-annual (10 to 20 years period) land cover map/database using satellite images and other sources available (forest maps, cadastre, buildings and roads…).* *Collect and organise the various sets of data needed for accounting. Official data sources are given priority: official statistics, meteorological data, hydrological data… where available, accounts produced for IPCC reporting, REDD+, SEEA Water… are important inputs. Satellite data sometimes as second best.*

Summary: 5 steps for implementing ecosystem natural capital accounts

Objective	*Datasets/ Accounts*	*Tasks to the accountant*
Step 3: Produce the core accounts		
Produce the core ecosystem natural capital accounts, measure total ecosystem capability, assess degradation or enhancement	• Land cover change account • Ecosystem carbon account • Ecosystem water account • Ecosystem integrity and functional services accounts • Ecosystem overall capability account (including exchanges between ecosystems)	*Compile the accounts with basic data collected at step 2, additional data for specific items and physical data modelling. Geo-process datasets. Estimate of missing data. Integrate of the accounts.*
Step 4: Functional accounts in physical units		
Functional analysis of ecosystem capital and services in physical units	• Accountability of economic sectors to ecosystem capital degradation /enhancement • Ecosystem degradation embedded into trade • Ecological Balance Sheet (in ECU) • Social demand for ecosystem services (by ecosystem units, municipalities, regions…)	*Targeted, detailed analysis to be carried out with statistical offices, planning agencies, environment agencies, research sector…* *Compilation of the ecological balance-sheet* *Mapping and assessing ecosystem services*
Step 5: Functional accounts in monetary units		
Functional analysis of ecosystem capital and services in monetary units: measurement of unpaid degradation costs; valuation of ecosystem services	• Unpaid remediation costs: Accountability of economic sectors to ecosystem capital degradation /enhancement • Ecosystem degradation embedded in trade • Ecological Balance Sheet in money • Adjustment of the Final Demand from unpaid costs • Monetary value of key ecosystem services • Total (direct and indirect) value added induced by ecosystem services (agriculture, forestry, fishery, water, tourism…)	*Economic analysis of remediation costs (restoration works, alleviation, opportunity costs of reducing pressure on ecosystems…).* *Economic analysis of ecosystem services monetary value.* *Input/Output analysis of Value Added induced by ecosystem services; sustainability assessment*
Steps 1 to 3 have to be done for all ecosystems and sectors. Steps 4 and 5 can focus on one particular ecosystem, service or economic sector.		

Thank you!

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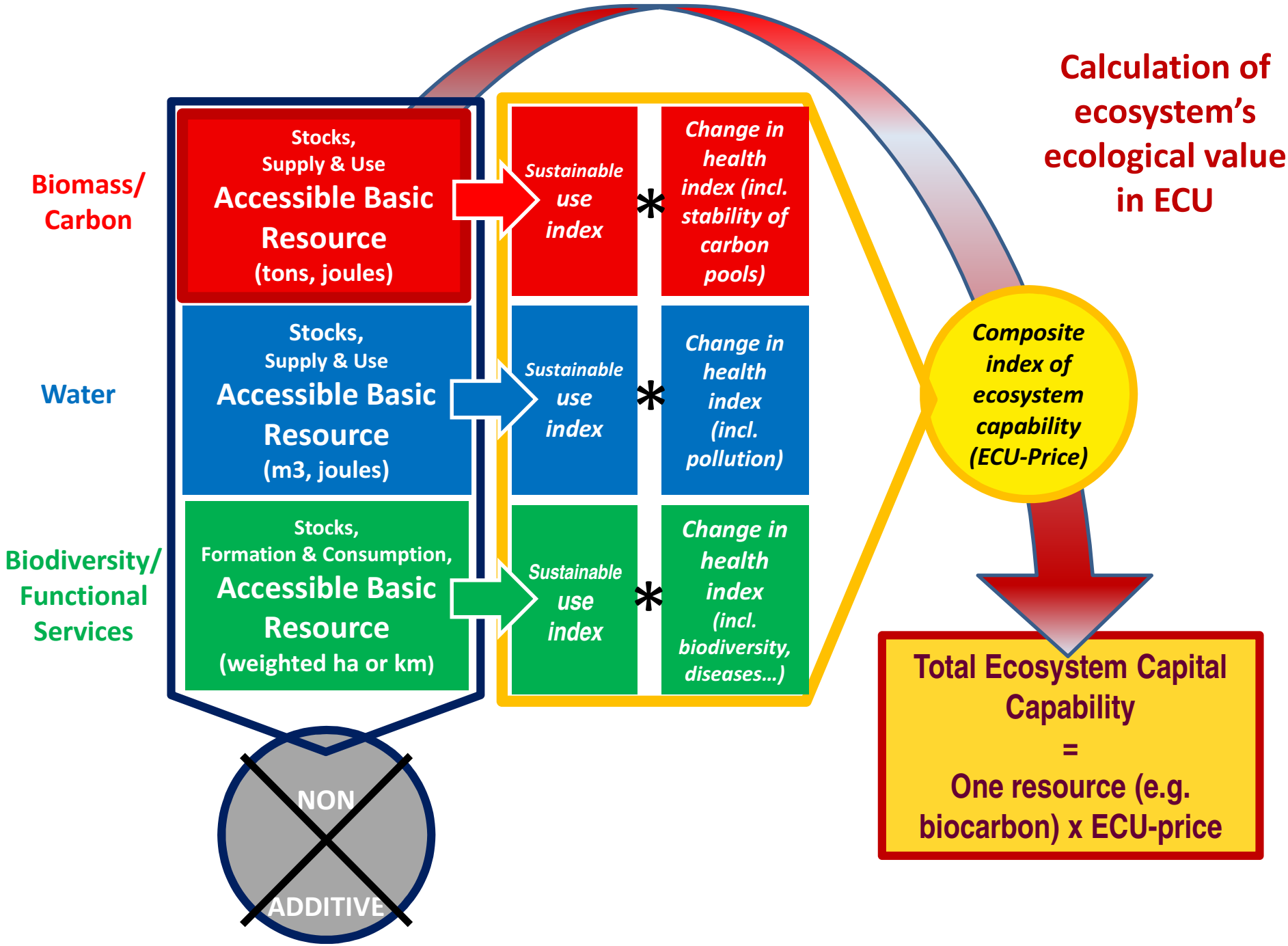

Jean-Louis Weber – 22 Nov. 2013