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ENVIRONMENTAL AND ECOSYSTEM ACCOUNTING

Biomass/Carbon Accounting

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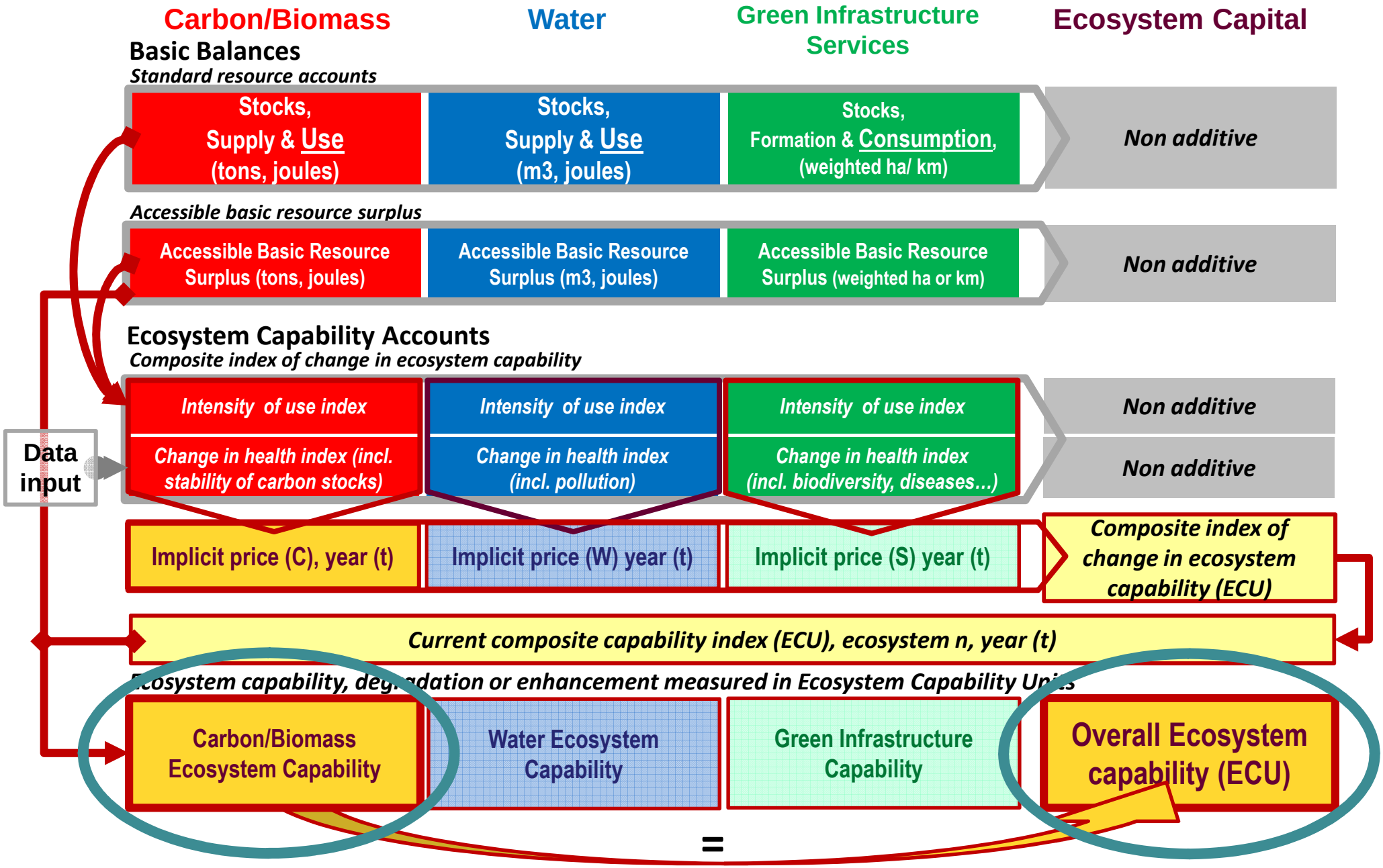
Carbon accounting: a cross-cutting issue

- C accounts development with Climate Change/ Clean Development Mechanism put in place in Kyoto
- Carbon trading (CO2 emission permits) is based on accounts
- IPCC models are based on implicit Carbon accounts
- CO2 emissions accounting is Carbon accounting
- Energy accounts are for a large par Carbon accounts
- The UNFCCC/ LULUCF programme is developping carbon accounts for soil and vegetation
- REDD+ verification scheme is creating carbon accounts

- In Ecosystem Capital Accounts, the Ecosystem Bio-Carbon Account is the pivot for calculating ecosystems' capability

Calculation of Ecosystem Capital Capability in ECU



Jean-Louis Weber 2013

Carbon accounting and integration of "decoupling analysis" for resource-efficiency policies

"resource efficiency" means doing the same thing or more with less resource and less damages resulting from resource use.

- The first approach is generally referred as **decoupling** (of GDP from resource use). Absolute 1st decoupling is when resource use declines; relative 1st decoupling is when resource use increases less than GDP…

  Such indicators are compiled by OECD as outcomes of MFA (material flows analysis) and measurements of green growth. The EU has chosen the indicator **Direct Material Consumption/GDP** as headline indicator of the "flagship initiative" for a resource efficient Europe by 2020. Life Cycle Analysis of products can be seen as an attempt to detail MFA an assess the harmfulness (or potential impact) of materials.

- The second approach is by analogy named **"second" decoupling** (of GDP from environmental impacts). It can be addressed by ecosystem accounts.

1st decoupling

Reduction of resource use below tipping points:

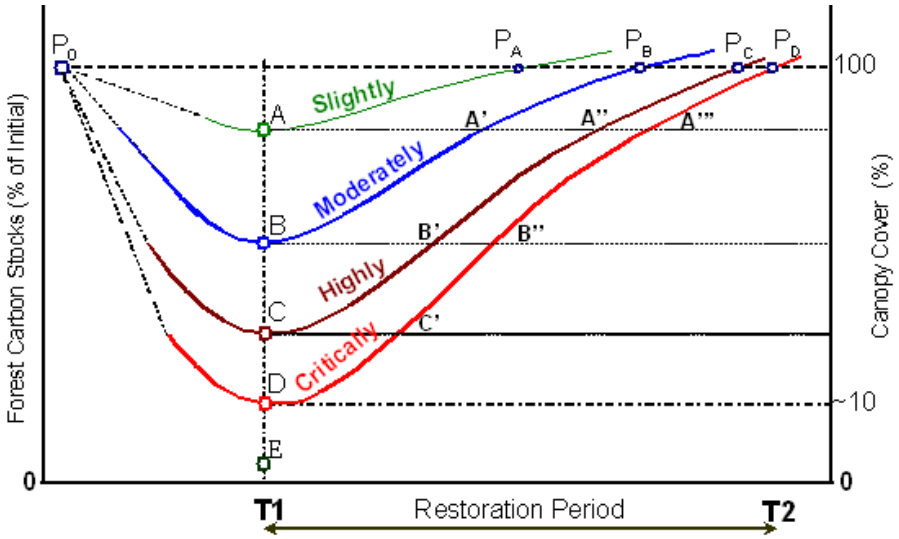
- GHGs, IPCC, Stern, 2008
- Ecological footprint
- Water footprint
- “sustainability gaps” (Ekins & Simmons)
- “safe operating space” (Rockstrom, 2009) for quantitative components (but not biodiversity which is not a depletable resource…)

Absolute decoupling as ultimate target, relative decoupling as a first step…

2nd decoupling

Ecosystem functions maintenance, restoration & enhancement.

Target: capacity to deliver services in a sustainable way, including adaptability to social and ecological change. Biodiversity considered as a resource which can be degraded (or destroyed) even though not “depleted”.



Forest degradation & restoration

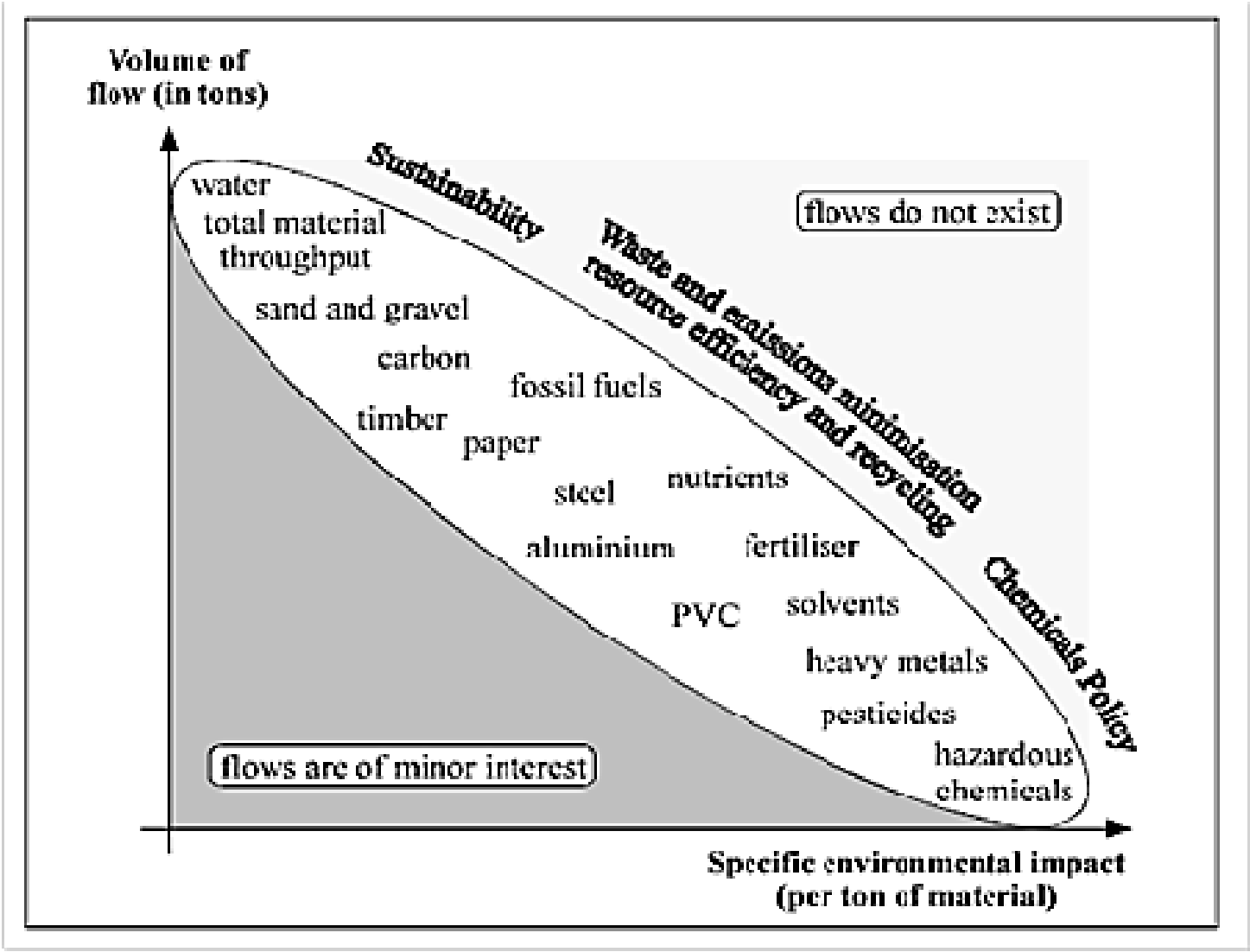
Limitations of “first decoupling” indicators

- A first and well known limitation of “relative first decoupling” is that the improvement of the ratio GDP/resource use can be upset by a faster increase of GDP and result finally in an increased burden on the environment.

- Even in the case of a reduction of resource use (absolute decoupling), degradation may continue if thresholds have been bypassed as it is the case in several fisheries around the World.

- There are in addition issues with the format of indicators based on “economy wide” material flows accounts.

Heterogeneity of material flows presently used for decoupling analysis



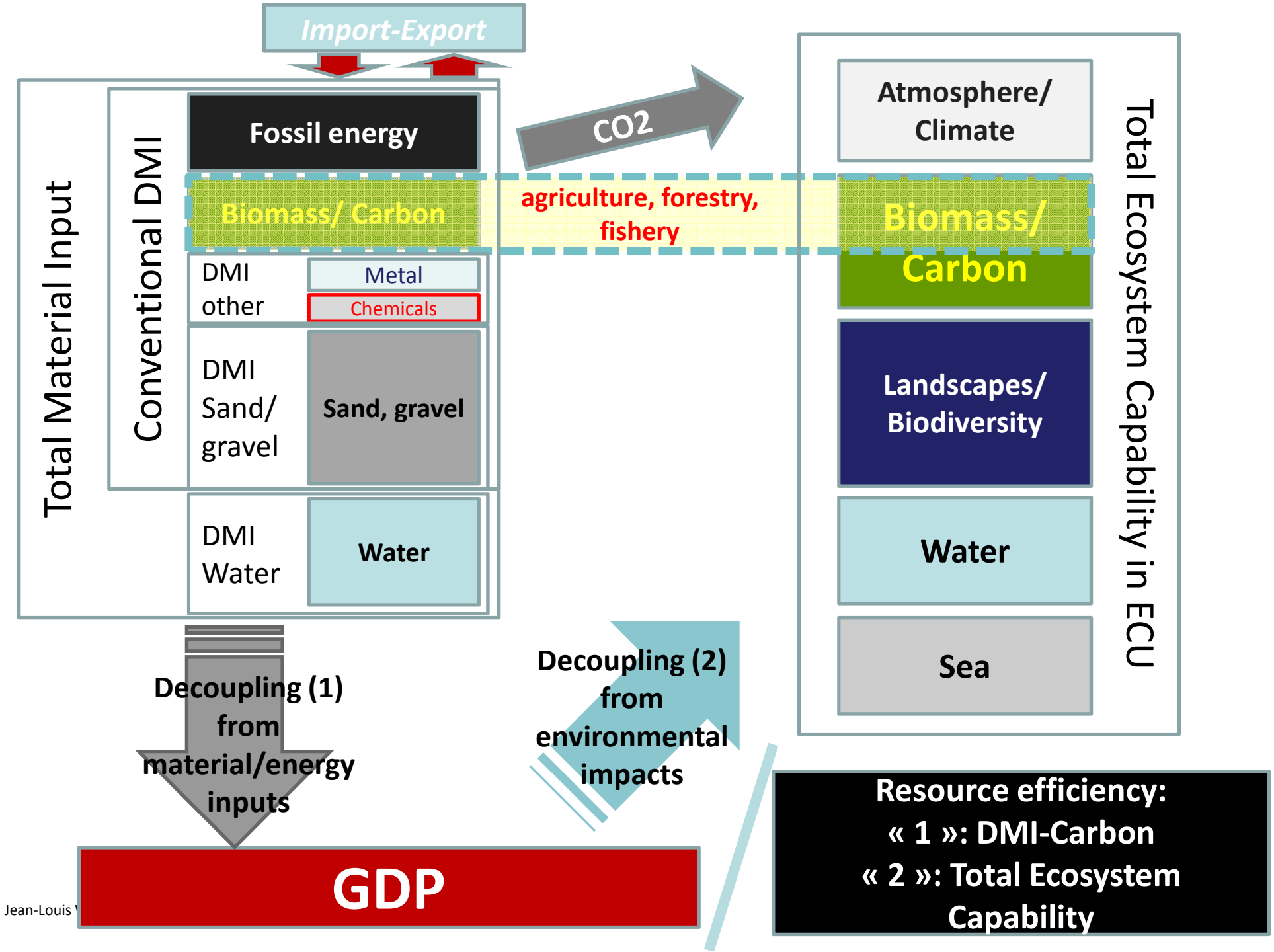
Source : Steurer A. and Radermacher, W., 1996

Carbon accounts : Integrating ‘first’ and ‘second’ decoupling

- The **total carbon balance** can be the pivot account of economic material flow accounts as well as ecosystem accounts.

- It is sufficiently general to work as **surrogate of the whole economy-nature relation**: fossil energy, biofuels extraction and use, food and fiber materials, GHGs emissions, ecosystem carbon pools…

Integrated carbon accounting with ecosystem accounting (SEEA Part 2) can streamline resource-efficiency policies


Import-Export
Total Material Input
Conventional DMI
Fossil energy
Biomass/ Carbon
DMI other
Metal
Chemicals
DMI Sand/ gravel
Sand, gravel
DMI Water
Water
CO2
agriculture, forestry, fishery
Atmosphere/ Climate
Biomass/ Carbon
Landscapes/ Biodiversity
Water
Sea
Total Ecosystem Capability in ECU
Decoupling (1) from material/energy inputs
Decoupling (2) from environmental impacts
GDP
Resource efficiency:
« 1 »: DMI-Carbon
« 2 »: Total Ecosystem Capability

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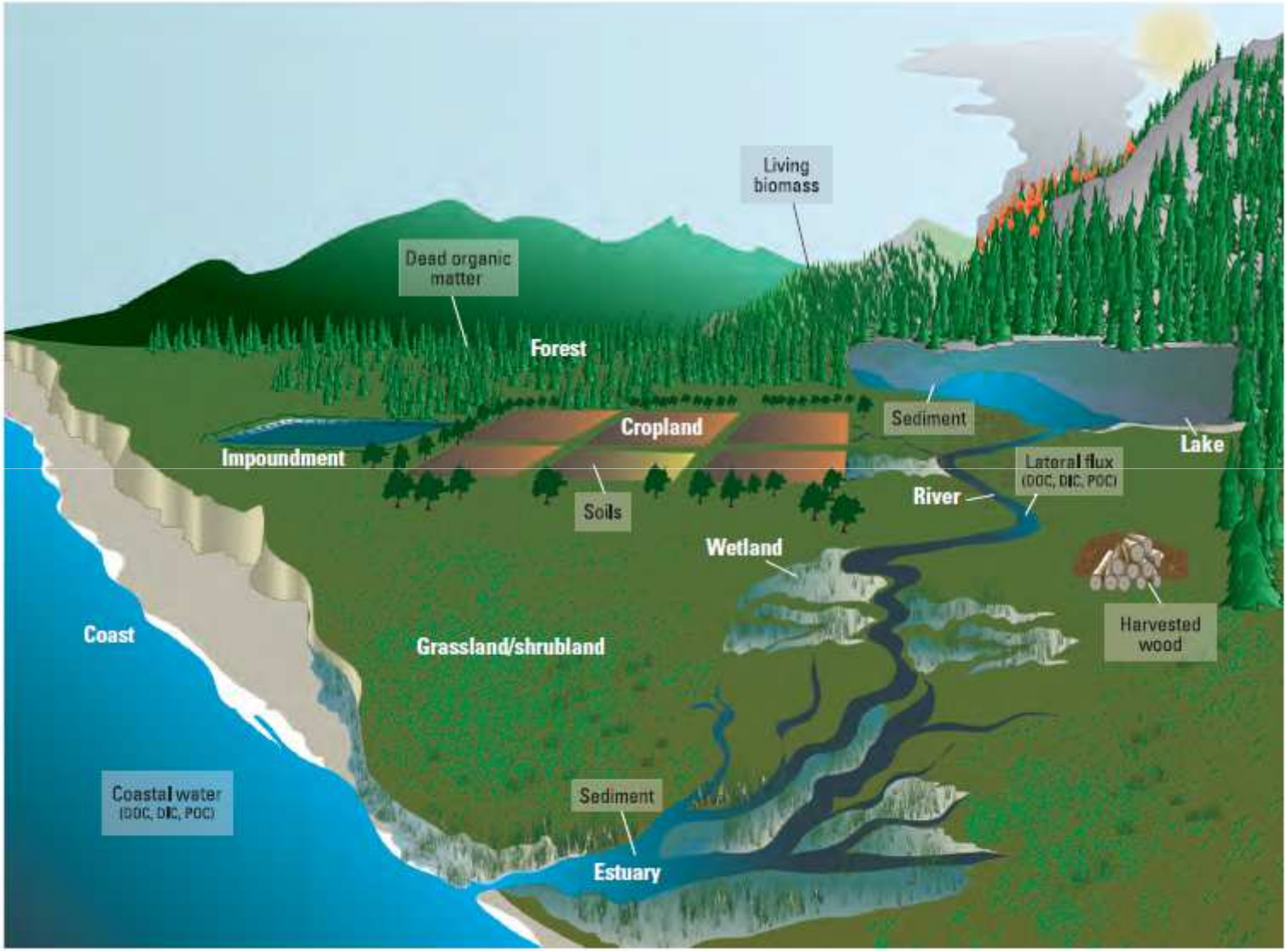
Ecosystem carbon stocks (pools) and flows)



Source: USGS, Scientific Investigations Report 2010–5233

Figure 2.1. Diagram showing the terrestrial ecosystems covered in the assessment and the major carbon pools (in boxes). Abbreviations as follows: DIC, dissolved inorganic carbon; DOC; dissolved organic carbon; POC, particulate organic carbon.

The biomass/carbon account

Stock t0

+ Net Primary Production of biomass

- Harvest of crops
- Grazing by livestock
- Logging of timber

+ manure and organic fertilisers deposition

+ - leftovers, leakages and adjustements

= Stock t1

Stock t1- Stock t0 = Net Ecosystem Carbon Balance

Bio-Carbon Accounts: Basic balance/ Standard resource account (SEEA P1)

ECOSYSTEM CAPITAL ACCOUNTS: BIO-CARBON							
		Forest biomass	Crops biomass	Grassland / pastures biomass	Other natural vegetation biomass	Water bodies biomass	TOTAL
1. BASIC BALANCE/ *STANDARD RESOURCE ACCOUNT*							
COSA	**Opening Stocks**						
1.A INCREASE IN STOCKS (NATURAL AND SECONDARY BIO-CARBON RESOURCE FLOWS)							
CRF1	**Net primary production of bio-carbon (NPP)**						
CRF2	Net internal transfers vegetation-soil (received minus provided)						
s/t (CRF1+CRF2)	***Total primary renewable bio-carbon resources ($TRCR_{natural}$)***						
CRF3	***Total secondary bio-carbon resources ($TSCR_{secondary}$)***						
CRFA	**Total increase in stocks**						
1.B DECREASE IN STOCKS (BIO-CARBON EXTRACTION, CONSUMPTION AND OUTFLOWS)							
CRFB = CRF4to6	***Total removals of bio-carbon from internal assets***						
CRFC = CRF7to11	***Other decreases in bio-carbon stocks***						
CRFD = CRFA-CRFB-CRFC	**Net Ecosystem Carbon Balance (NECB) or Net Accumulation [1]**						
CRF11	Other change in volume of stocks						
CRFEa	**Total decrease in stocks before adjustment**						
CSSB = COSA-CCSA	***Net Accumulation [2] = Closing Stocks minus Opening Stocks***						
ADJ = CRFD-CCSB	***Adjustment of change in stocks***						
CRFEb = CRFEa+ADJ	**Total decrease in stocks after adjustment**						
CCSA = COSA+CRFEb	**Closing Stocks**						

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Bio-Carbon Accounts: Basic balance/ Bio-C Uses (SEEA Part 1)

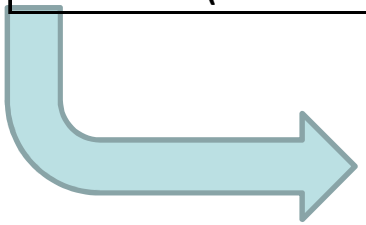
2. BASIC BALANCE/ *BIO-CARBON USES*	
CUS11=CRF41	*Trees harvest*
CUS12=CRF42	*Agriculture crops harvests*
CUS13=CRF43	*Withdrawals of harvest leftovers, straw…*
CUS14=CRF44	*Vegetation grazed by livestocks*
CUS1=CRF4	Agriculture crops, wood & other vegetation bio-carbon
CUS21=CRF51	Withdrawals from stock farming
CUS22=CRF52	Fish catches/ fishfarms
CUS23=CRF53	Fish catches/ fisheries
CUS23=CRF54	Other animal withdrawals
CUS2=CRF5	Animal bio-carbon
CUS31=CRF61	Peat extraction
CUS32=CRF62	Other withdrawals of bio-carbon
CUS3=CRF6	Other bio-carbon
CUSA	**Total use of ecosystem bio-carbon**
CUS41 = CRF41	*Imports of commodities from other territories*
CUS42 = CRF42	*Imports of residuals from other territories*
CUS4	Imports of bio-carbon from other territories
CUS51=CRF313	*Withdrawals of bio-carbon from the sea/ Fish and other animal products*
CUS5=CRF314	*Withdrawals of bio-carbon from the sea/ Algae and other vegetal products*
CUS5	Withdrawals of bio-carbon from the sea
CUS6	Use of bio-carbon received from other economic units
CUS7	Re-use bio-carbon within economic units
CUSB	**Total bio-carbon uses**

Bio-Carbon Accounts: Basic balance/ **Accessible Resource Surplus**

3. BASIC BALANCE/ *ACCESSIBLE BASIC RESOURCE SURPLUS*	
3.1 TOTAL INCREASE OF BIO-CARBON RESOURCES STOCKS	
CRFA	**Total increase in stocks**
3.2 ACCESSIBILITY ADJUSTMENTS OF RENEWABLE BIO-CARBON RESOURCES	
CAR1	Growth of immature stands of timber (-)
CAR2	Growth of environment protection forests (-)
CAR3=CRF7	Leakage and dumping of bio-carbon to water bodies
CAR41=CRF81	*Heterotrophs and decomposers respiration (Rh)*
CAR42=CRF82	*Forest and shrub fires*
CAR43=CRF83	*Emissions to atmosphere from artificial combustion of bio-carbon*
CAR44=CRF84	*Emissions to atmosphere of VOC, CH4*
CAR4=CRF8	Heterotrophic respiration (Rh), combustion & other emissions to the atmosphere
CAR5=CRF9	Natural outflows to other territories and the sea
CAR6=CRFEb (t-1(forest))	Previous net accumulation in forests stocks (+ or -)
CAR7	Other bio-carbon accessibility adjustments (+ or -)
CARA	**Total accessibility adjustment of renewable bio-carbon resources**
s/t (CRF1+CRF2) + CARA	***Exploitable (or manageable) natural bio-carbon resources***
CAR8	Secondary bio-carbon resource unusable due to quality (-)
CAR9	Other adjustments
CARB	**Total accessibility adjustment of secondary bio-carbon resources**
s/t = CRF3 + CARB	***Exploitable (or manageable) secondary bio-carbon resources***
CARC = CRFA+CARA+CARB	**Accessible basic bio-carbon resource surplus**

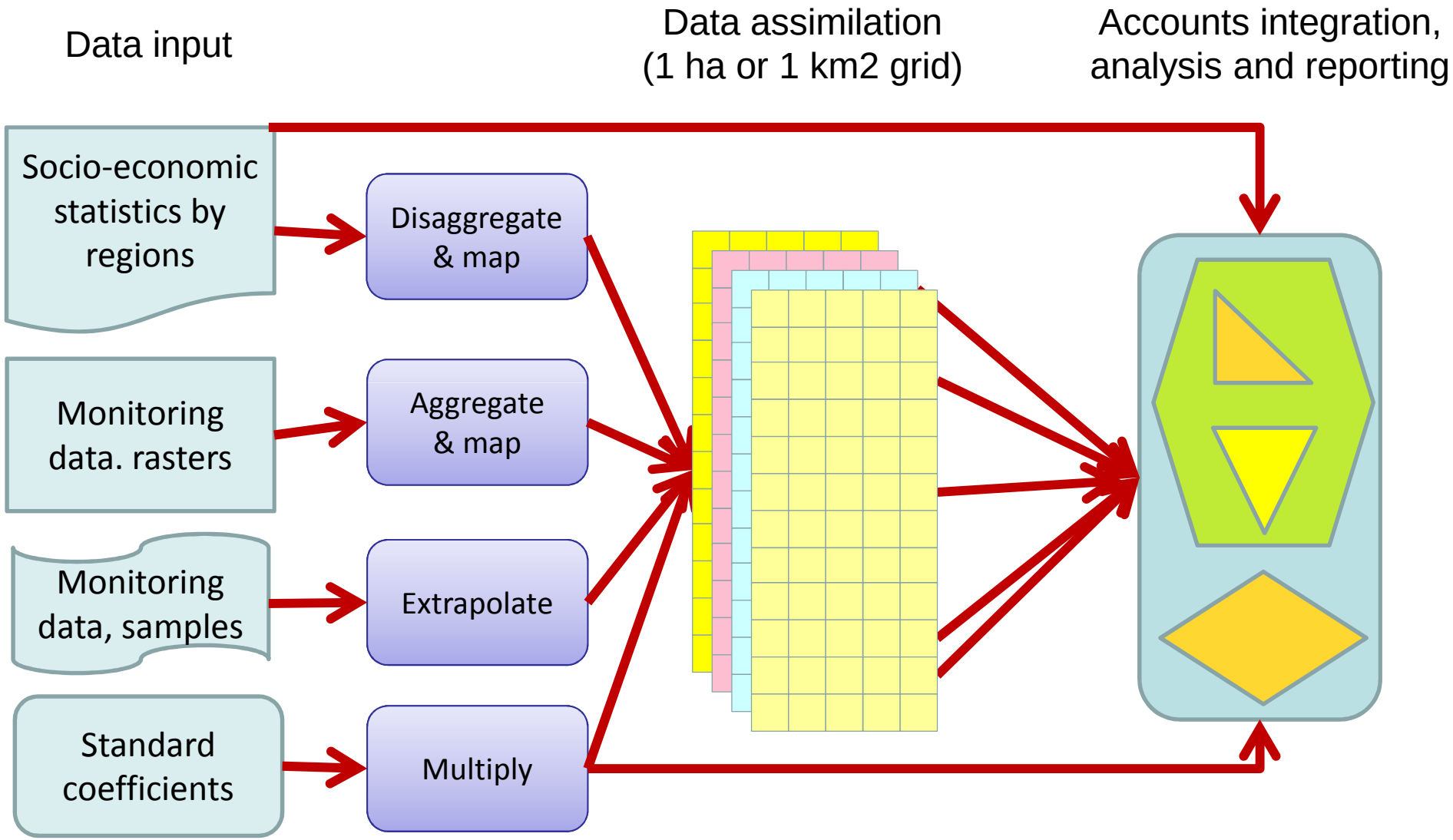
Bio-Carbon Accounts: Basic balance/ **Indexes of Ecosystem Health/Distress**

4. TABLE OF INDEXES OF ECOSYSTEM HEALTH/DISTRESS	
4.1 INDEX OF INTENSITY OF USE IMPACT [IF<1, = overuse, dilapidation; IF>1, accumulation]	
CEHA = CARC/CUSA	**Bio-carbon intensity of use impact**
4.2 COMPOSITE INDEX OF ECOSYSTEM HEALTH CHANGE	
CEH1	Soil eutrophication
CEH2	Change in mean forest age
CEH3	Change in forest trees diversity
CEH4	Change in other vegetal diversity
CEH5	Dependency from artificial inputs
CEH6	Change in probability of fires
CEH7	Other…
CEHB	**Composite index of change of ecosystem health**
4.3 ANNUAL CHANGE IN INTERNAL PRICE OF BIO-CARBON RESOURCE	
CEHC = AVG(CEHA+CEHB)	**Annual change in resources internal price-equivalent**



Input to ECU calculation

Main data flows to compile ecosystem capital accounts

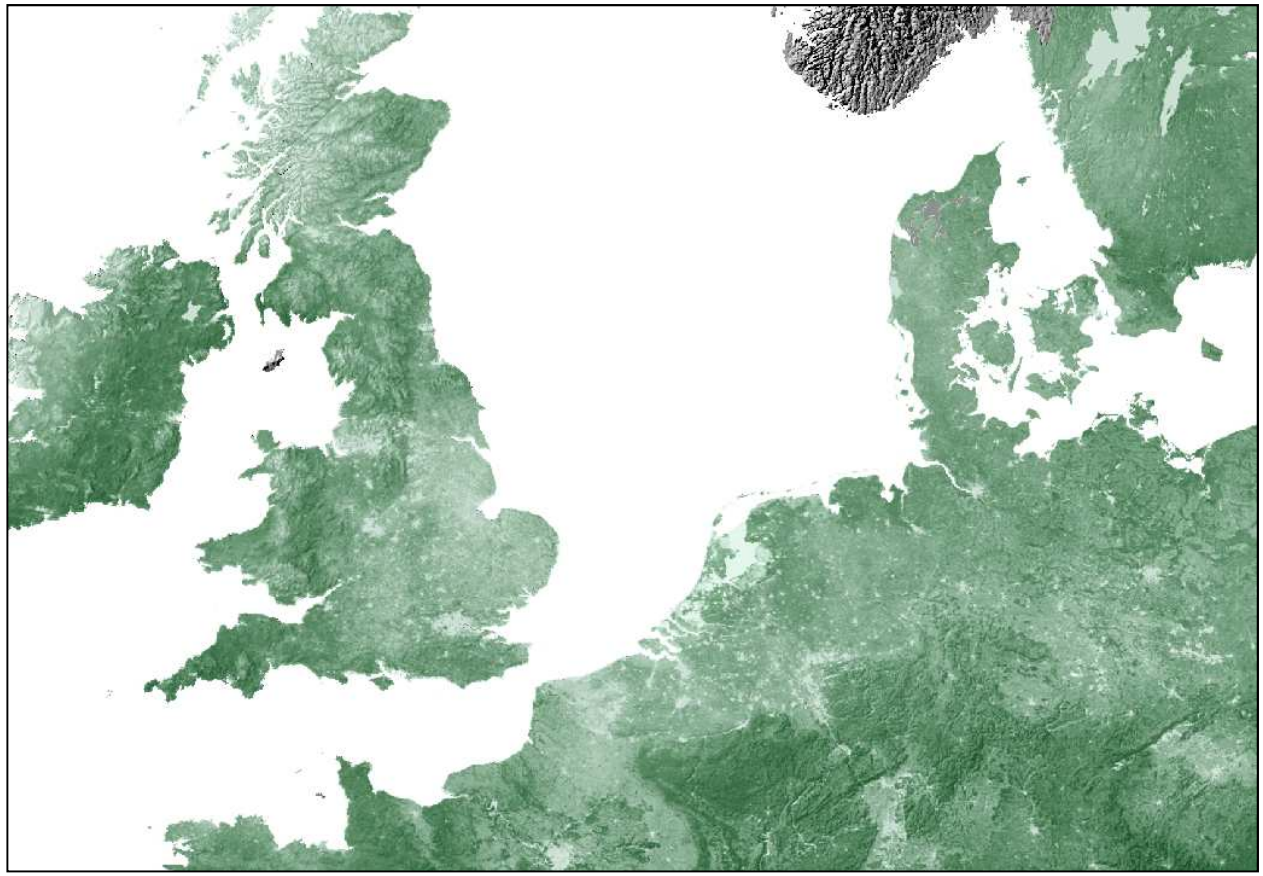


Biomass/carbon account: main data requirements

By accounting statistical units or using a regular grid

- NPP… or variables to calculate it, both in situ measurements (samples), NDVI (vegetation index) and meteo
- Stocks of above ground vegetation and below ground (soil) biomass by ecosystem types: forest, grassland, shrubland, sugar cane, other agriculture, water, algae/grass seabeds
- Type, age of forests
- Trees removal
- Harvests by main crops types
- Leftovers, returns
- Manure, compost application
- Respiration of decomposers
- Combustion, other leakages to the air
- Erosion, leakages to water

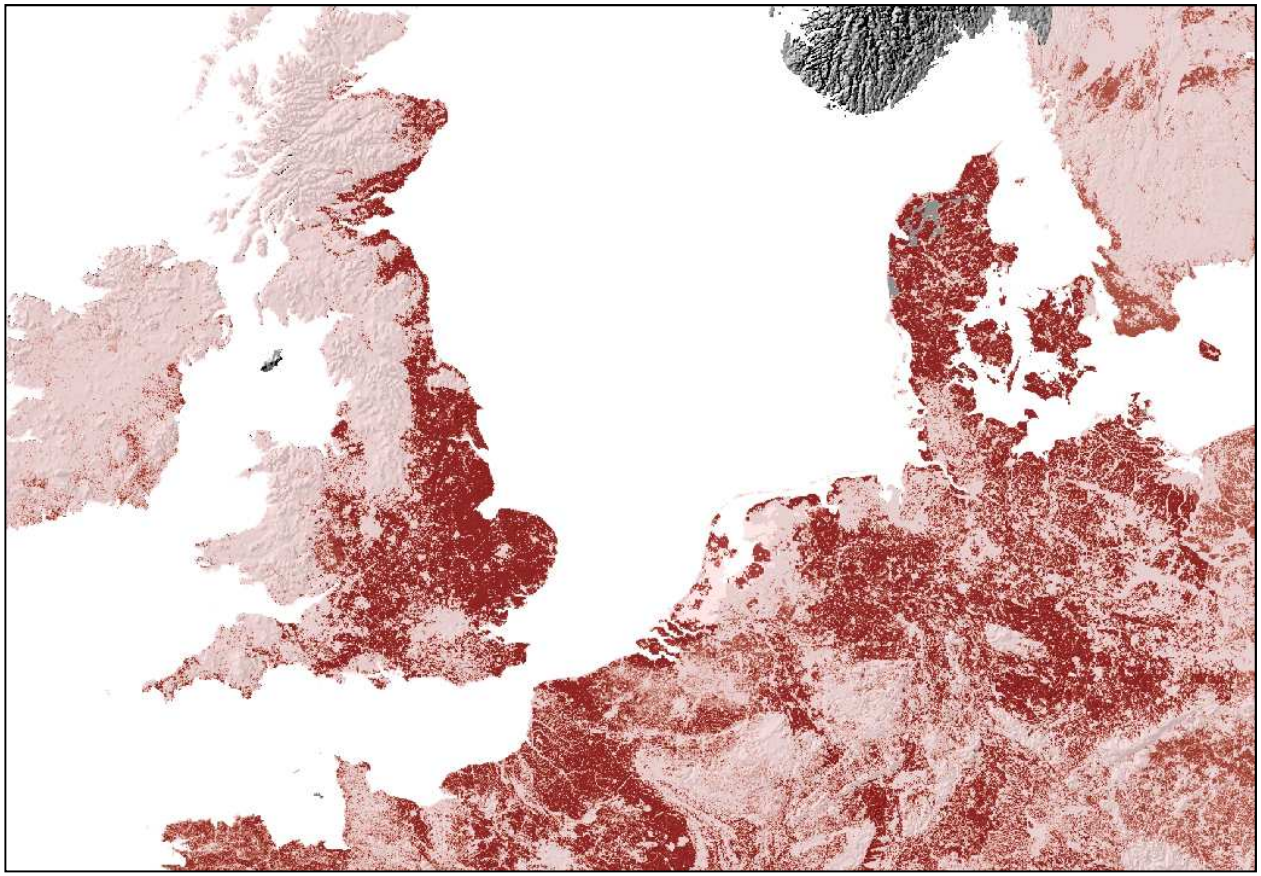
Examples of results



Net Primary Production of biomass/carbon

(2000, in tons of carbon)

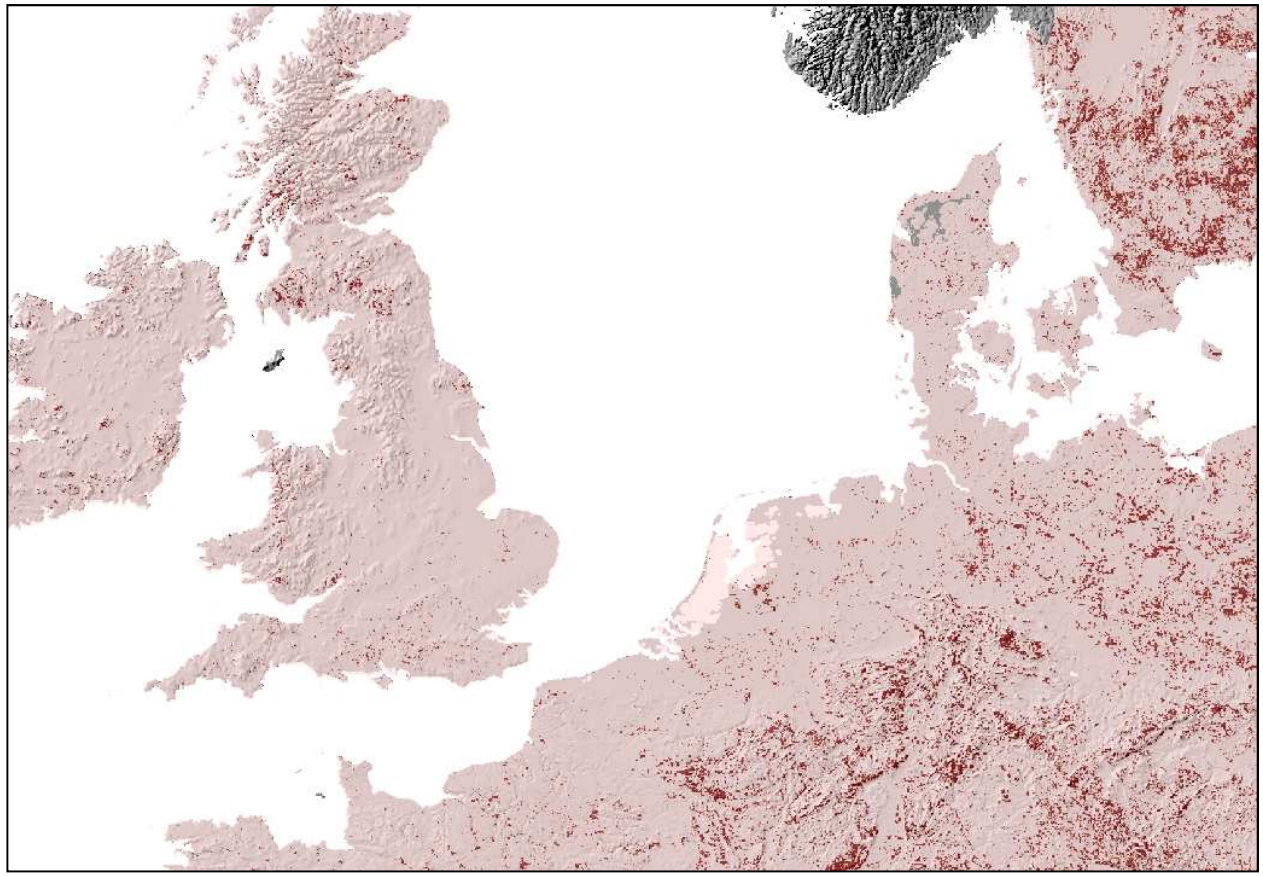
From satellite images (Vegetation Index/NDVI), modelling (meteo, land cover) and in situ monitoring (as in LULUCF guidelines) – 1 km2 grid



Harvest of crops

(2000, in tons of carbon)

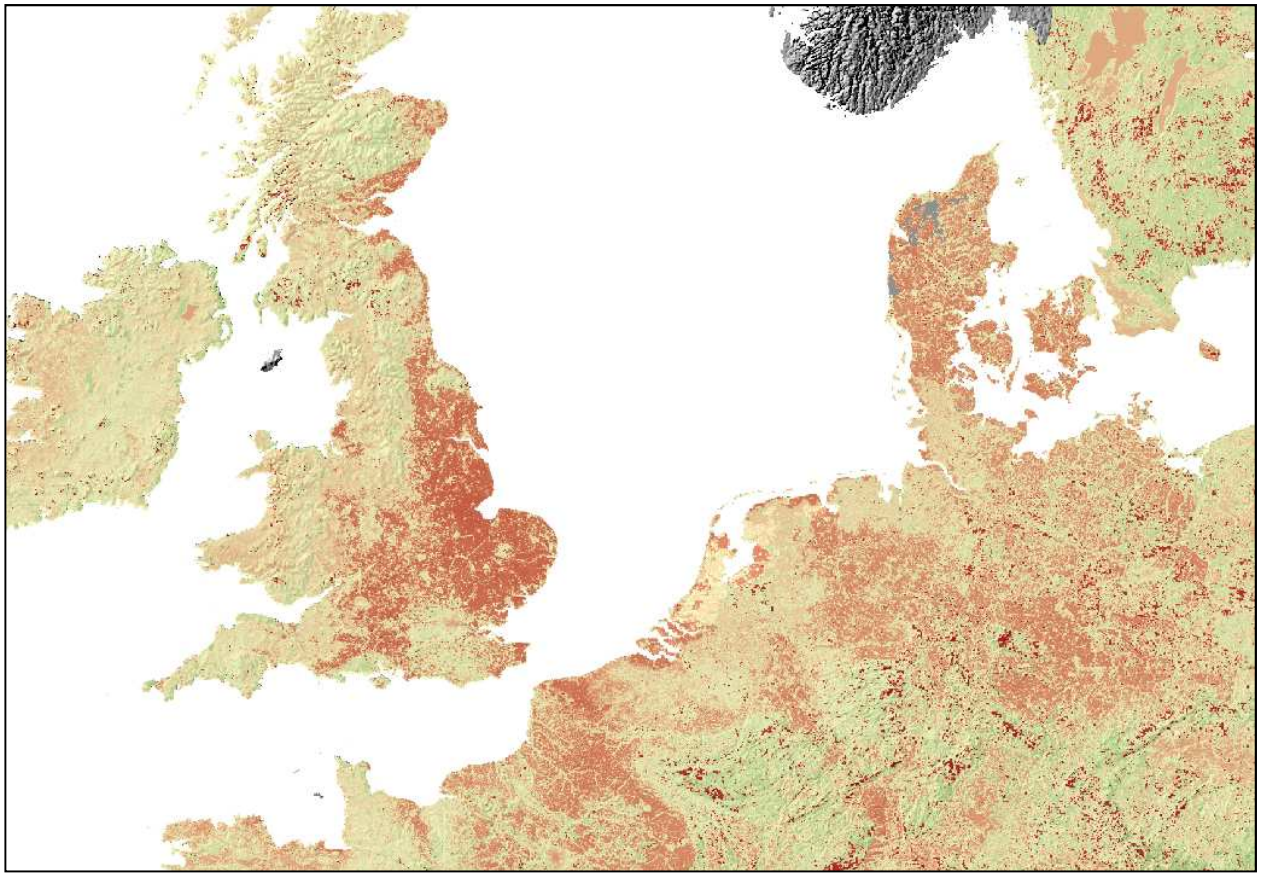
Statistics of crops downscaled to the 1 km2 grid



Wood removals

(2000, in tons of carbon)

Statistics of wood removals downscaled to the 1km2 grid



Net Ecosystem Carbon Balance (NECB)

(2000, in tons of carbon)

NECB = NPP – Harvest of crops and Timber + - other flows (organic fertilization, erosion, emissions to air from decomposition…)

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