International Seminar

on Environment Statistics and Environmental-Economic Accounting

IBGE and UNSD

Rio de Janeiro, 21 & 22 September 2009

Land & Ecosystem Accounts

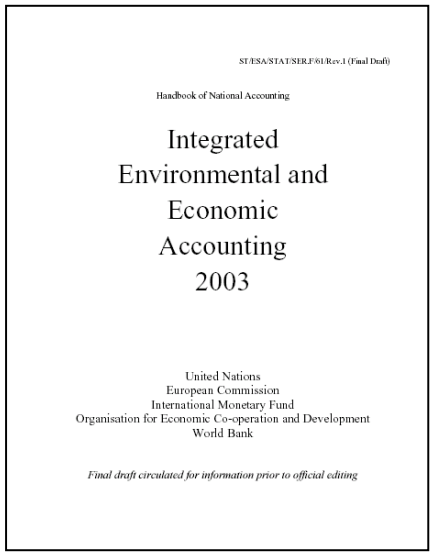
Jean-Louis Weber Senior Adviser, EEA

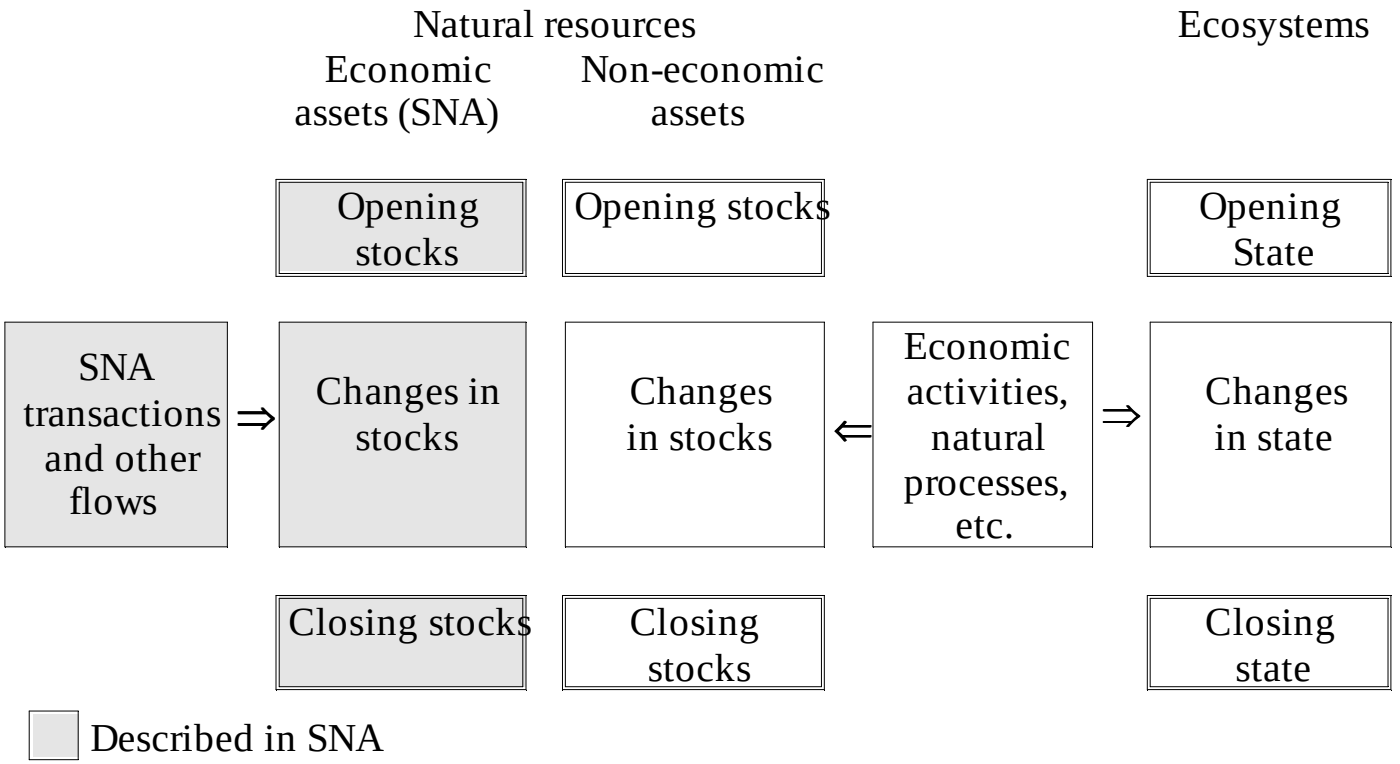
"The same rule of self-destructive financial calculation governs every walk of life. We destroy the beauty of the countryside because the unappropriated splendours of nature have no economic value. We are capable of shutting off the sun and the stars because they do not pay a dividend."
John Maynard Keynes 1933

" Because National Accounts are based on financial transactions, they account for nothing 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 1968

European Environment Agency

SEEA2003: enlargement of SNA1993 for a better description of the economy-environment relation





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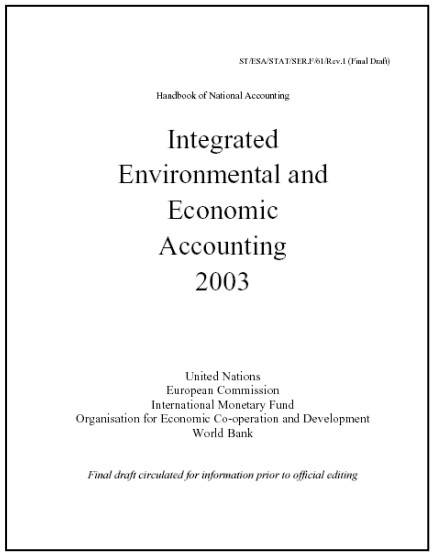
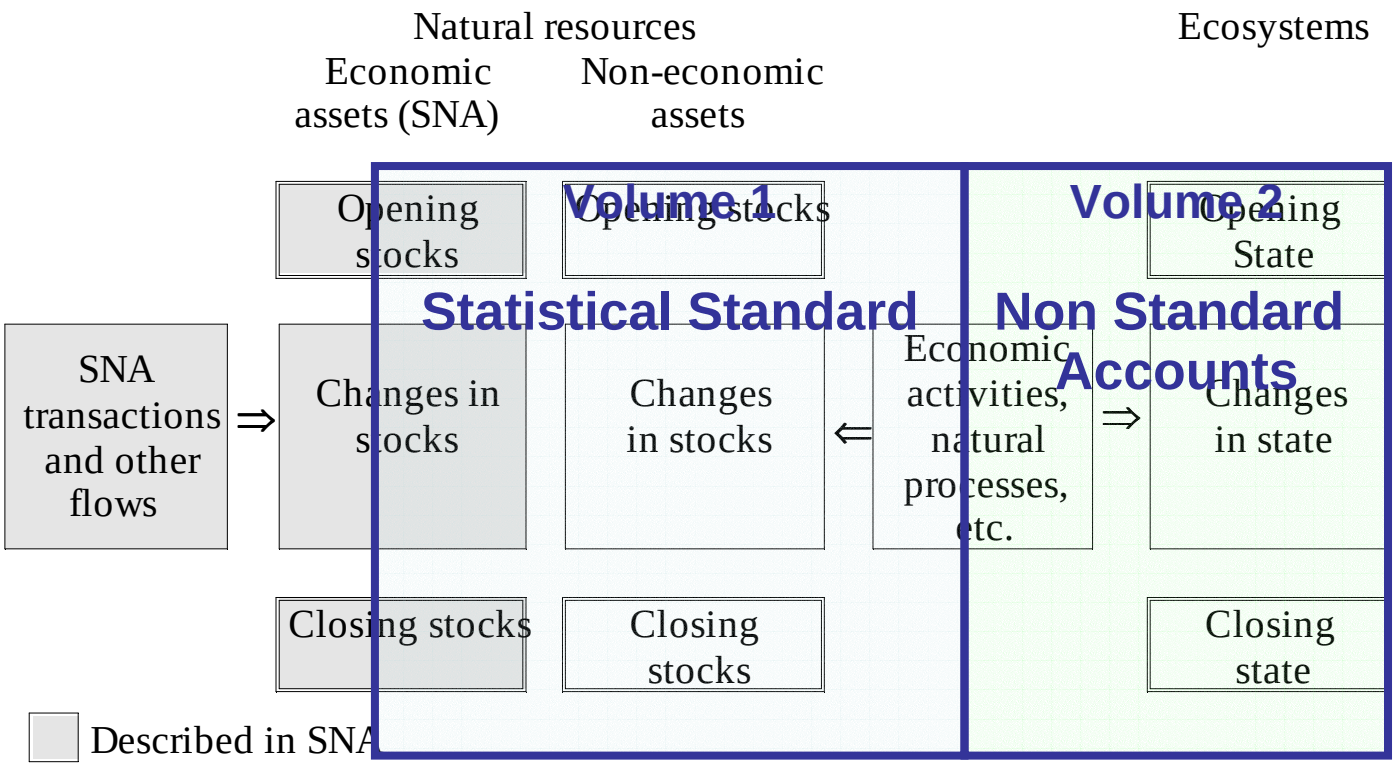
SEEA2003: enlargement of SNA1993 for a better description of the economy-environment relation

Revision ➔ SEEA2012





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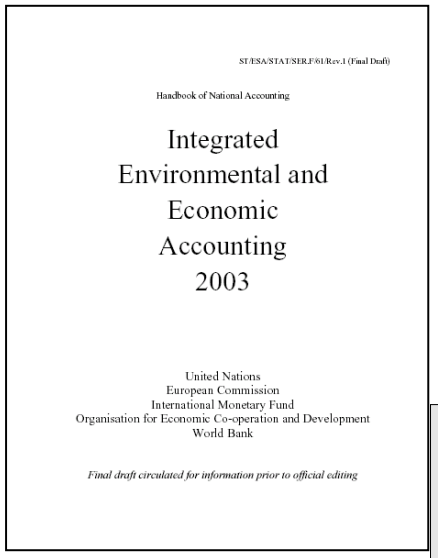

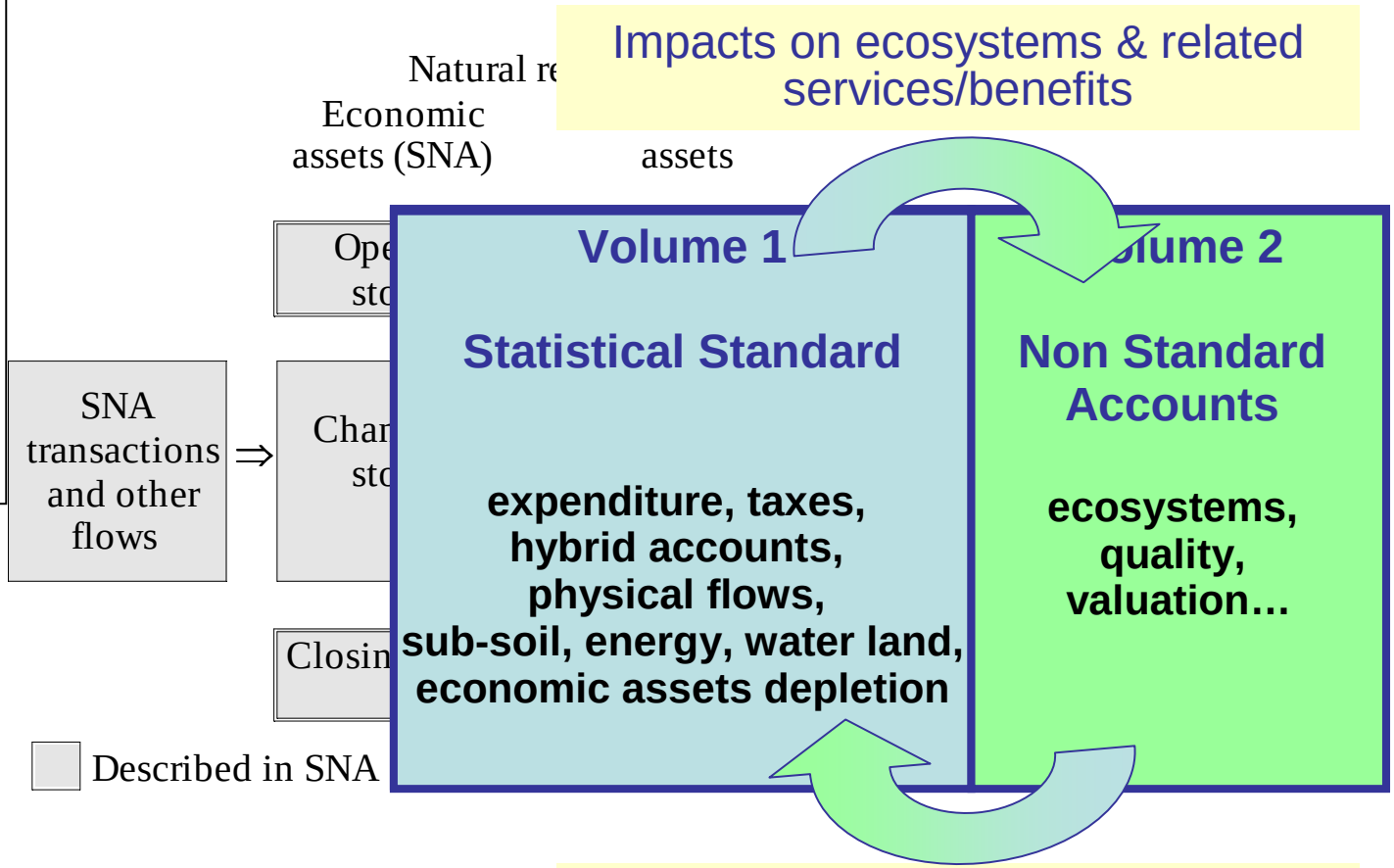

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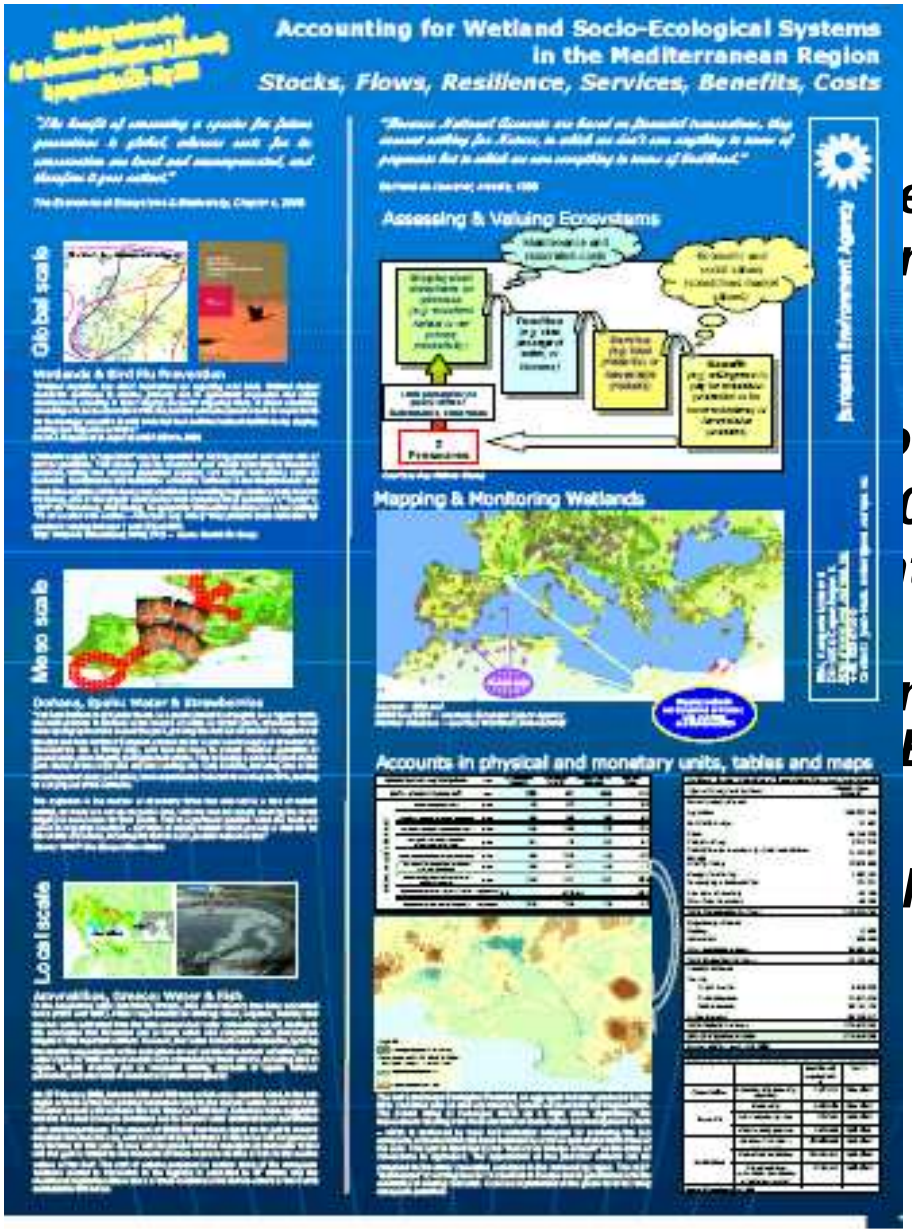
Land & Ecosystem ACcounting (LEAC)

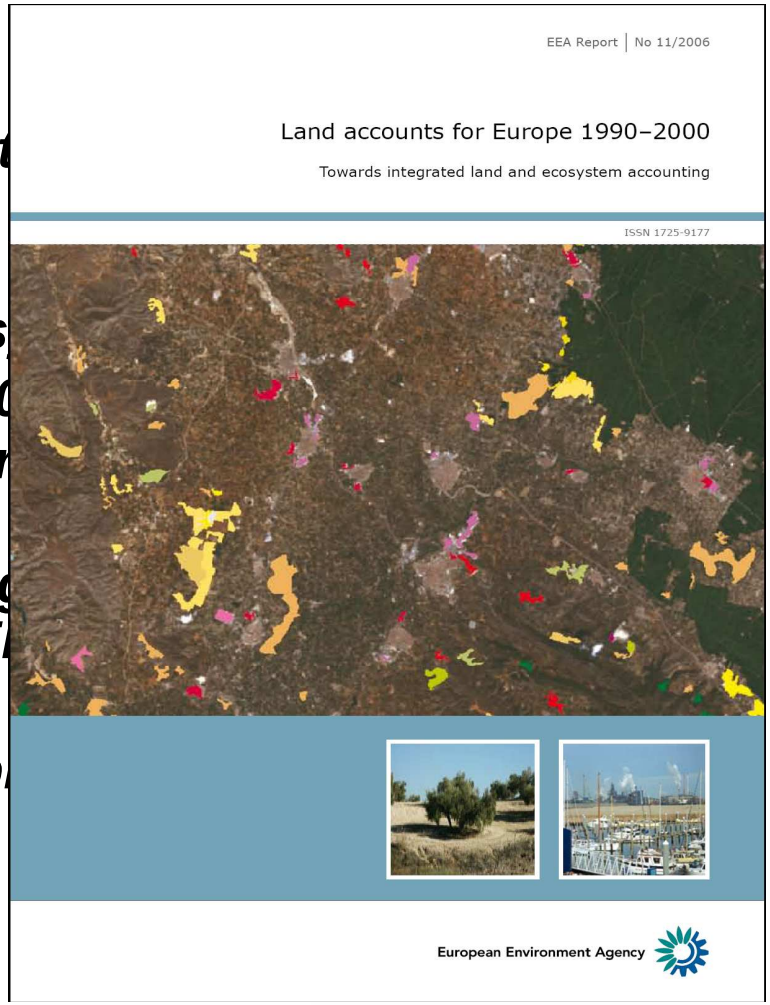
- ***Land & ecosystem accounts are present in the UN system of economic-environmental accounts (SEEA2003) but not fully developed***

- ***Implementation of land and ecosystem accounts in Europe:***
  - ***Land accounts 1990-2000 [2006], 24 countries; ongoing update for 2006 and 35 countrries; tests out of Europe [e.g. Burkina Faso 1992-2002];***
  - ***Ecosystem accounts: ongoing tests [e.g. for Mediterranean Wetlands in the context of TEEB]***

- ***Land and ecosystem accounts planned to be developed in SEEA2012/2013 revision***

Land & Ecosystem ACcounting (LEAC)





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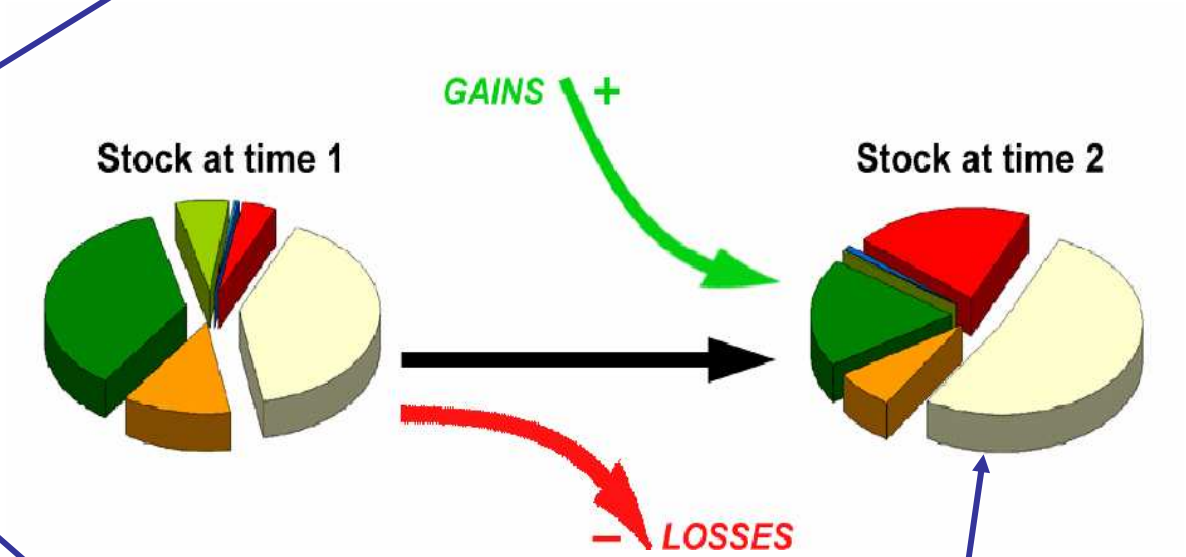
Land Cover Accounts

Gain in stock
e.g. by afforestation

Do gains compensate for losses?



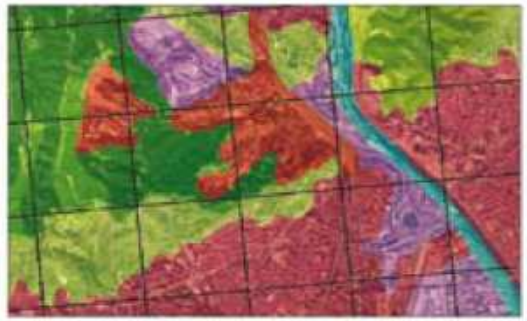
Loss of stock
e.g. by deforestation

Has the quality of the stock been maintained?

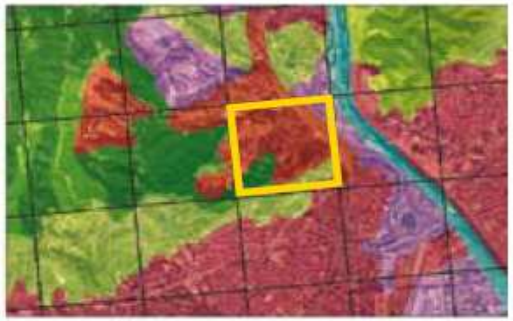
The approach used to generate the LEAC record for stock

Step 1: The raw image data are interpreted for a land cover map

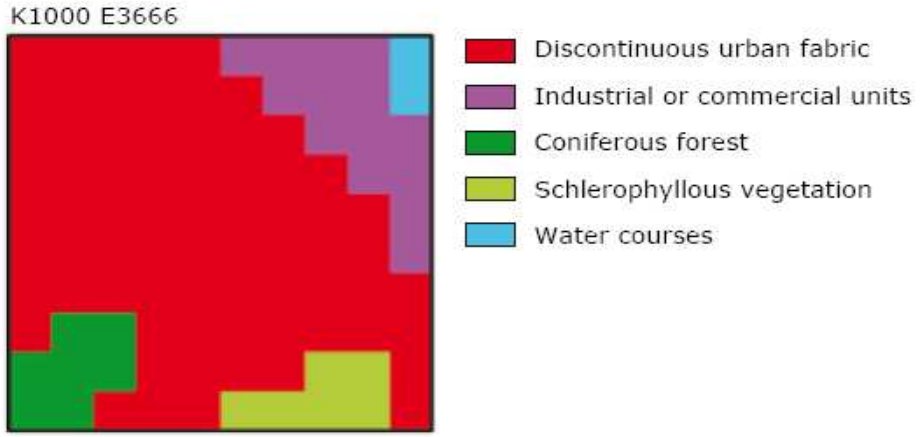
Step 2: Interpreted CLC map for 1990 and 2000



Step 3: Superimposition of the 1 km x 1 km accounting grid

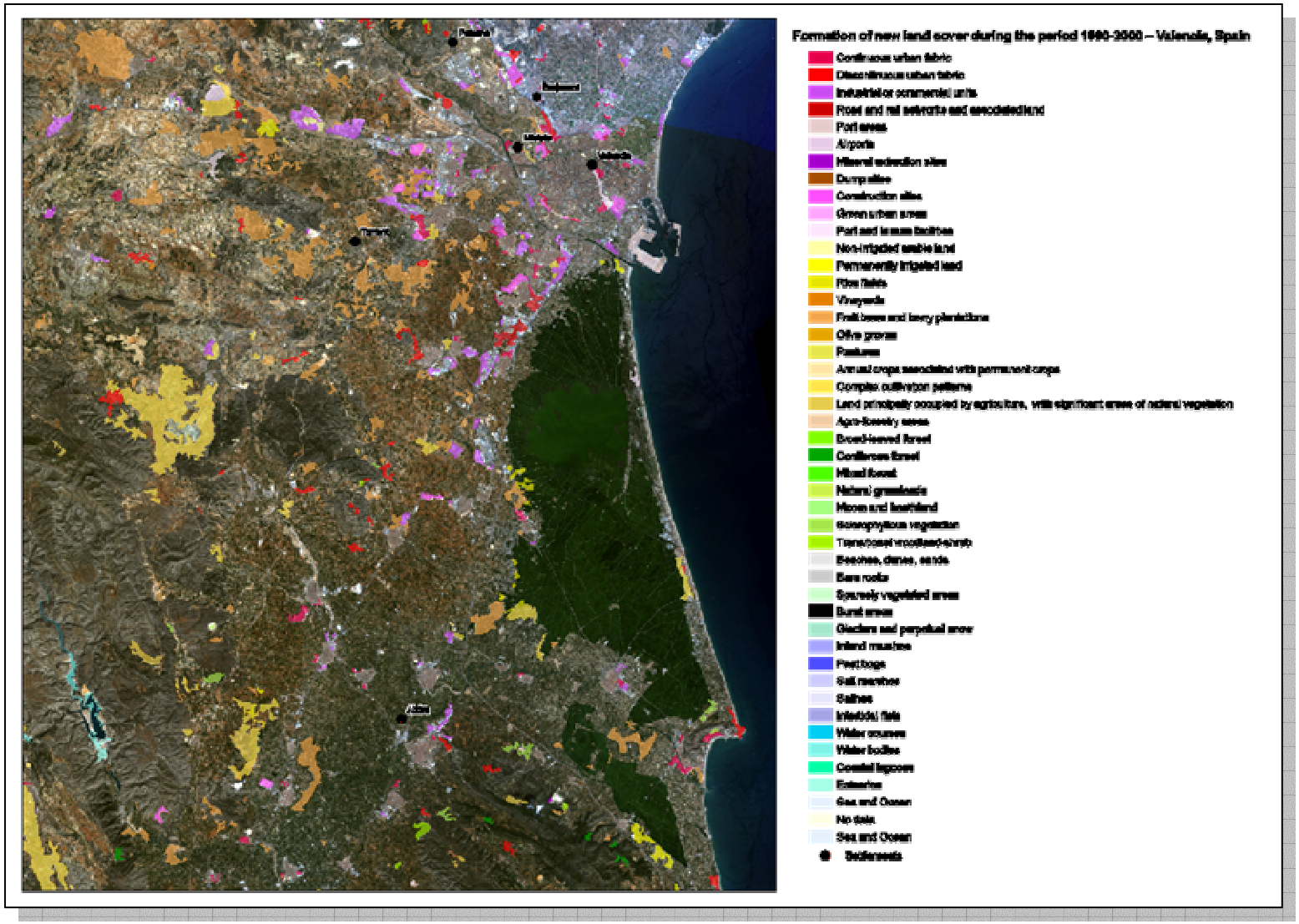


Step 4: Location of an individual record for the LEAC database



Step 5: The underlying 100 m raster used for stock calculation for the selected record

Change detection



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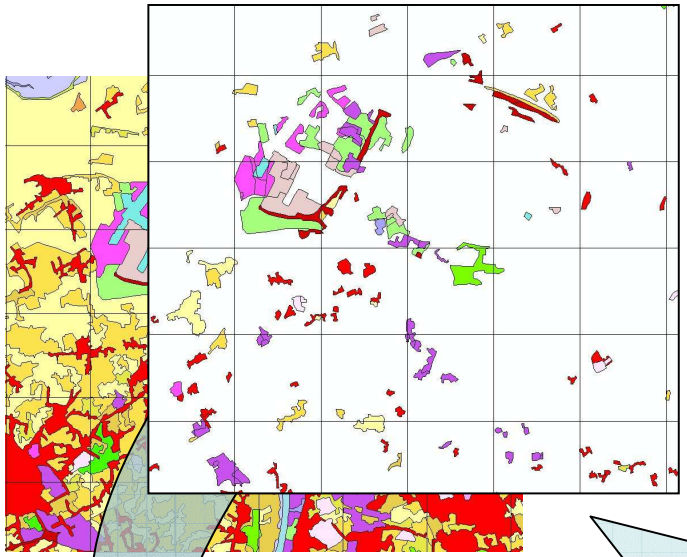
Land cover change accounts: from maps to statistics

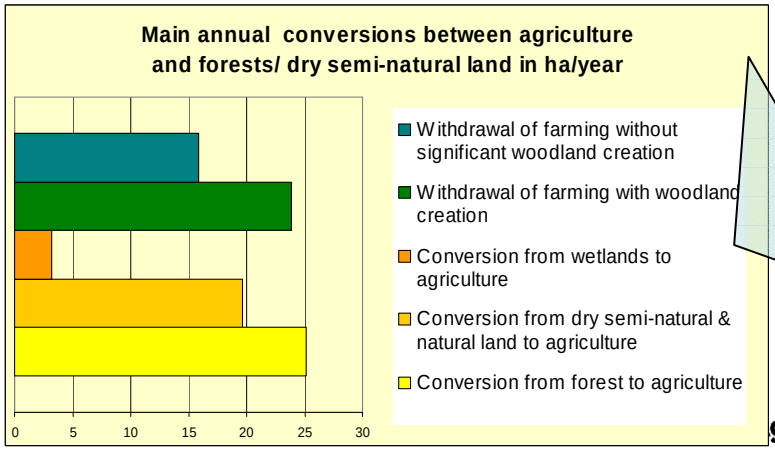
Land cover 1990 & 2000 and land cover change are first converted to a grid (below, 3x3 km)



CORRESPONDANCE BETWEEN LAND COVER CHANGES (CLC LEVEL 3) AND THE LAND COVER FLOWS											
		132	133	141	142	211	212	213	221	222	223
		Dump sites	Construction sites	Green urban areas	Sport and leisure facilities	Non-irrigated arable land	Permanently irrigated land	Rice fields	Vineyards	Fruit trees and berry plantations	Olive groves
243	Land principally occupied by agriculture with significant areas of natural vegetation	Extension of impervious	Construction	Development of green urban areas	Extension of sport and leisure facilities	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture
244	Agro-forestry areas	Extension of impervious	Construction	Development of green urban areas	Extension of sport and leisure facilities	Intensive conversion of agriculture	Intensive conversion of agriculture	Intensive conversion of agriculture	Planting of vineyards, fruit and olive trees over arable & pasture	Planting of vineyards, fruit and olive trees over arable & pasture	Planting of vineyards, fruit and olive trees over arable & pasture
311	Broad-leaved forest	Extension of impervious	Construction	Development of green urban areas	Extension of sport and leisure facilities	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture
312	Coniferous forest	Extension of impervious	Construction	Development of green urban areas	Extension of sport and leisure facilities	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture
313	Mixed forest	Extension of impervious	Construction	Development of green urban areas	Extension of sport and leisure facilities	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture	Intensive conversion of forest to agriculture
321	Natural grassland	Extension of impervious	Construction	Development of green urban areas	Extension of sport and leisure facilities	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture
322	Moors and heathland	Extension of impervious	Construction	Development of green urban areas	Extension of sport and leisure facilities	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture	Intensive conversion of marginal land to agriculture

Individual changes are grouped by land cover flows that describe processes

LCF1	**Urban land management**
LCF2	**Urban residential sprawl**
LCF3	**Sprawl of economic sites and infrastructures**
LCF4	**Agriculture internal conversions**
LCF5	**Conversion from other land cover to agriculture**
LCF6	**Withdrawal of farming**
LCF7	**Forests creation and management**
LCF8	**Water bodies creation and management**
LCF9	**Changes due to natural & multiple causes**



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Summary indicators

Figure 2.1 **Total land cover 2000 (%)**

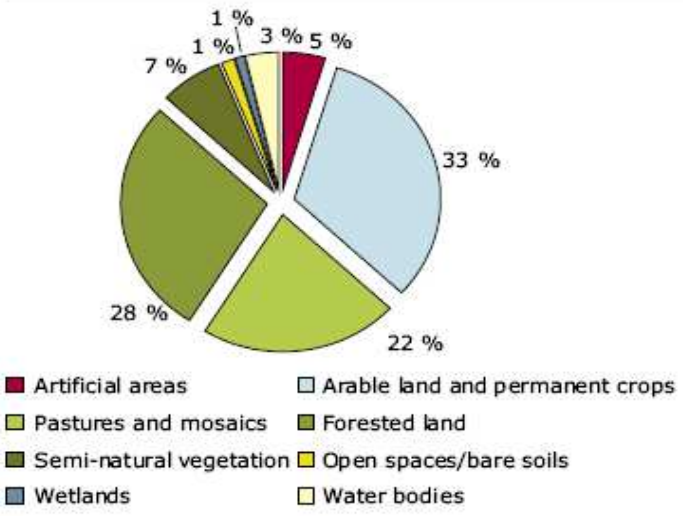


Figure 2.2 **Net change in land cover 1990–2000 — EEA-23 (ha)**

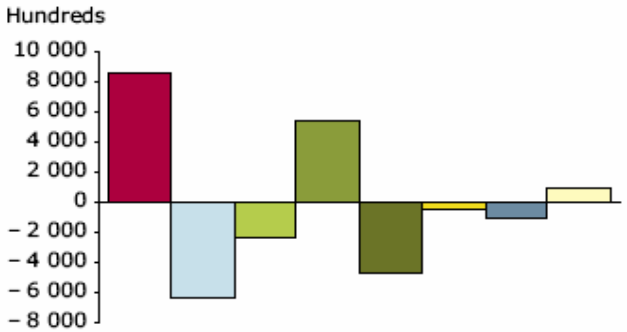
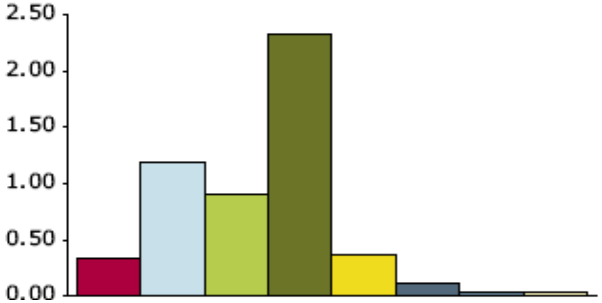


Figure 2.3 **Total land cover turnover 1990–2000 as % of total territory for EEA-23**



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Artificial land uptake

Figure 2.5 **Origin of artificial land uptake 1990–2000, EEA-23 (%)**

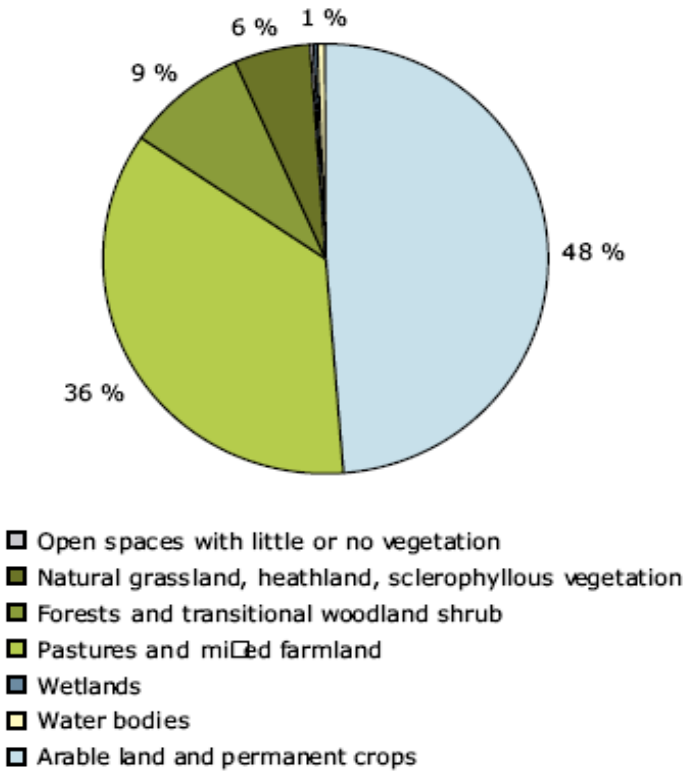
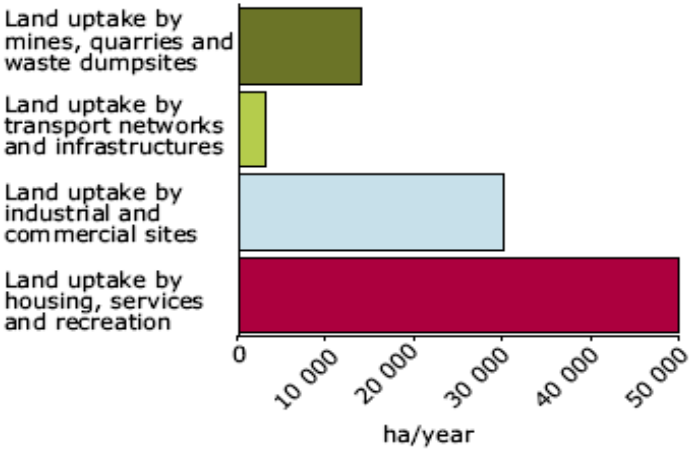


Figure 2.4 **Drivers of artificial land development**



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Comparison of artificial land uptake by countries

Figure 2.6 **Mean annual urban and infrastructures land take as % of artificial land cover 1990**

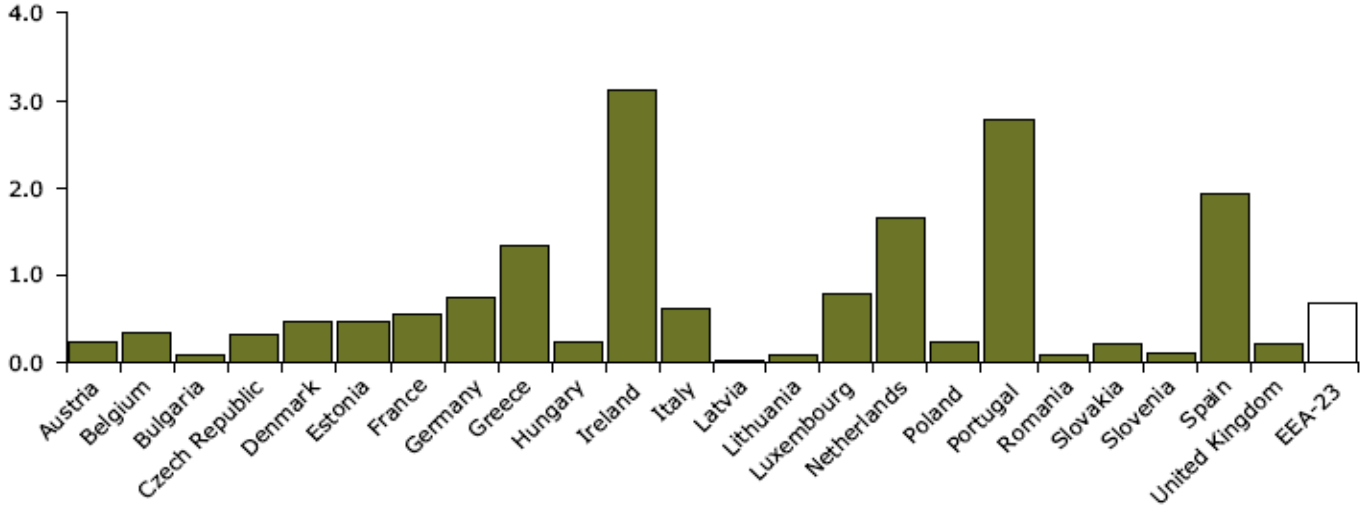
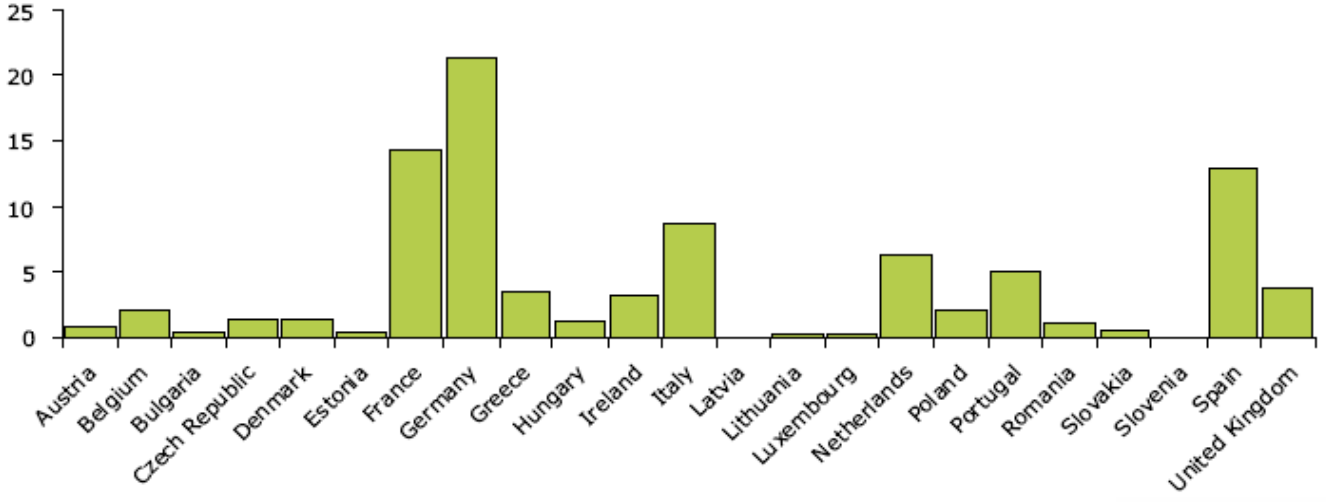


Figure 2.7 **Mean annual urban and infrastructures land take as % of total EEA-23 urban land take**



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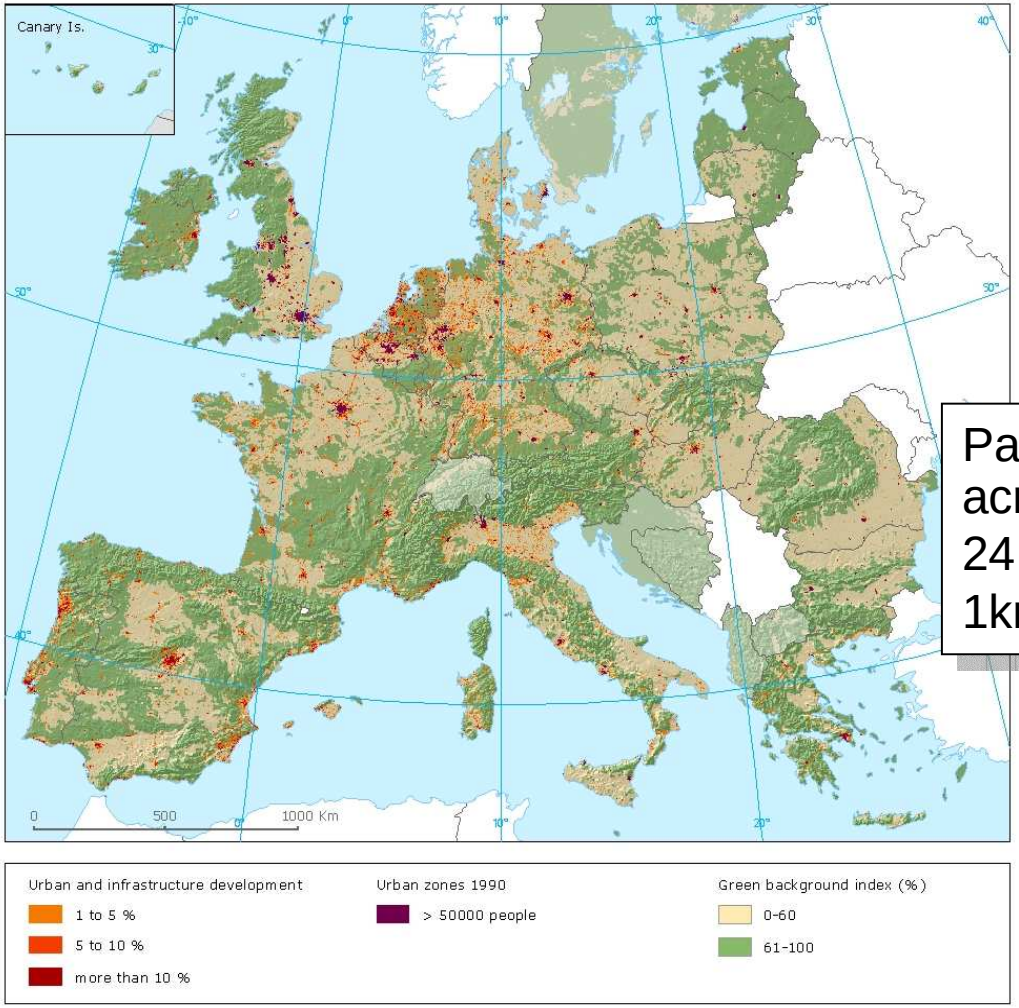
Mapping flows: urban sprawl, by grid



Patterns of urban sprawl
across Europe,
24 countries, 1990-2000,
1km x 1km grid

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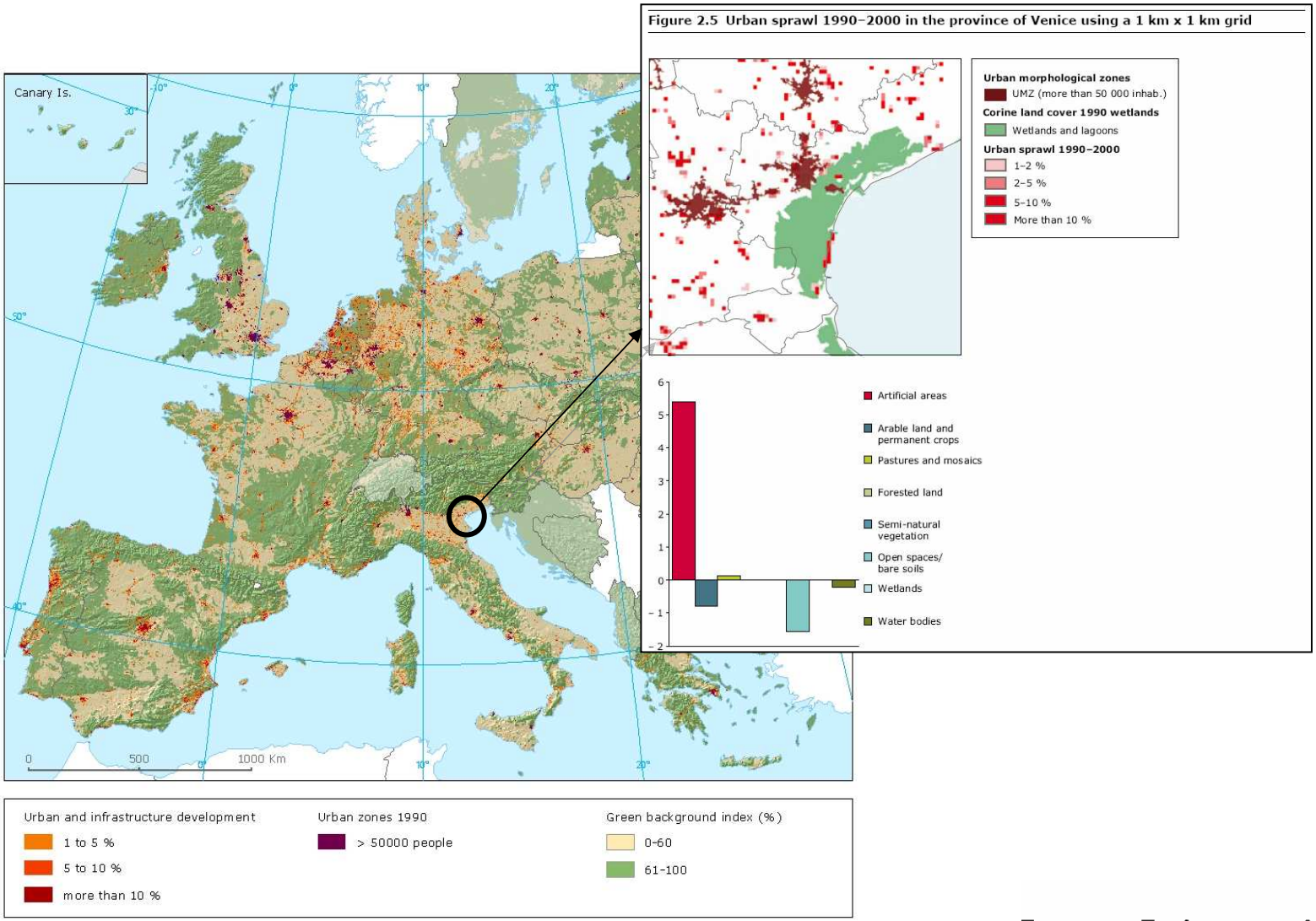
Mapping flows: urban sprawl, by grid



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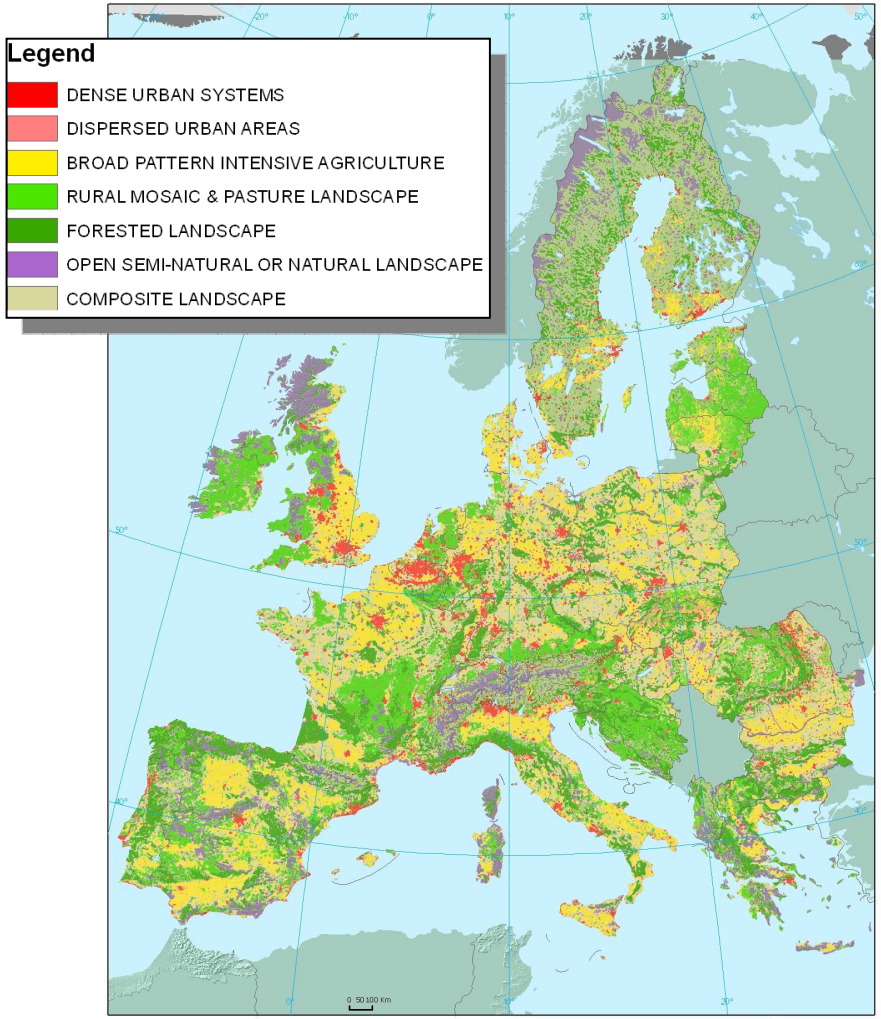
Mapping & analysing flows

Dominant Landscape Types



Data held on a standardised 1km x 1km Europe wide grid which enables construction of a different 'zonal accounts' including those for:

- Regions
- Biogeographical zones
- Mountain areas
- Coastal zones
- Major sea basins
- Dominant landscape types…

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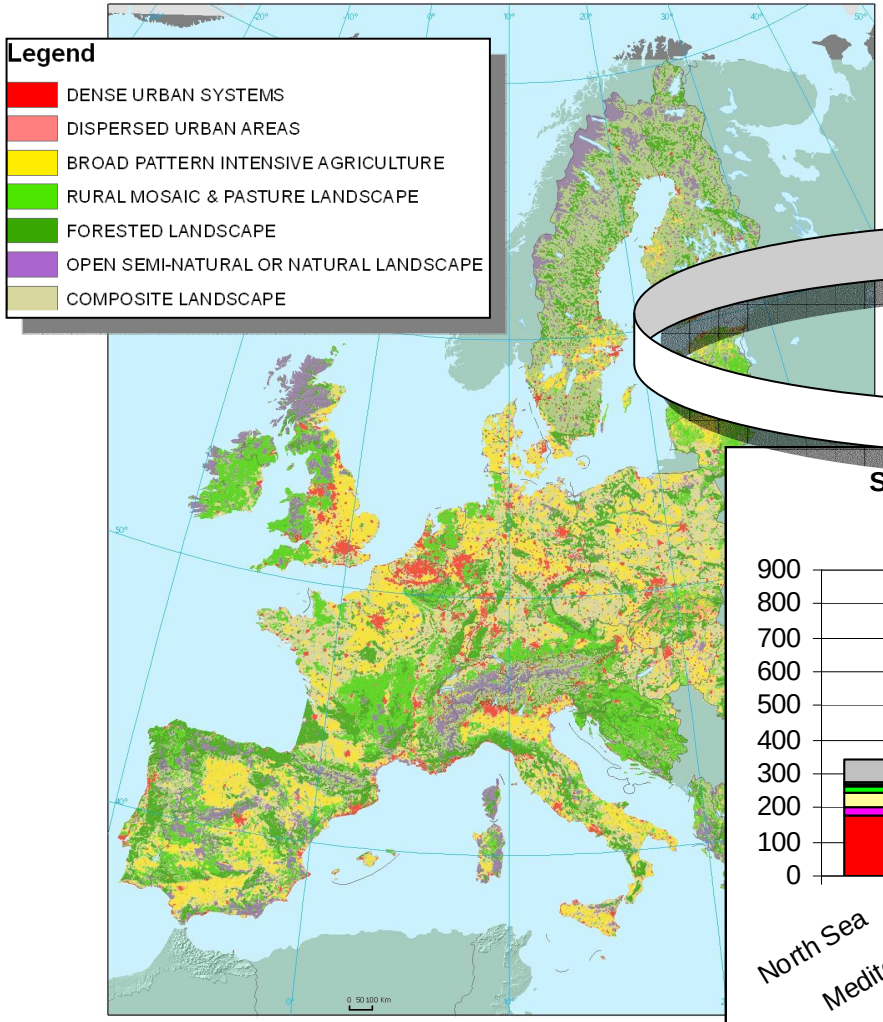
Mapping & analysing flows

Dominant Landscape Types



Data held on a standardised 1km x 1km Europe wide grid which enables construction of a different 'zonal accounts' including those for:

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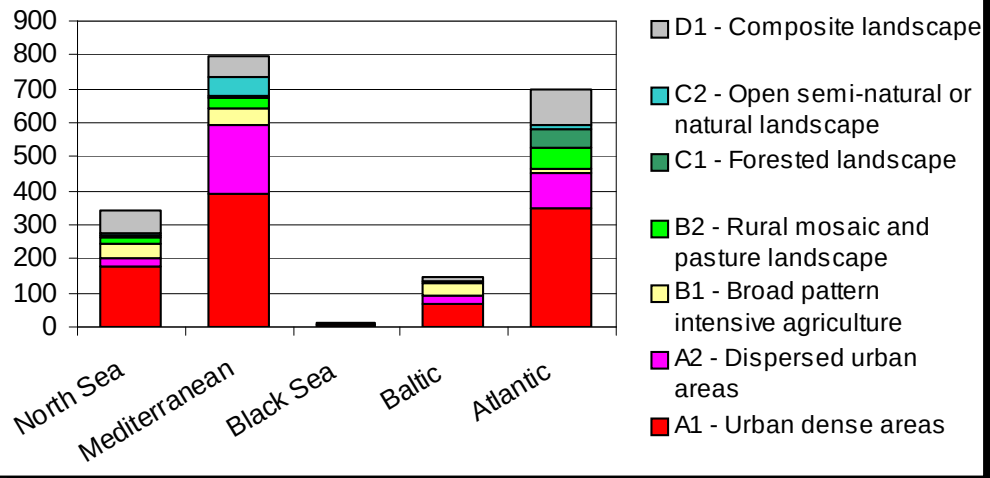
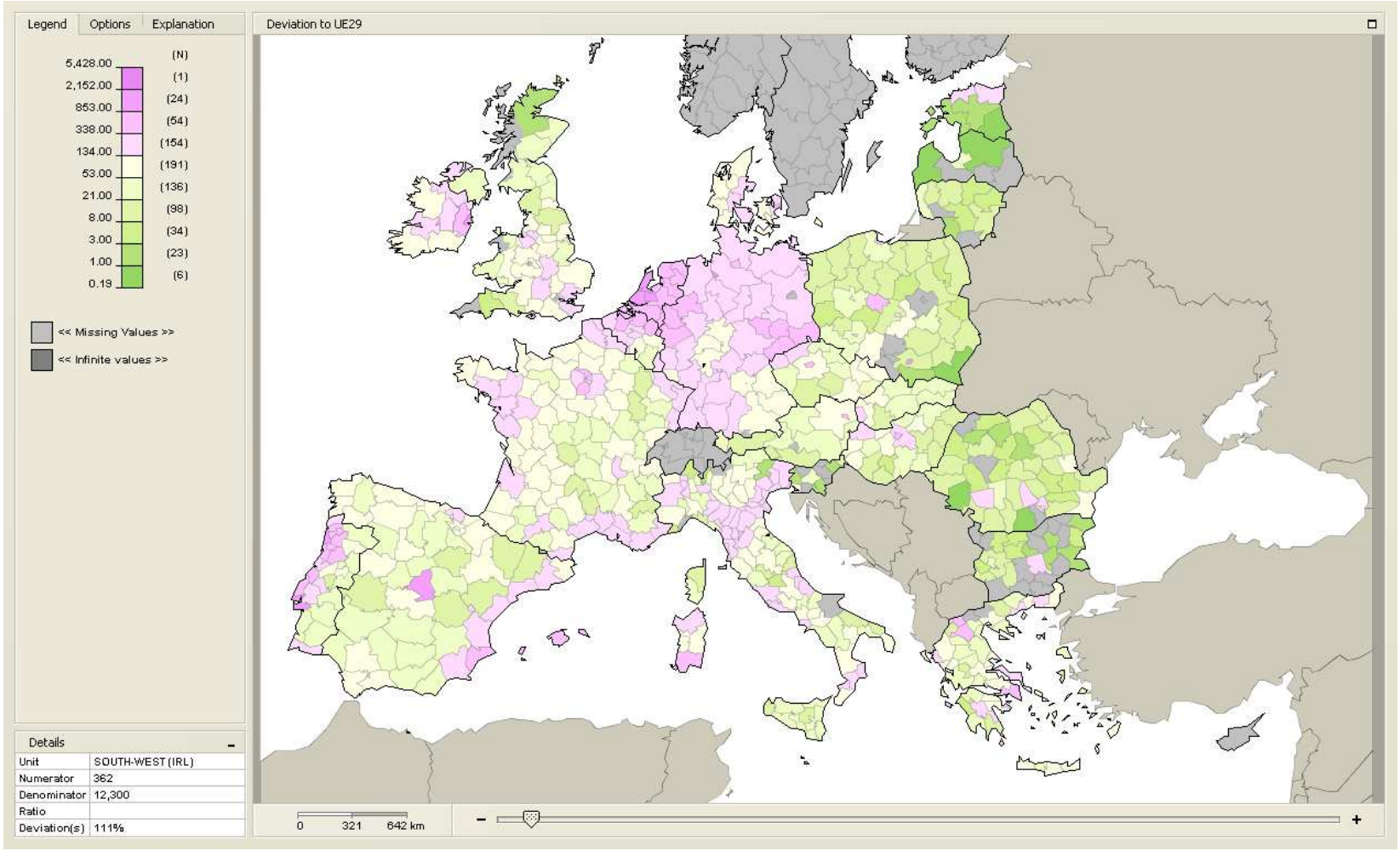
- Major sea basins

e.g

Sprawl of artificial areas 1990-2000 on Europen coasts, by dominant land cover types, km²



e.g. land uptake by artificial development, NUTS2/3, deviation of the European average, mean annual values



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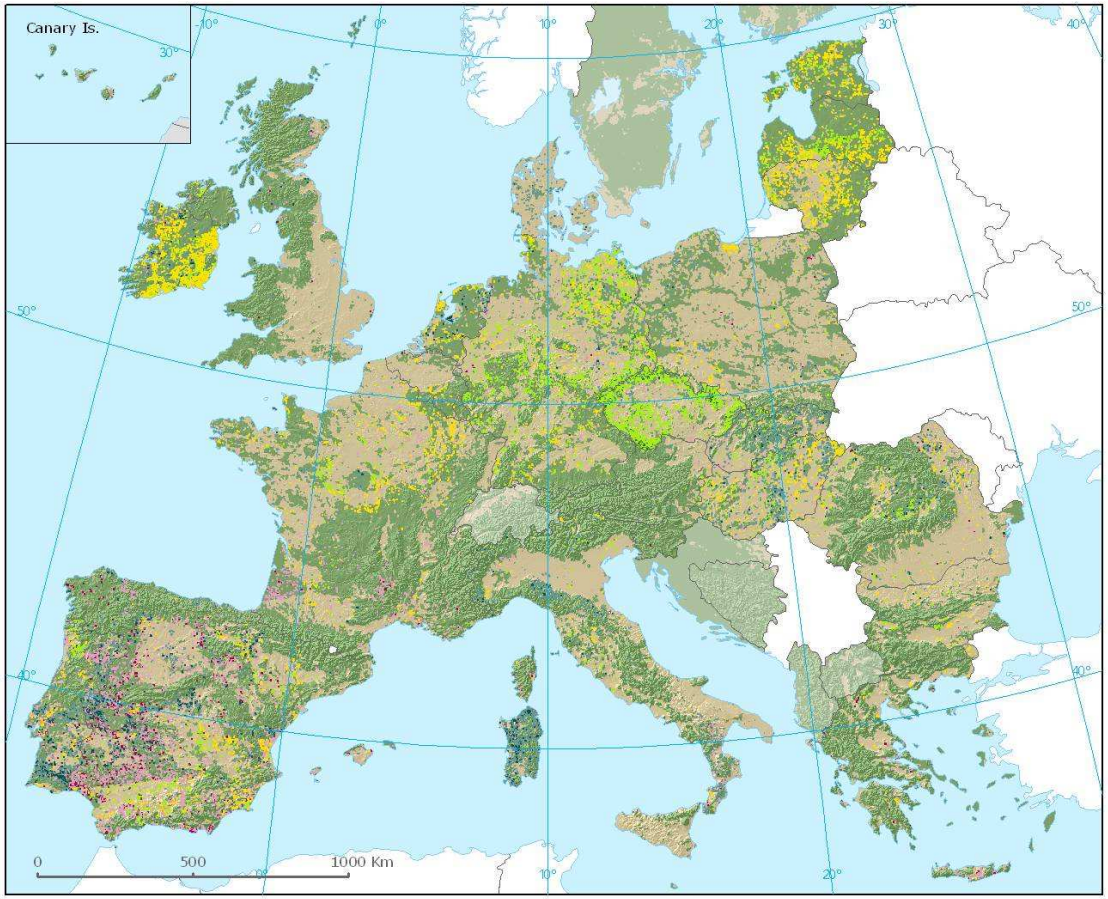
Change in agriculture / indicators

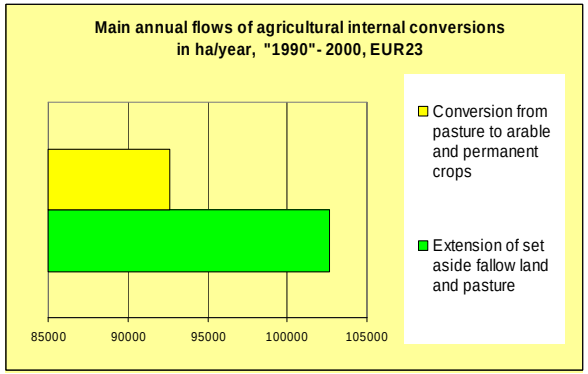


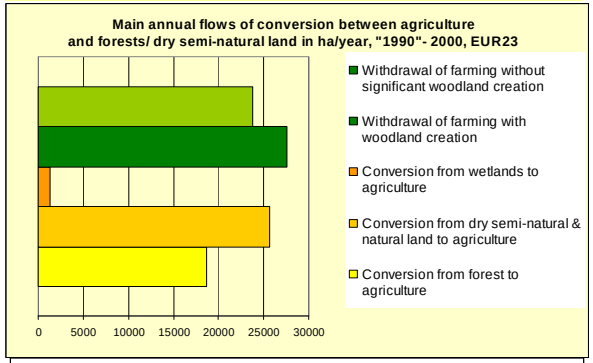
Net conversion of pasture to crop land
- Net increase of set aside/fallow land >30 %
- Net increase of set aside/fallow land 5 % to 30 %
- Net conversion of pasture to arable 5 % to 30 %
- Net conversion of pasture to arable >30 %

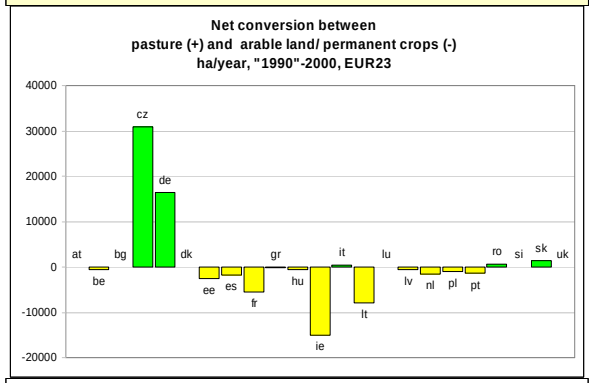
Withdrawal of farming (total)
- 2 % to 10 %
- more than 10 %

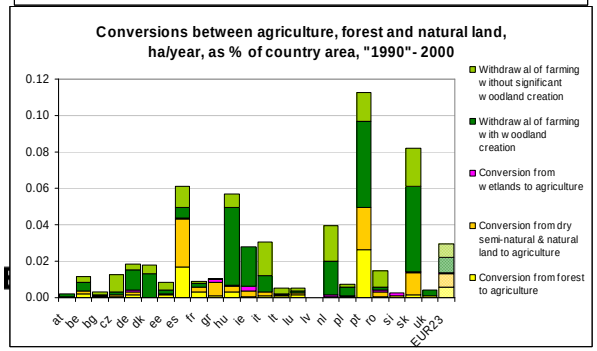
Conversion of land to agriculture
- 2 % to 10 %
- more than 10 %

Green background index (%)
- 0-60
- 61-100

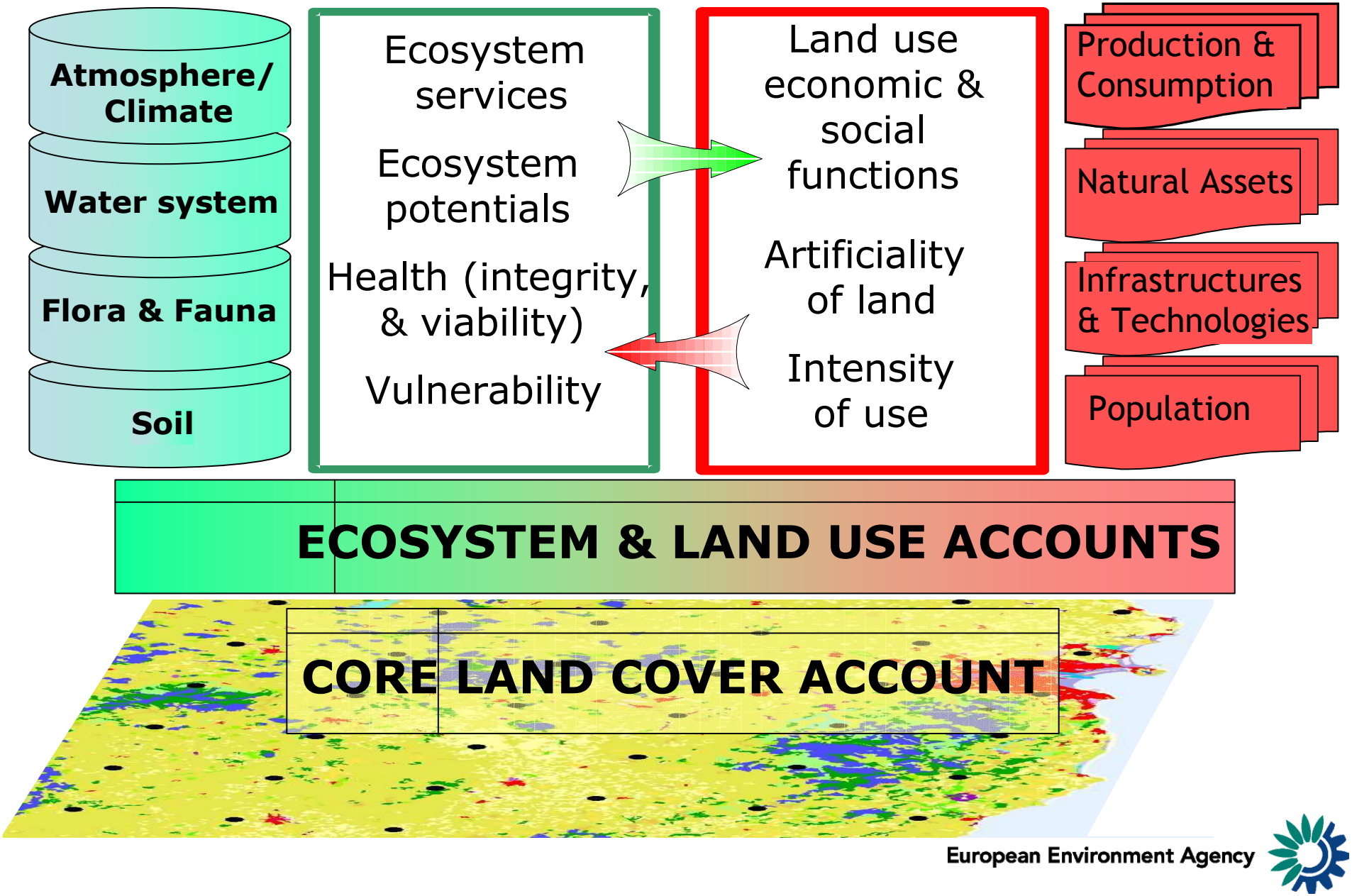








From land cover to land use & ecosystem accounting



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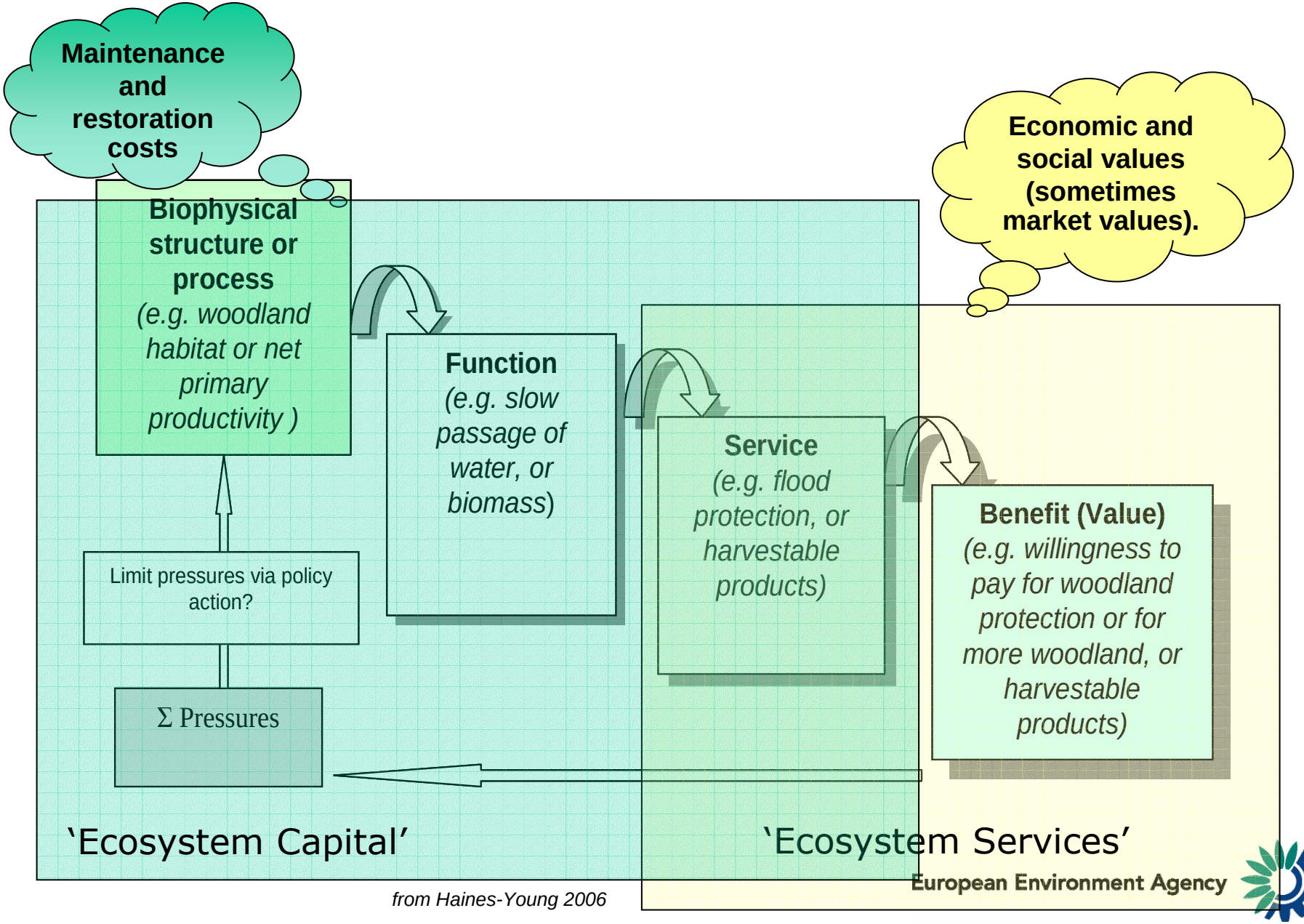
Ecosystem Capital and Ecosystem Services…



from Haines-Young 2006

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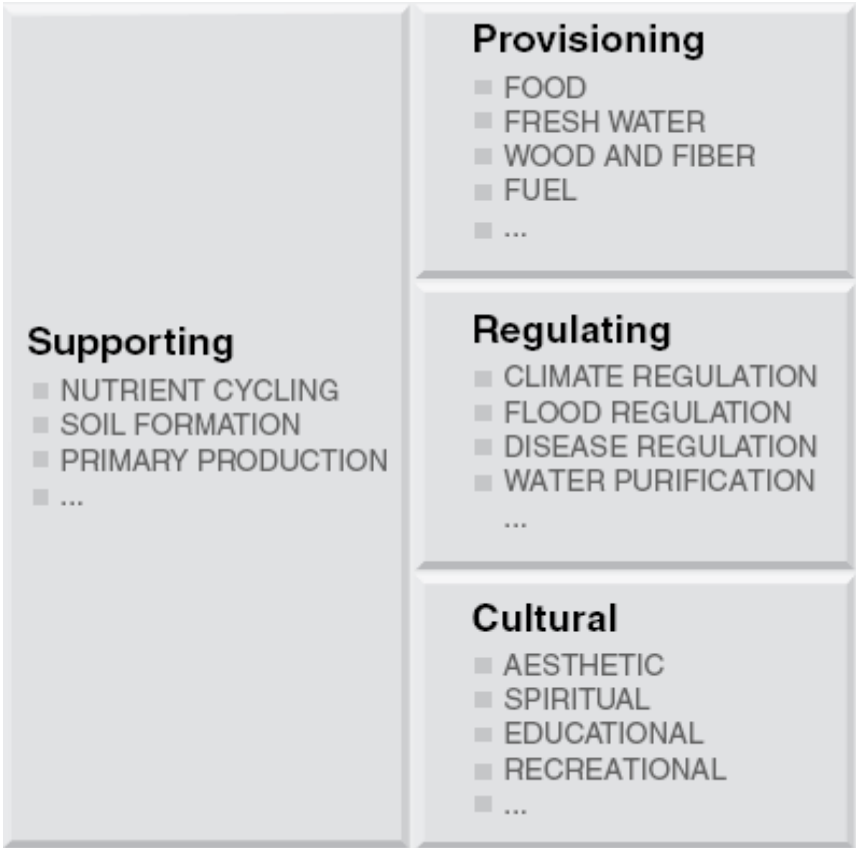
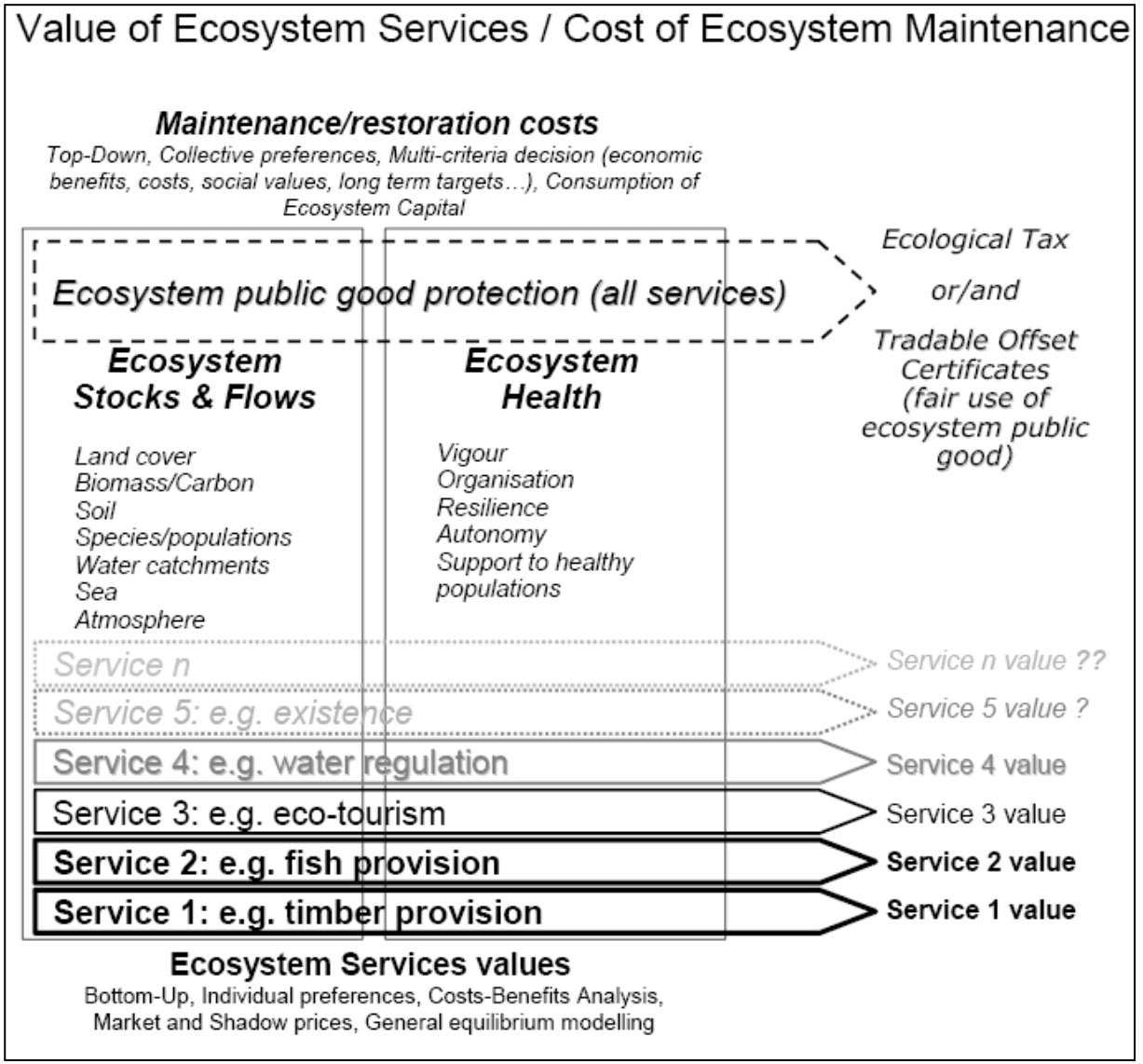
Ecosystem services classification

e.g. Millennium Ecosystem Assessment 2003



Common International Classification of Ecosystem Services definition process for SEEA2012/2013, MA2015, Eureca!2012, and other projects…

Values vs. Costs in Ecosystem Accounting



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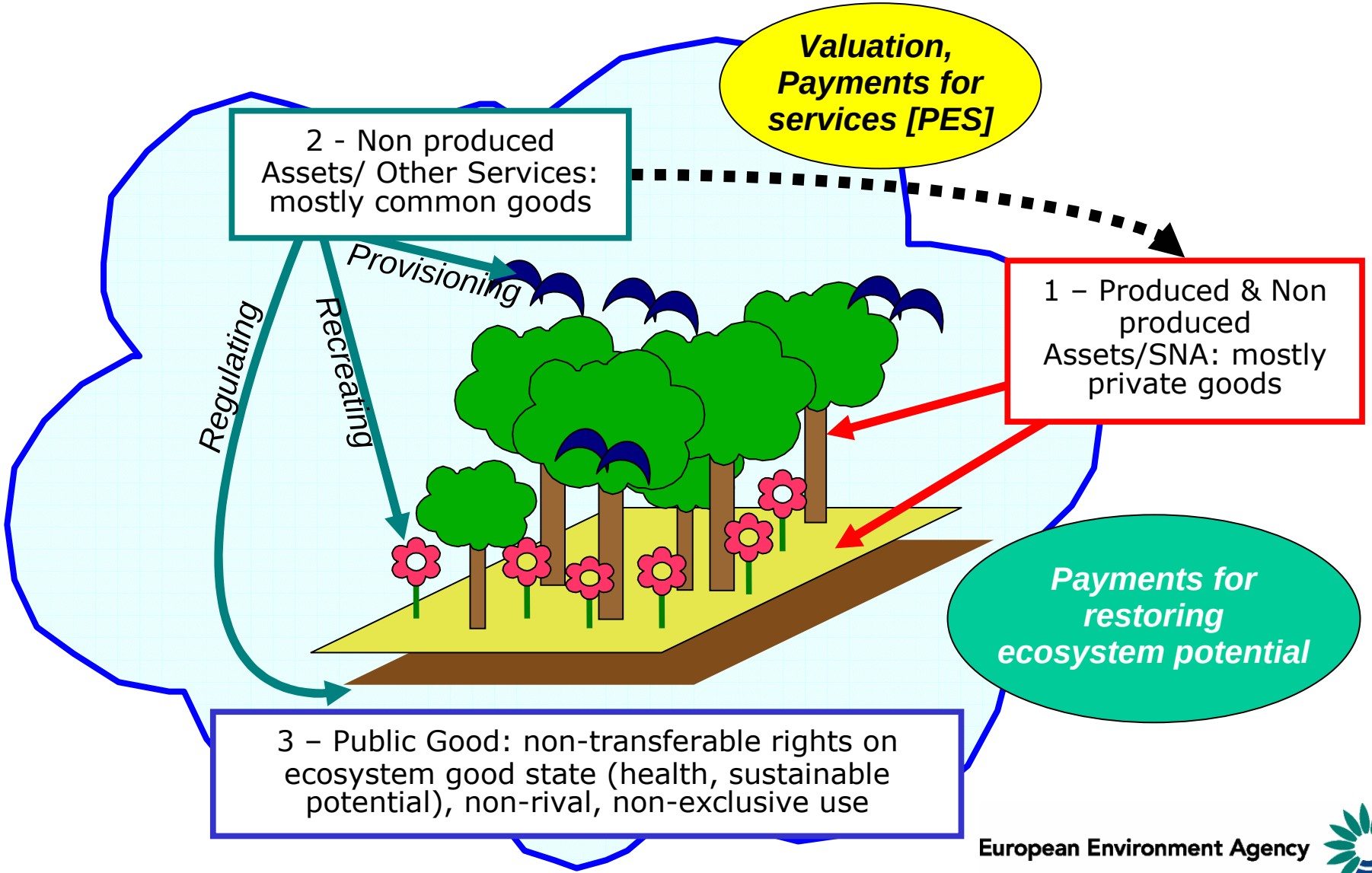
Assets, services and values: 3 components



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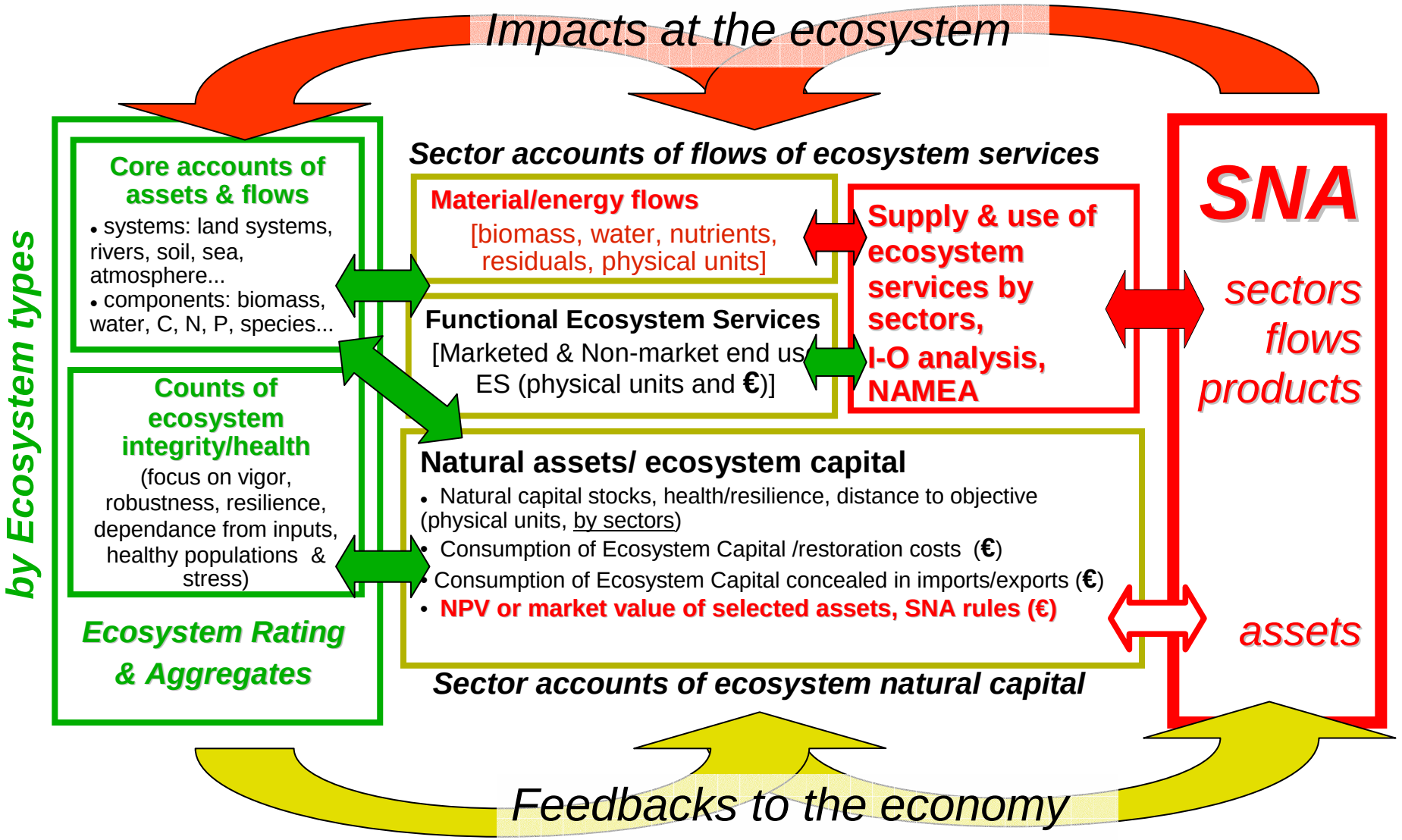
Ecosystem Accounts, SEEA2003 & SNA



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Basic accounts of stocks and flows by ecosystem types

- Terrestrial ecosystems:
  - land cover (km^2, number of land units)
  - rivers (standard-river-km, number of reaches)
  - small features (number of units)
- Marine ecosystem (km^2, km^3)
- Biodiversity
- Biomass (dry matter, C, energy…)
  - soil biomass
  - vegetation (non soil)
  - fauna
- Water quantity (m3)
- Nitrogen, Phosphorus (t)

Ecosystem health: counts of diversity/integrity

- Ecosystem Distress Syndrome model:
  - Disruptions of nutrients cycling (loss or excess)
  - Degradation of substrates (fragmentation, water stress, chemical stress)
  - Change in species composition (invasive…)
  - Dependence of systems from artificial input (energy, water, subsidies …)

- Specific diagnosis

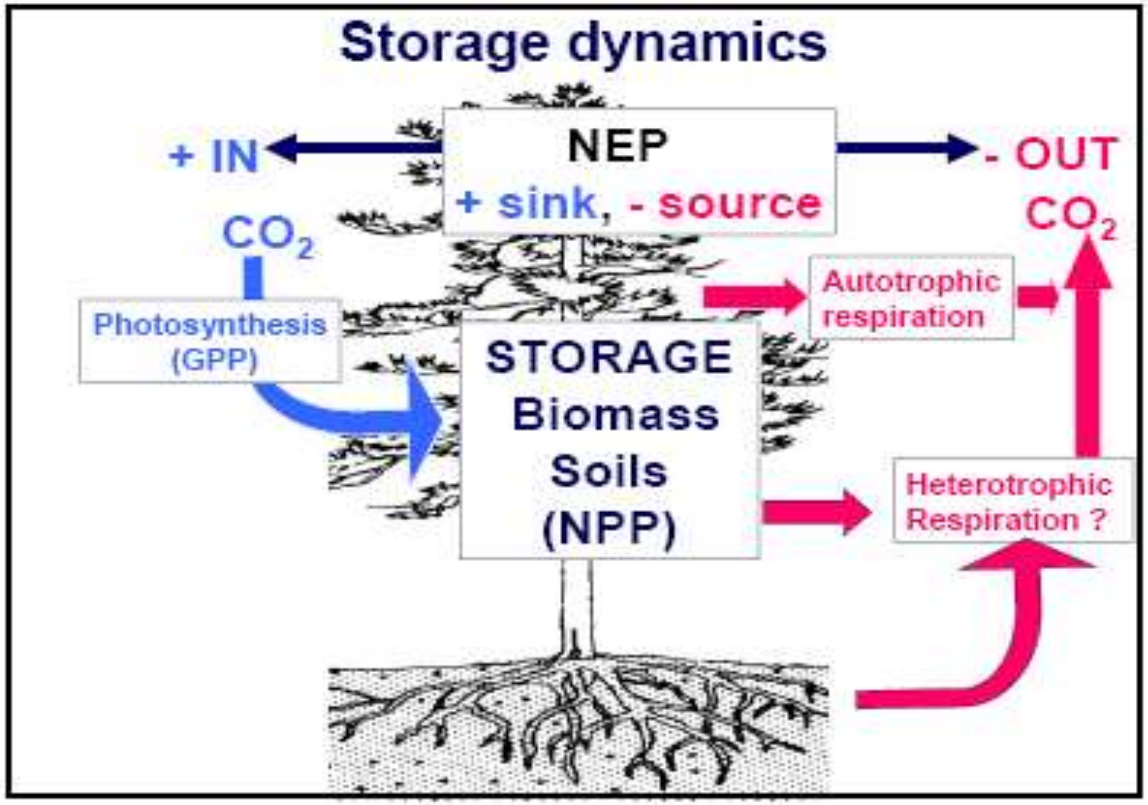
From selection of markers and threshold values according to habitat types, region, context

1. Homeostasis state (no alteration foreseen).
2. Resilience state (the disturbance that ecosystems are still able to absorb or compensate, *keeping the same functions, identity and feedbacks (Walker, 2005).*
3. Reversible process without compensation (degradation).
4. Irreversible change (death).

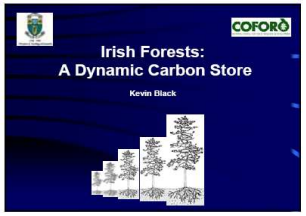
- Focussed research of stressors
  - overharvesting, overuse
  - land/rivers restructuring
  - deposition of residuals
  - introduction of species

- Physical wealth as stocks*coefficients (potential, resilience)

Biomass & NPP



- Anomalies, distress symptom
- Direct Material Consumption – Total Material Requirement (Material Flows Accounts)
- HANPP
- ‘Supporting service’



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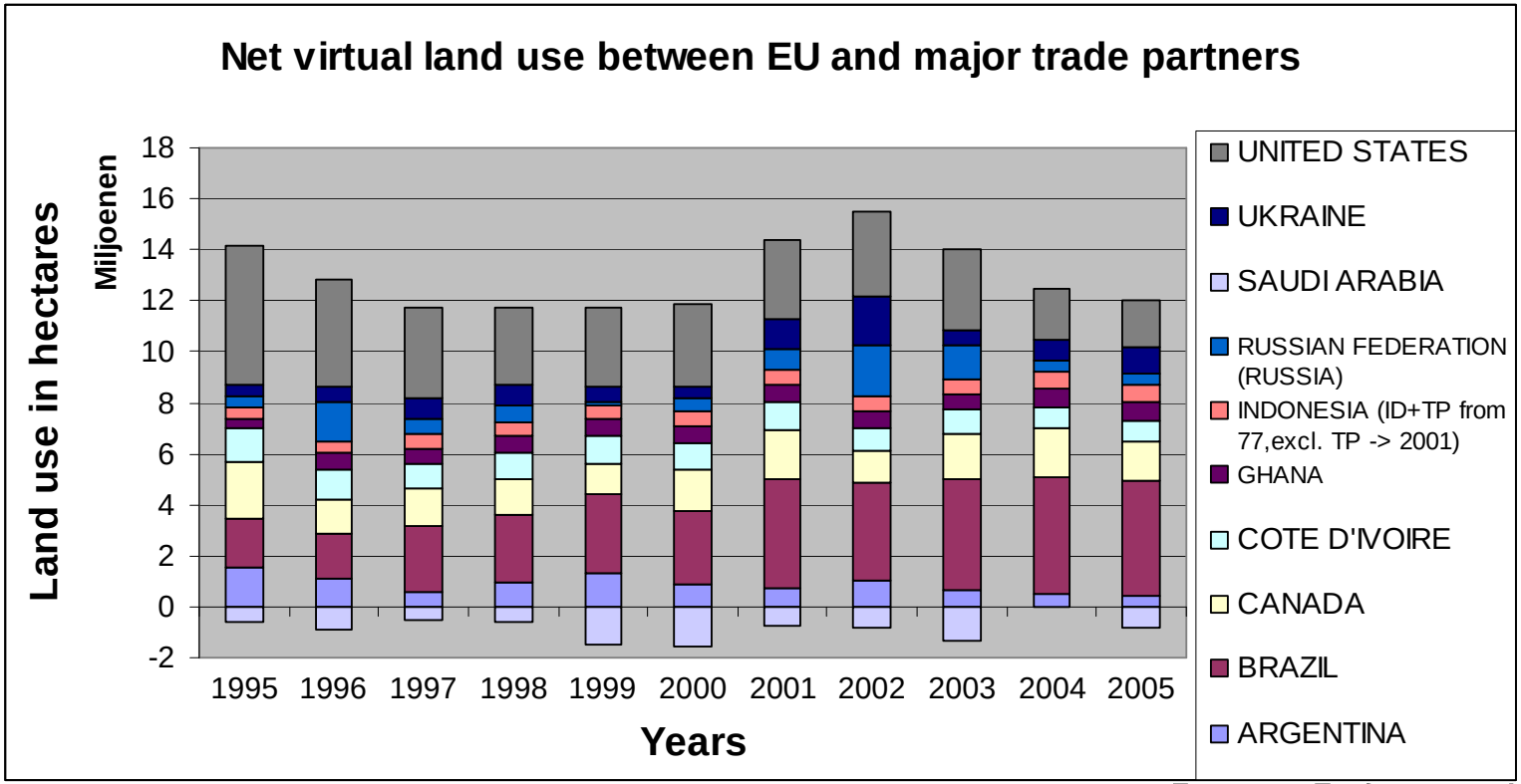
Virtual (embodied) land use

Trends in EU virtual land flows: EU agricultural land use through international trade between 1995-2005. Manel van der Sleen, EEA 2009



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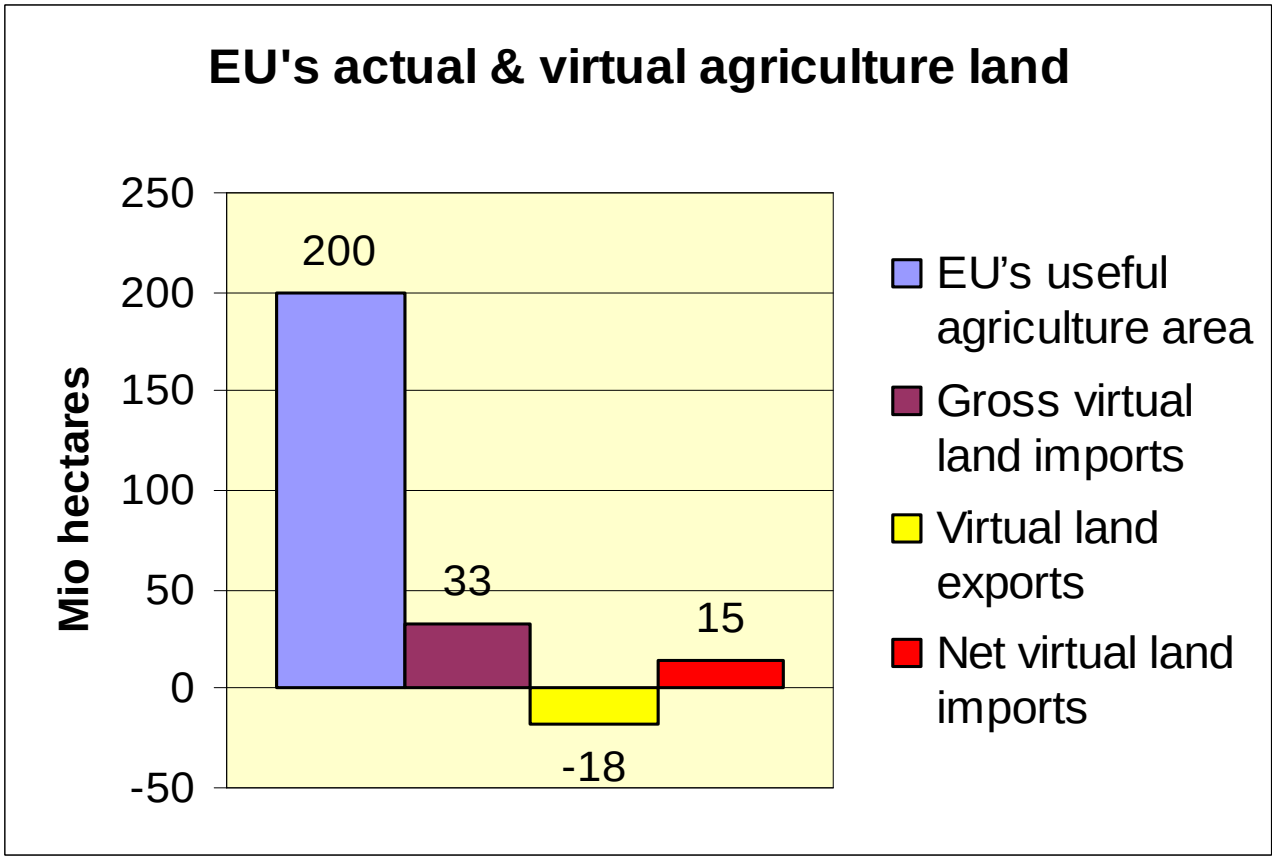
International Trade: Virtual land use & agriculture footprints



Source: Manel Van der Sleen, 2009

+ associated virtual water, virtual carbon emissions (CO2, CH4…)

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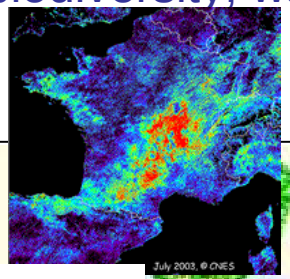
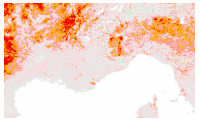
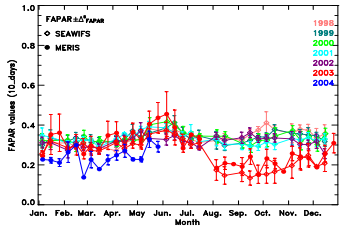
Integration of space monitoring into ecosystem accounting:

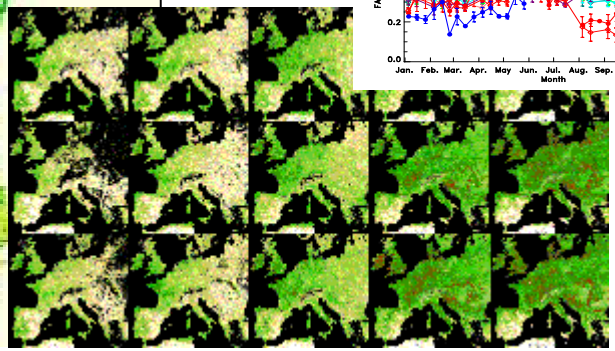
land cover change x NPP x structure/texture x short time variability x stratification of in situ monitoring (biodiversity, water…)



Fires Droughts
(SPOT4-Vegetation/ CNES – Vito)

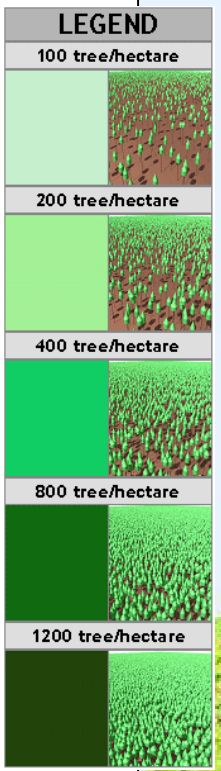


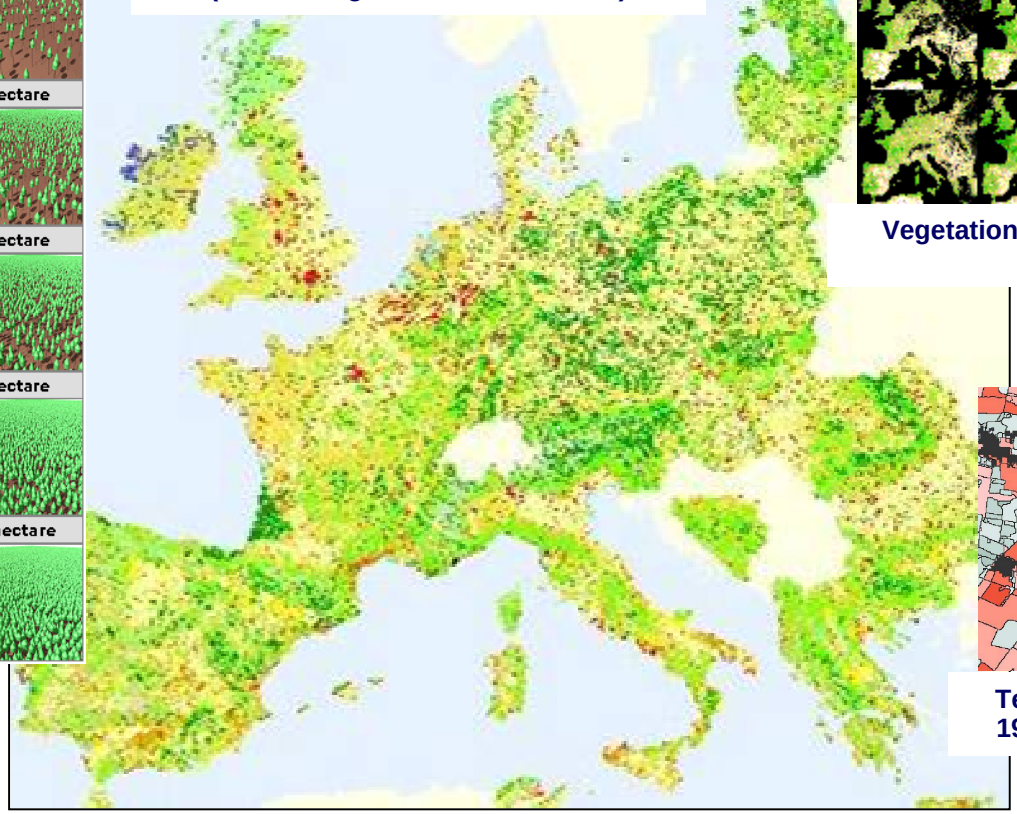


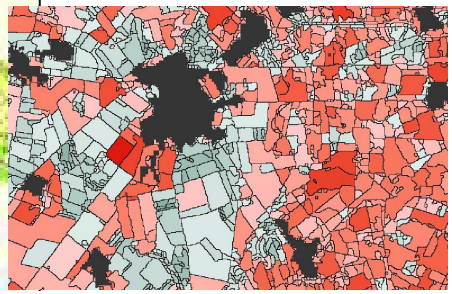


Vegetation productivity, seasonal change
(MERIS/JRC-IES)

Forest structure (MODIS-Multi-angle/JRC-IES)







Texture, parcelisation changes
1988 – 1998 (Landsat/JRC-IES)

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Ecological truth & market prices in the National Accounts

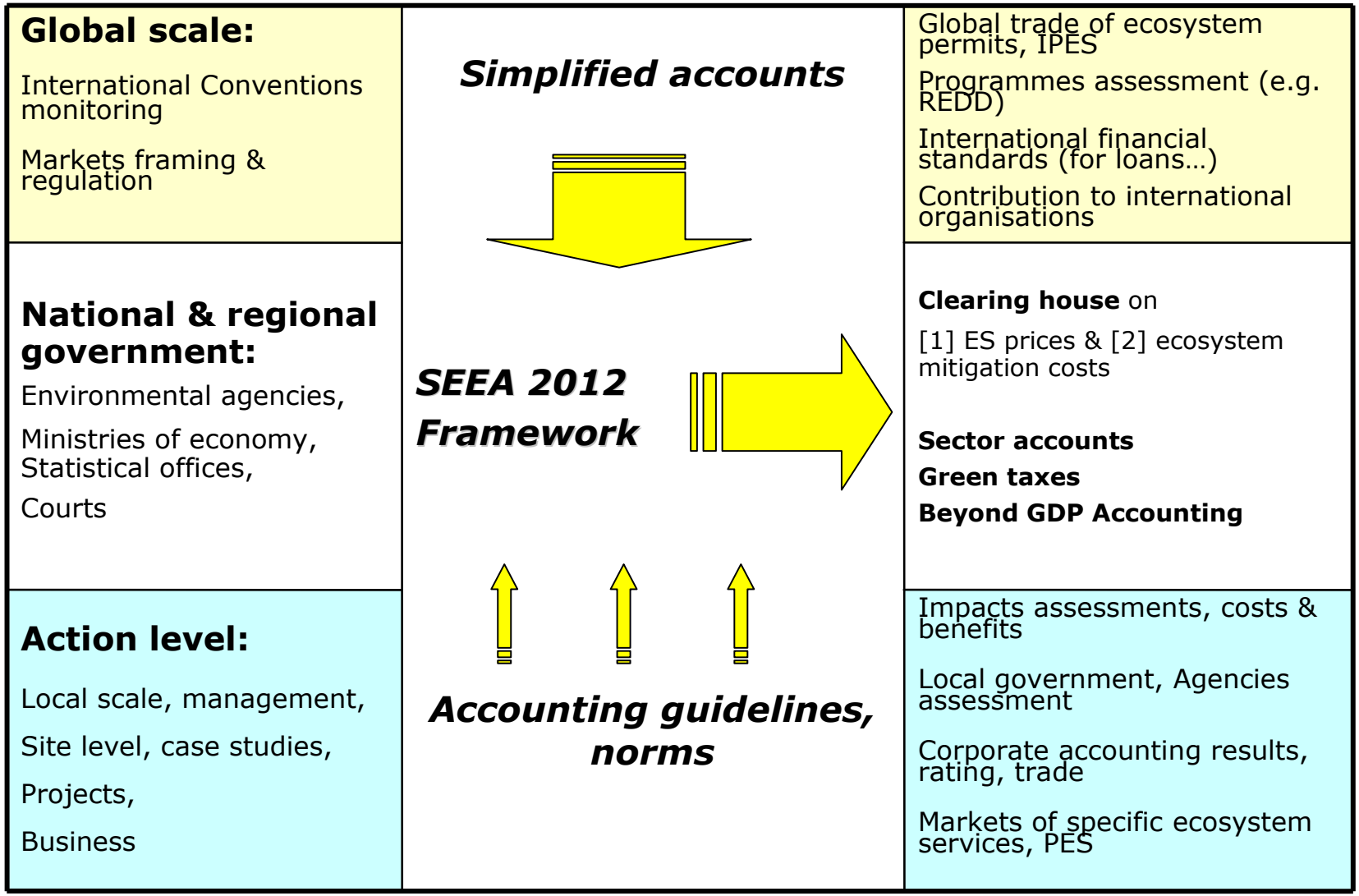
Risks of unsustainable use of the living natural capital are ignored: the negative impacts of over-harvesting, force-feeding with fertilisers, intoxication, introduction of species, fragmentation by roads, or sealing of soil by urban development have no direct immediate monetary counterpart in financial results (but consequences for the future).

Natural capital depreciation is not fully amortised in accounting books of companies and not at all in the national accounts – no allowance is made for maintaining ecosystems' critical functions and services, as it is done for manmade capital. Therefore the full cost of domestic products is not covered in many cases by their price.

This is as well the case of the price of imported products made from degrading ecosystems: their full cost is not covered by their price.

Free ecosystem services are not accounted (the market tells: price is zero) or entangled in market prices of commodities or economic assets.

Scales, accounts, governance



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Simplified ecosystem accounts

Markets need accounts, regulations [= control]

Land ecosystems are spatially distributed => grid data [e.g. 1 km2] connect scales

Globally, change matters [degradation or improvement of ecosystem functioning and attached cost or benefit], not the value of the stock

Global multicriteria rating is possible based on a small number of ecological potentials [derived from ecosystem accounts]:

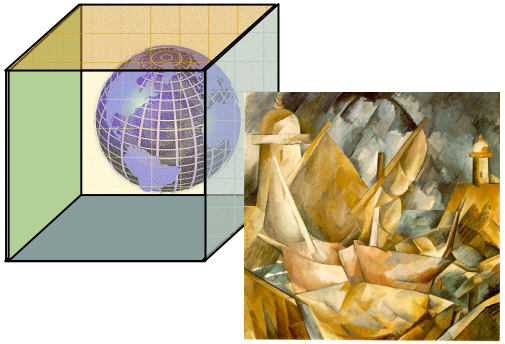
- ***Landscape ecological potential [LEP]***
- ***Human Appropriation of the Net Primary Production***
- ***Biodiversity rarefaction***
- ***Exergy loss [river basins]***
- ***Dependance from external inputs [material/energy, footprint]***

➔ losses/gains of "points of ecological potential"

➔ computation of restoration costs [needed for compensating losses // or accumulated by gains of points]

<u>Rating</u> can be detailed further on as necessary for policy [national, regional] and action scales [local, business]

Simplified Ecosystem Accounts : a “Cubist” Approach



Georges Braque – Harbour in Normandy, 1909

Multi-criteria rating

Dependency Index
(land, soil, energy, water, N,P,K...)

Biodiversity Index
(rarefaction, loss of adaptability)

Bio-productivity Index
(carbon, biomass, diversion from Nature)

Landscape Index
(the Landscape Ecological Potential)

Health Index
(human, wildlife and plants populations)

Water Index
(exergy loss from evaporation & pollution)

Total Ecological Potential
(terrestrial ecosystems)

Consumption of Ecosystem Capital = Change in TEP * €

No valuation of ecosystem assets is needed

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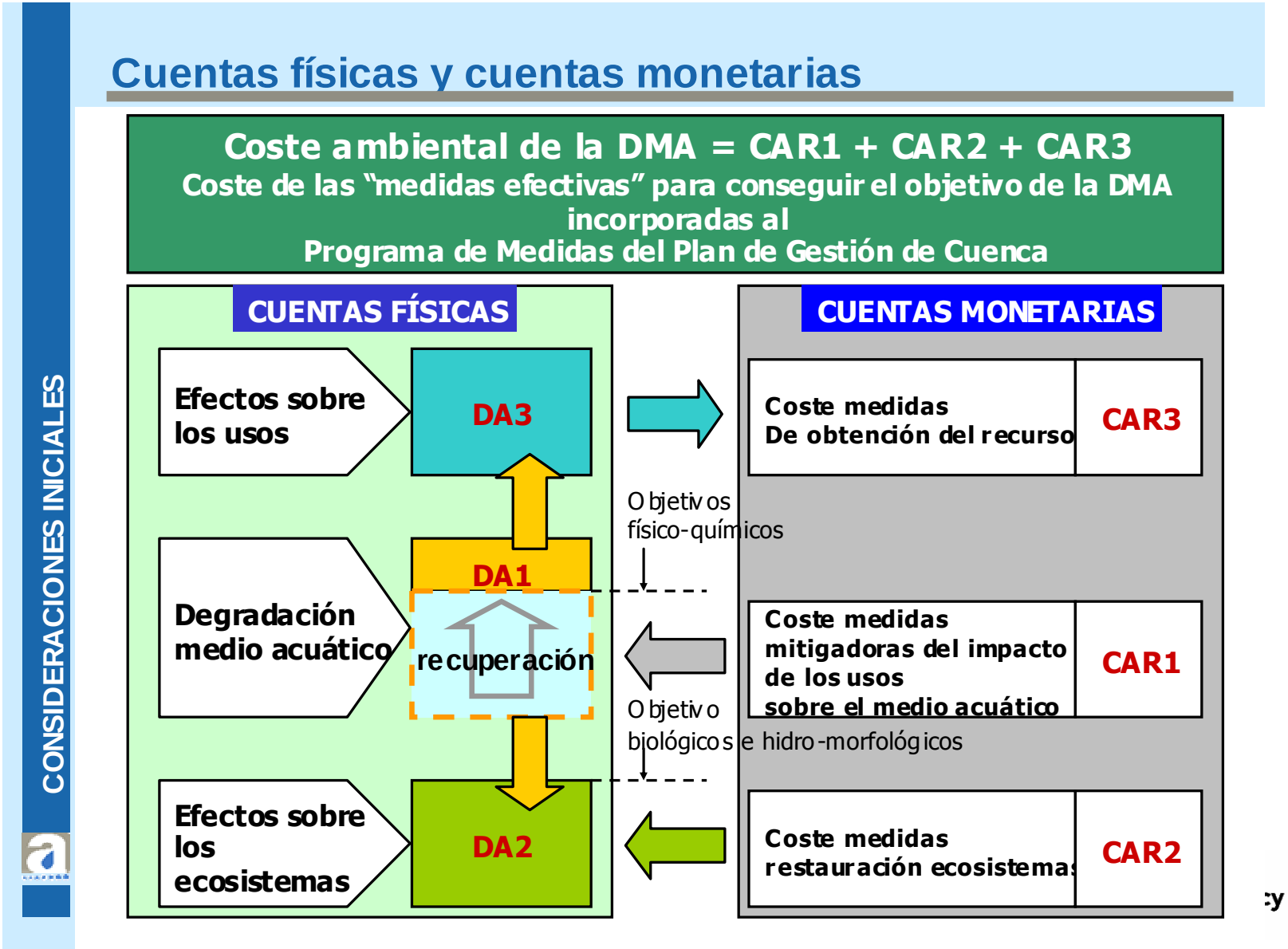
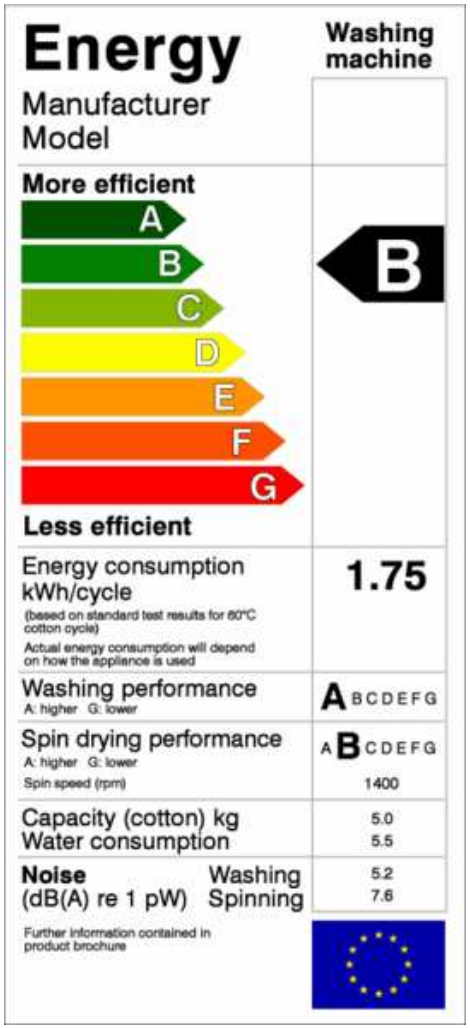
Similar approach in Spain (Escriu, Naredo…) for water ecosystems



Multicriteria rating



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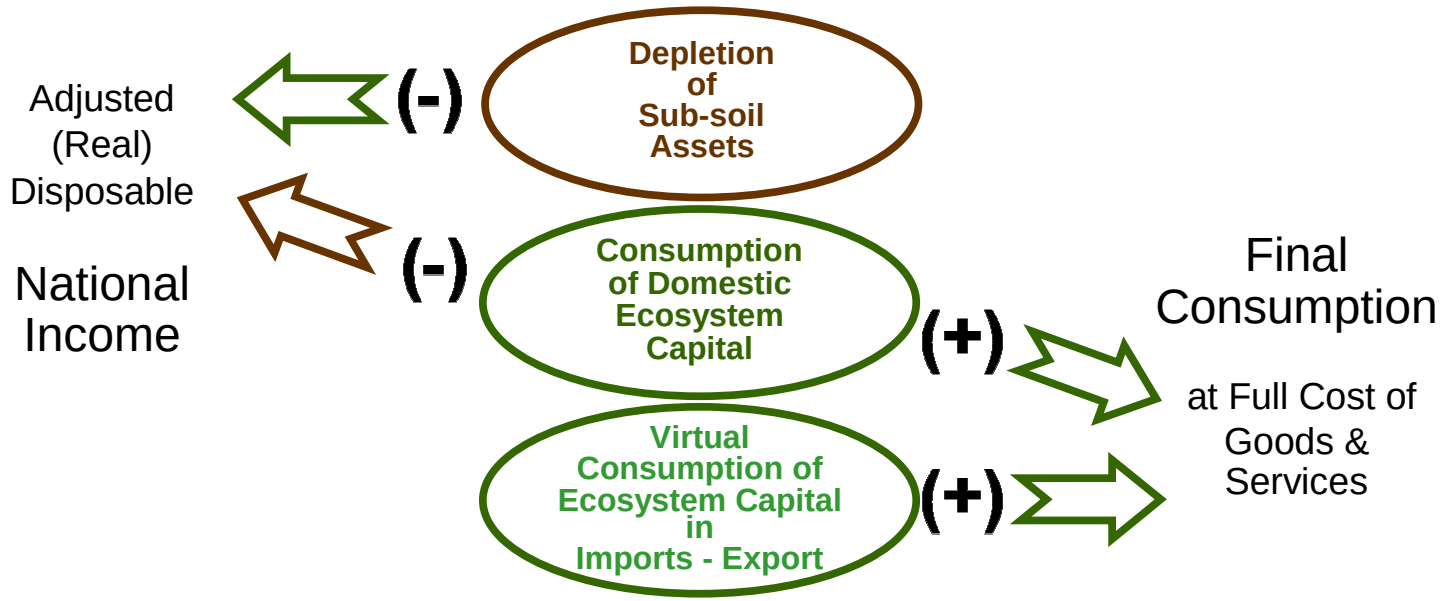
Ecosystem Accounts
& National Accounts Adjustment

Consumption of Ecosystem Capital
& Adjustments of National Accounts for “over-consumption” and/or “under-investment”



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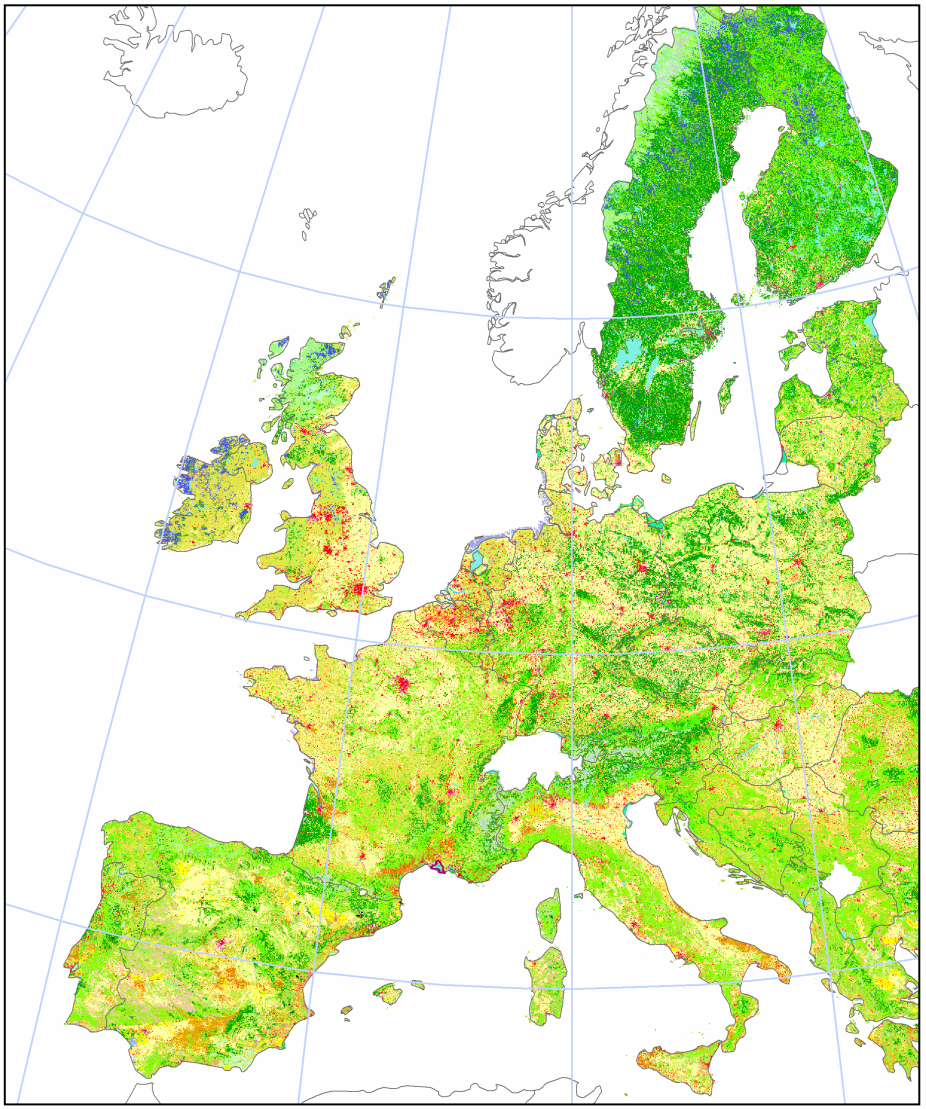
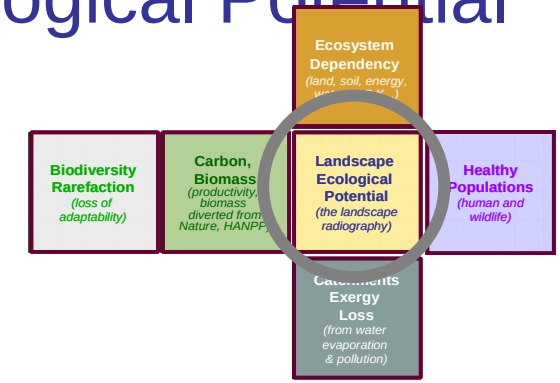
Example: making of Landscape Ecological Potential (1/6)





Corine land cover map *(derived from satellite images)*

Green Background Landscape Index *(derived from CLC)*

Naturilis *(derived from Natura2000 & CDDA)*

Effective Mesh Size *(MEFF, derived from TeleAtlas and CLC)*

Landscape Ecological Potential (LEP) 2000, by 1km² grid cell

LEP 2000 by NUTS 2/3

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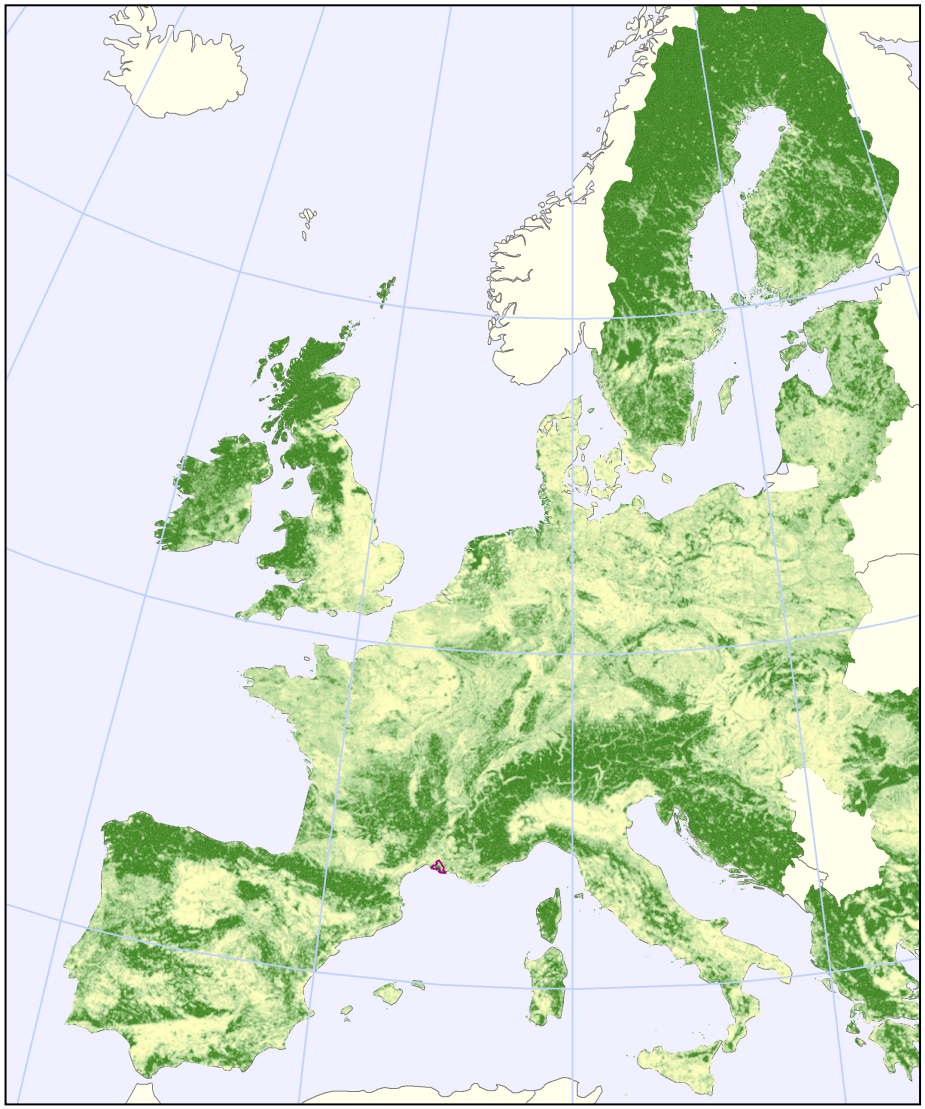
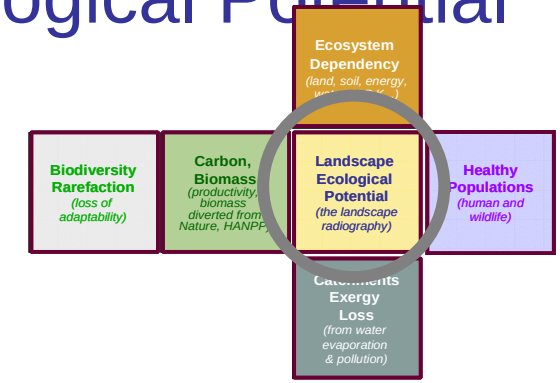
Example: making of Landscape Ecological Potential (2/6)





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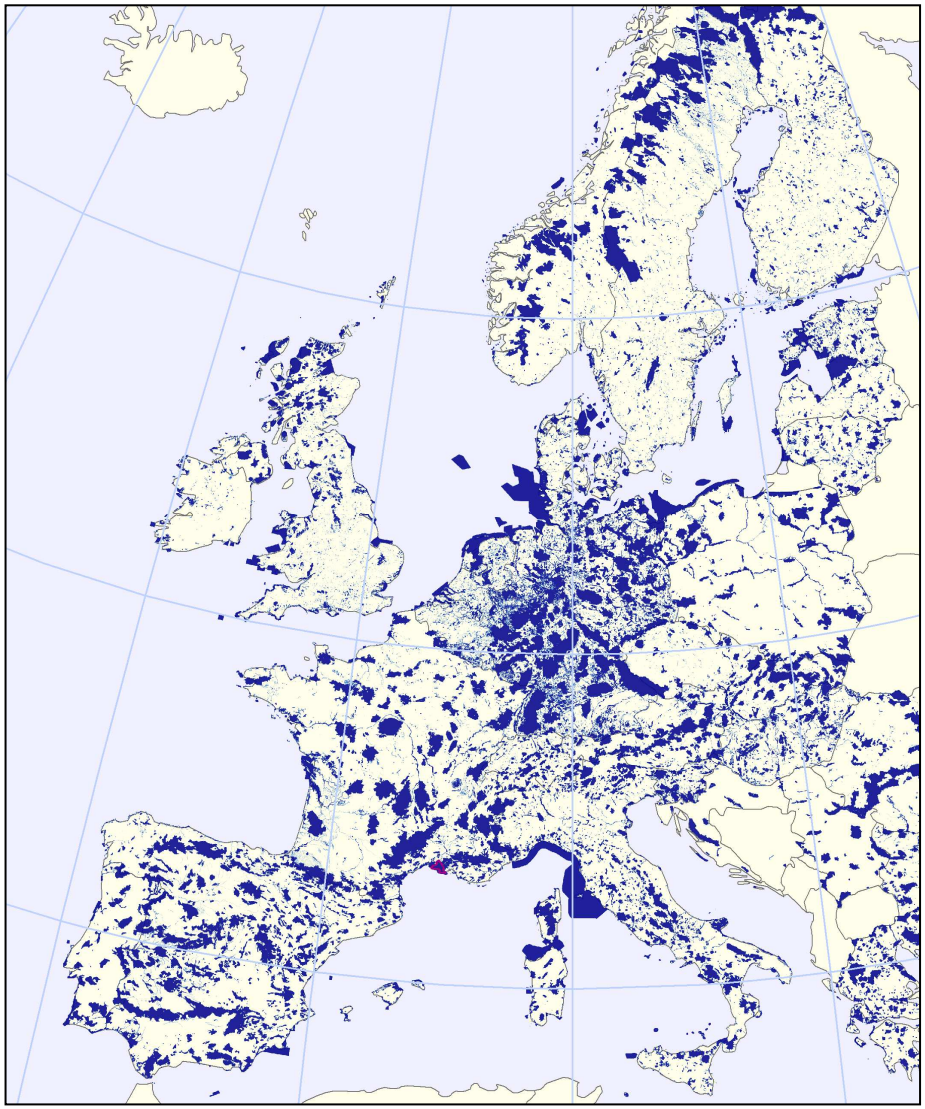
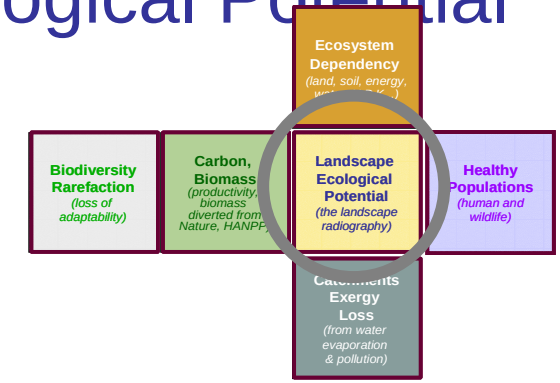
Landscape Ecological Potential (LEP) 2000, by 1km² grid cell

LEP 2000 by NUTS 2/3

European Environment Agency

Example: making of Landscape Ecological Potential (3/6)





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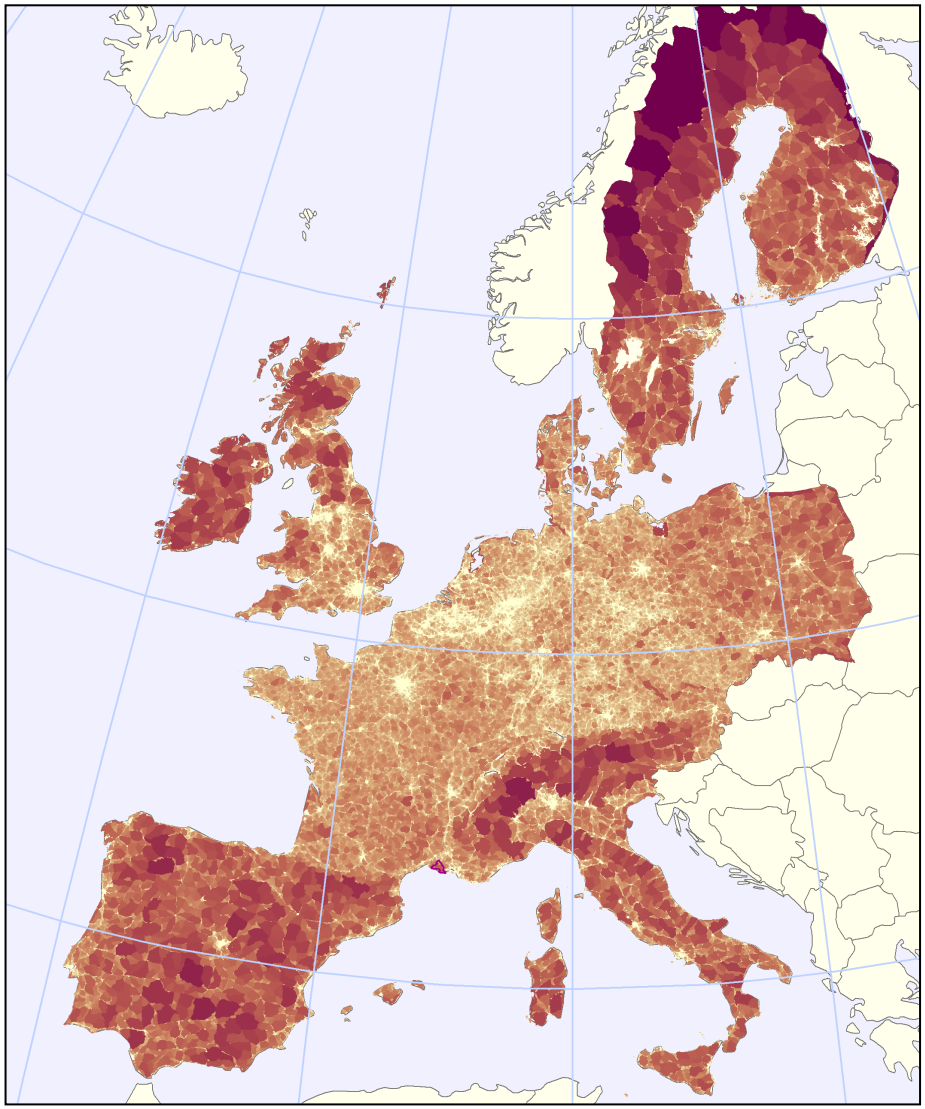
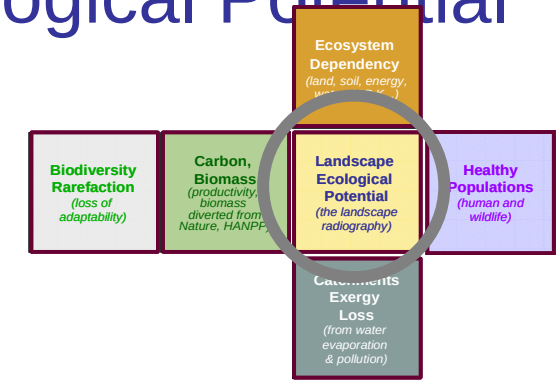
Landscape Ecological Potential (LEP) 2000, by 1km² grid cell

LEP 2000 by NUTS 2/3

European Environment Agency

Example: making of Landscape Ecological Potential (4/6)





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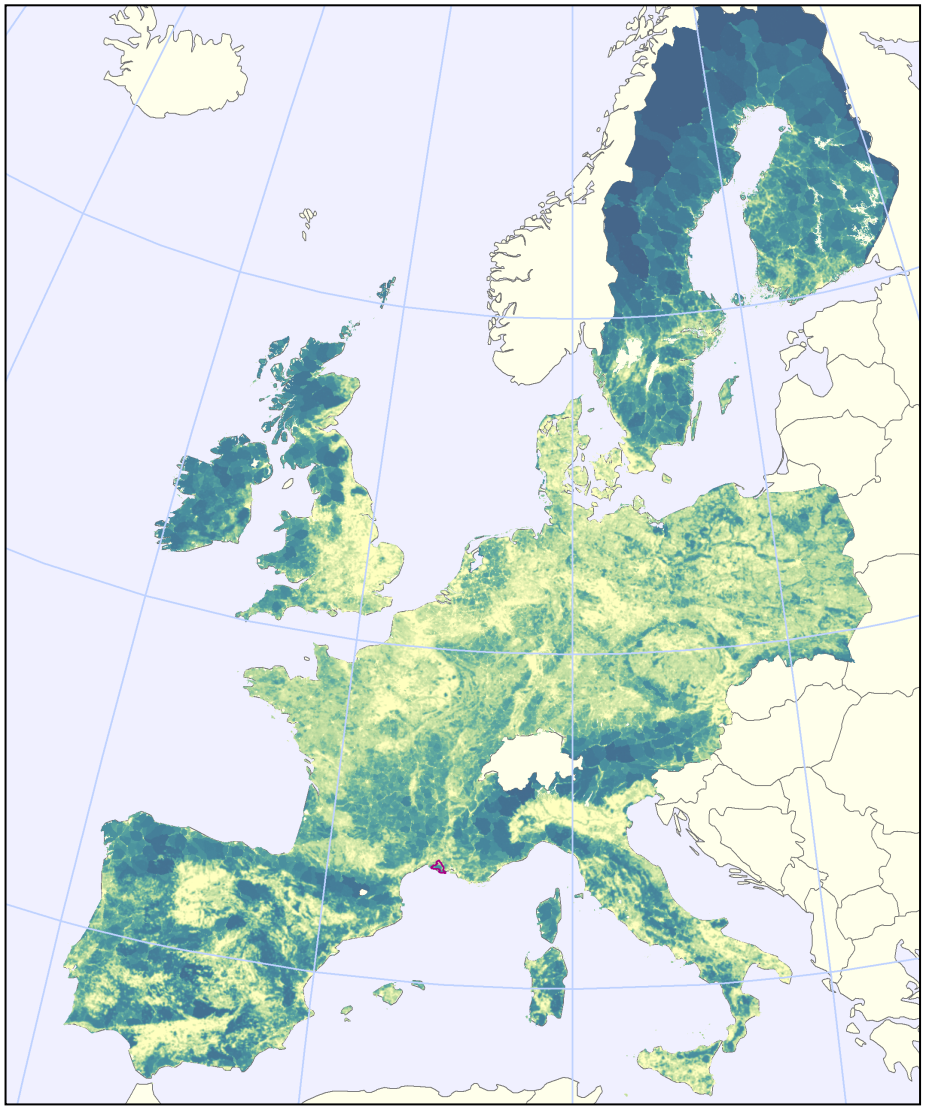
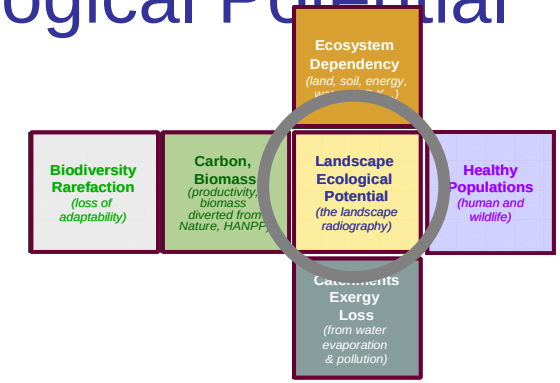
Landscape Ecological Potential (LEP) 2000, by 1km² grid cell

LEP 2000 by NUTS 2/3

European Environment Agency

Example: making of Landscape Ecological Potential (5/6)





Corine land cover map *(derived from satellite images)*

Green Background Landscape Index *(derived from CLC)*

Naturilis *(derived from Natura2000 & CDDA)*

Effective Mesh Size *(MEFF, derived from TeleAtlas and CLC)*

Landscape Ecological Potential (LEP) 2000, by 1km² grid cell

LEP 2000 by NUTS 2/3

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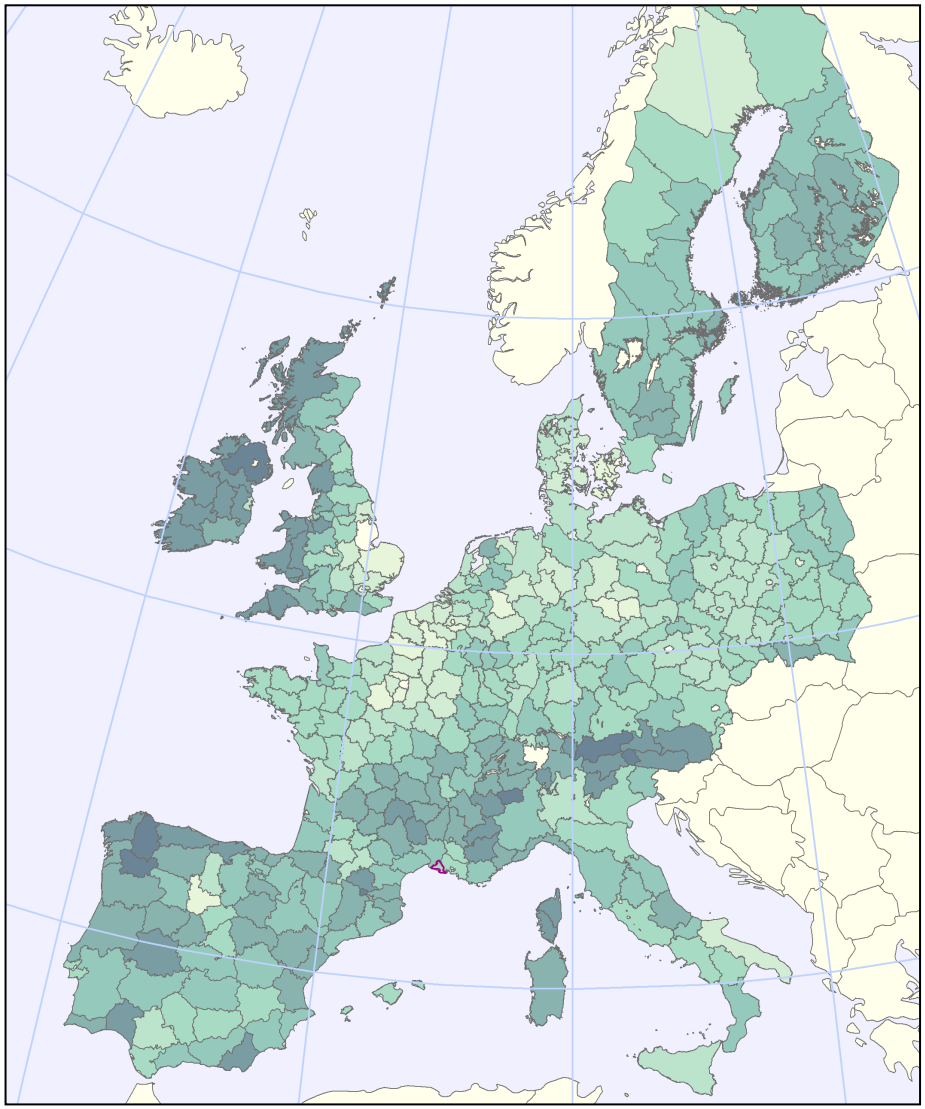
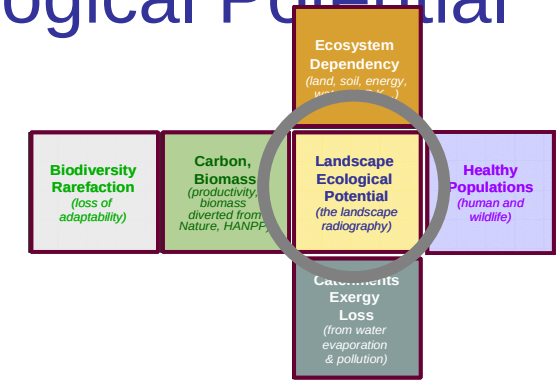
Example: making of Landscape Ecological Potential (6/6)





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Green Background Landscape Index *(derived from CLC)*

Naturilis *(derived from Natura2000 & CDDA)*

Effective Mesh Size *(MEFF, derived from TeleAtlas and CLC)*

Landscape Ecological Potential (LEP) 2000, by 1km² grid cell

LEP 2000 by NUTS 2/3

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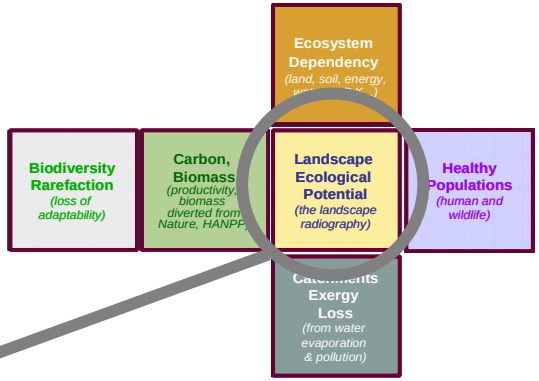
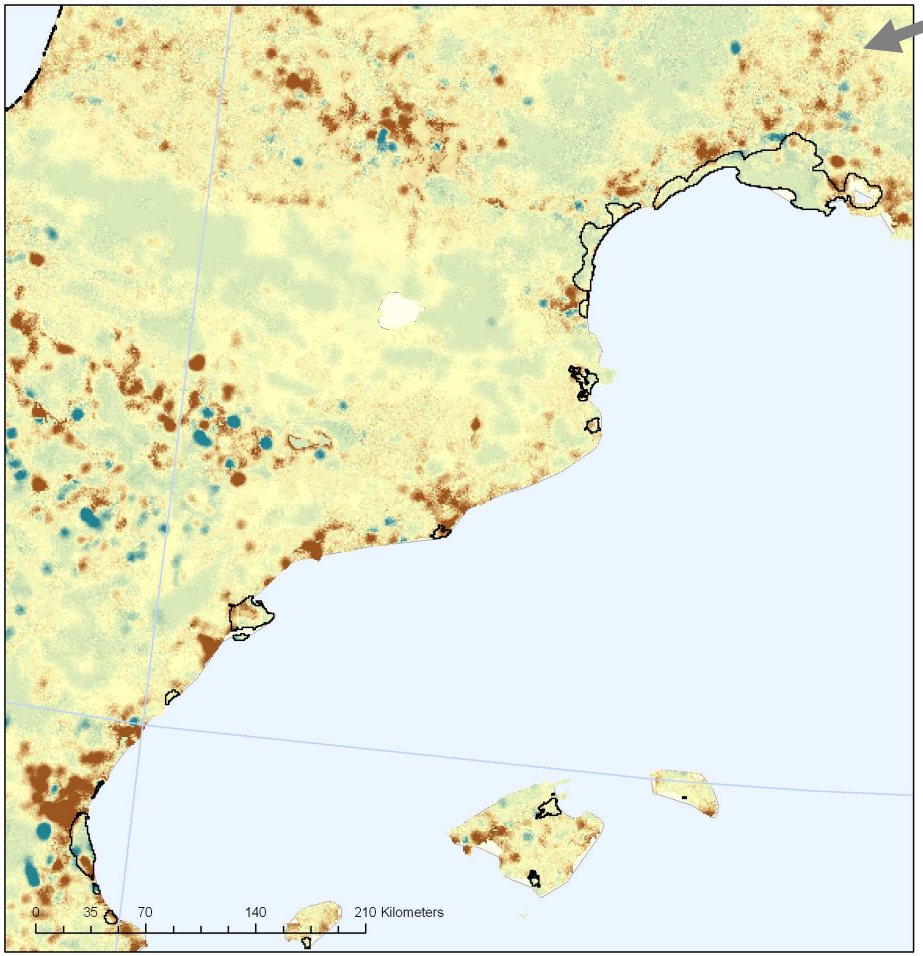
LEP, state and change

Landscape Ecological Potential 1990-2000, 1km² grid

(Source: Ecosystem Accounting for Mediterranean Wetlands, an EEA feasibility study for TEEB)

In brown grades, first clues of “ecosystem capital consumption”
Which will be validated with other “cube” indicators





Change 1990-2000

Legend

Change Net LEP 1990 to 2000

1 km² grid, range : -255 to +255

High : 118.464

Low : -84.664

Source:

EEA/ETCLUSI from GBLI, NATURILIS and MEFF

Methodology:

EEA/ETCLUSI

Provisional results – February 2008

European Environment Agency

LEP, state and change, local scale

Landscape Ecological Potential 1990-2000, 1km² grid

(Source: Ecosystem Accounting for Mediterranean Wetlands, an EEA feasibility study for TEEB)

In brown grades, first clues of “ecosystem capital consumption”
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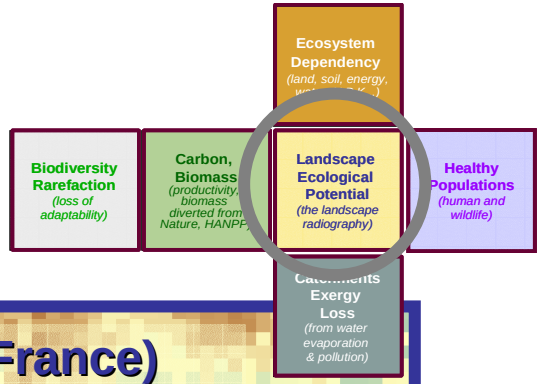

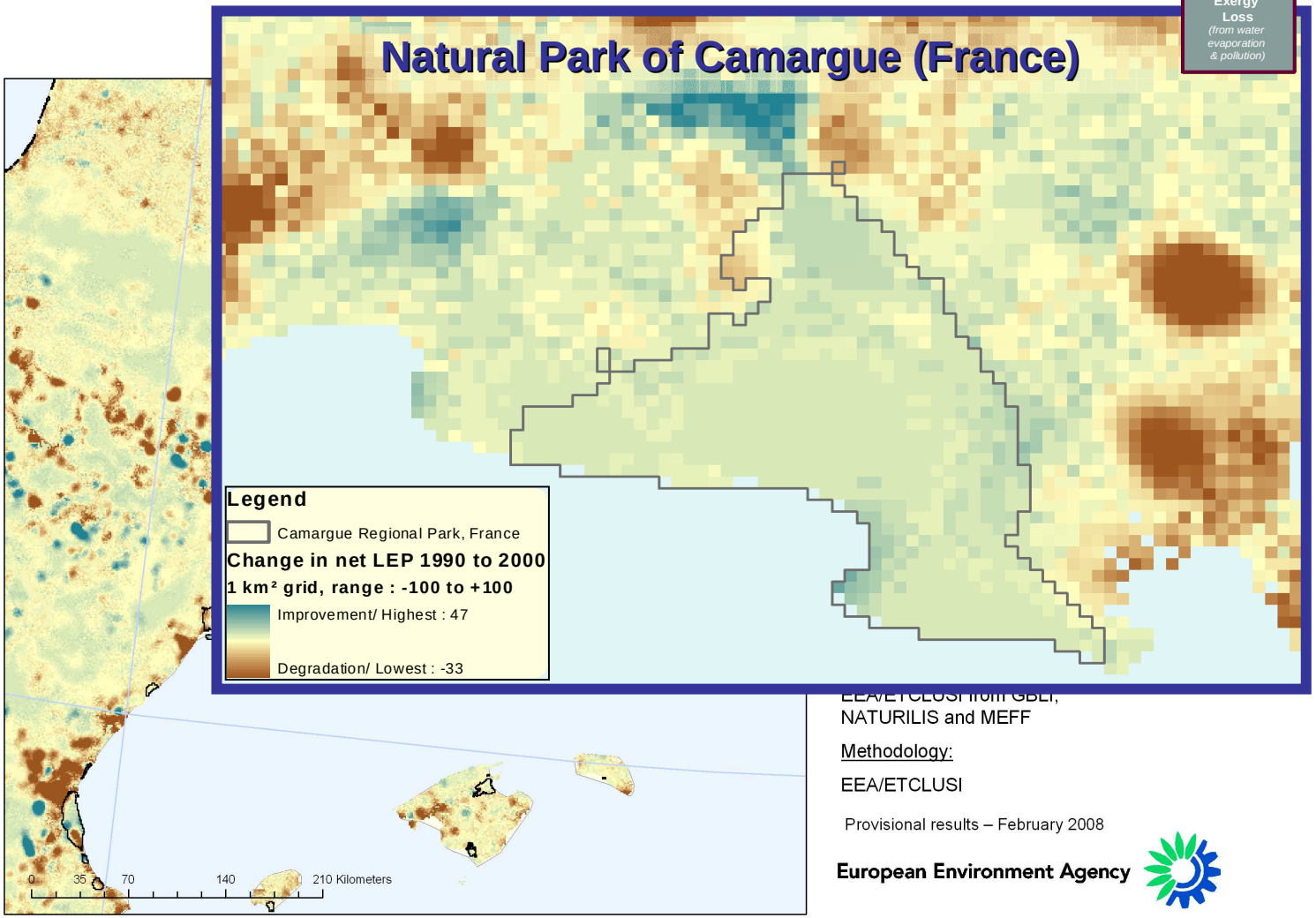

NATURILIS and MEFF

Methodology:

EEA/ETCLUSI

Provisional results – February 2008

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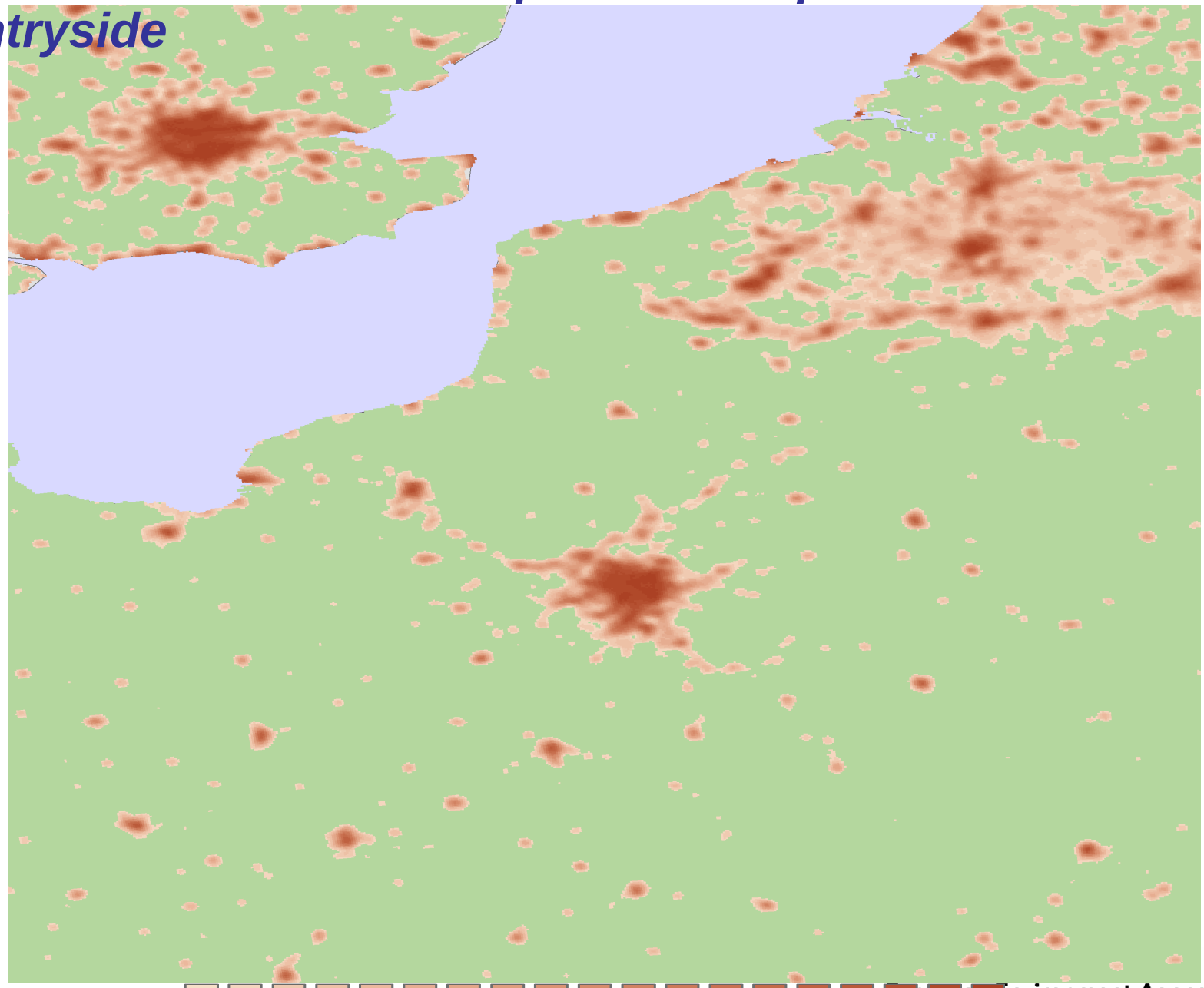
Quick Scan : when urban sprawl takes place in the countryside



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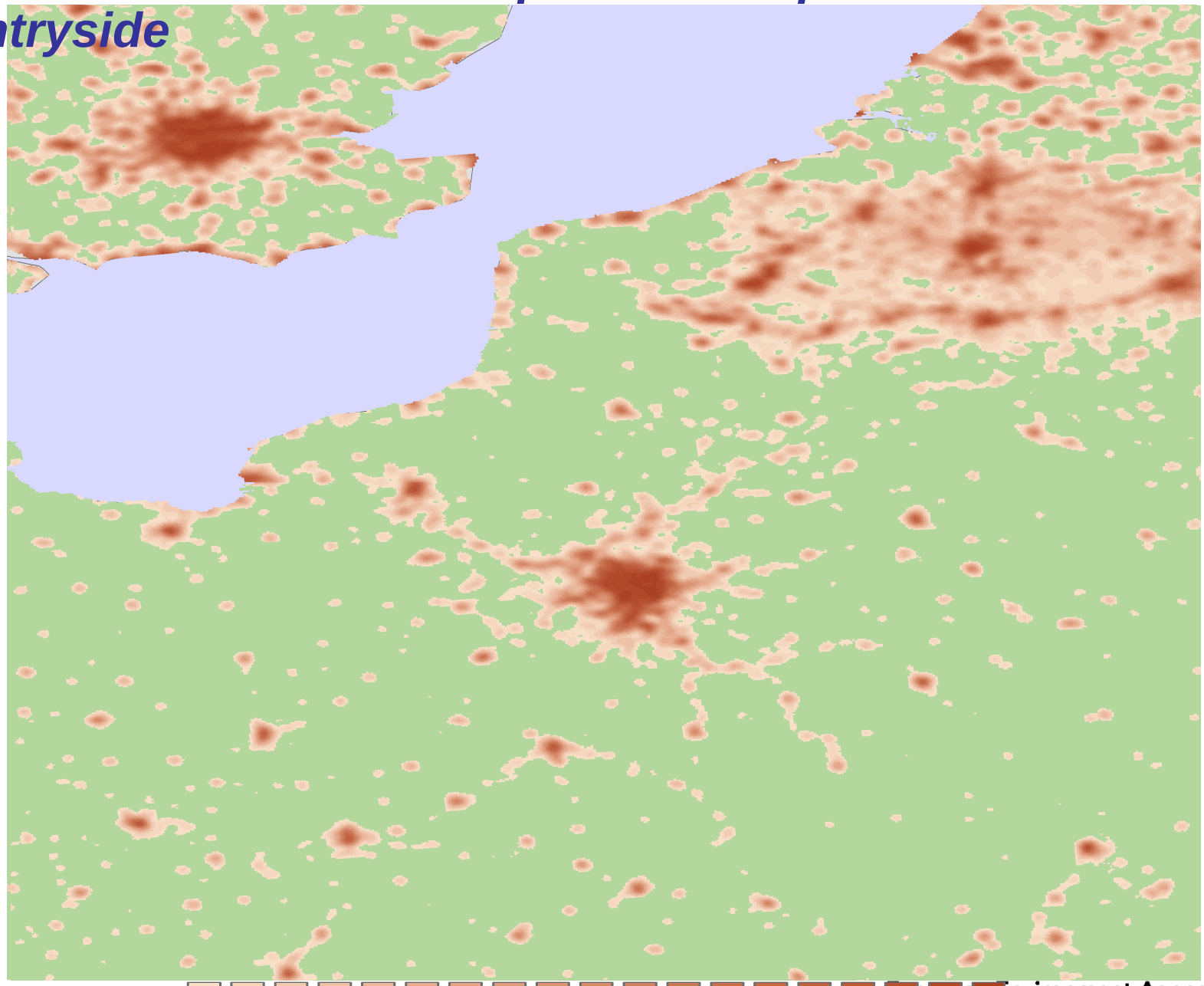
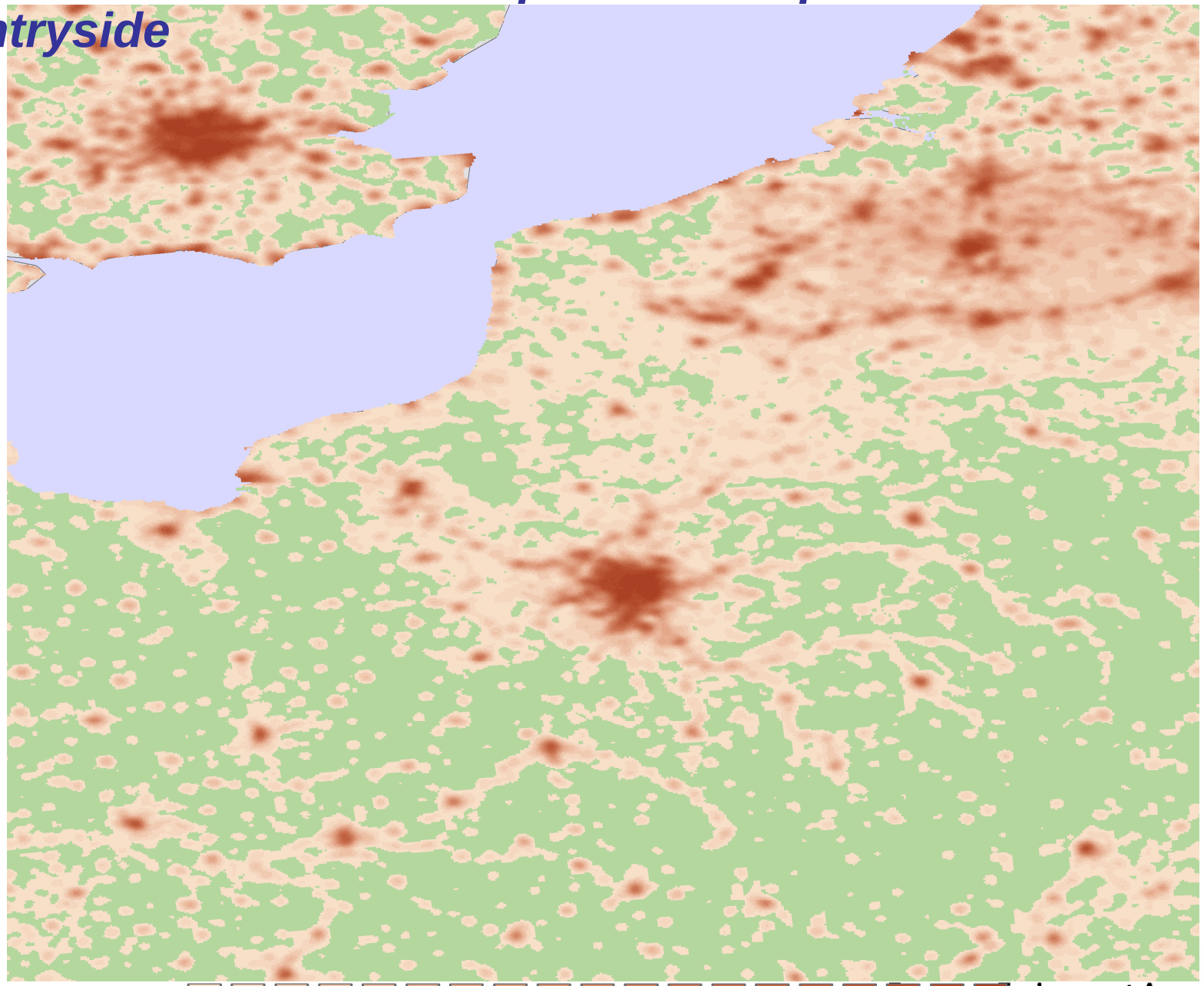
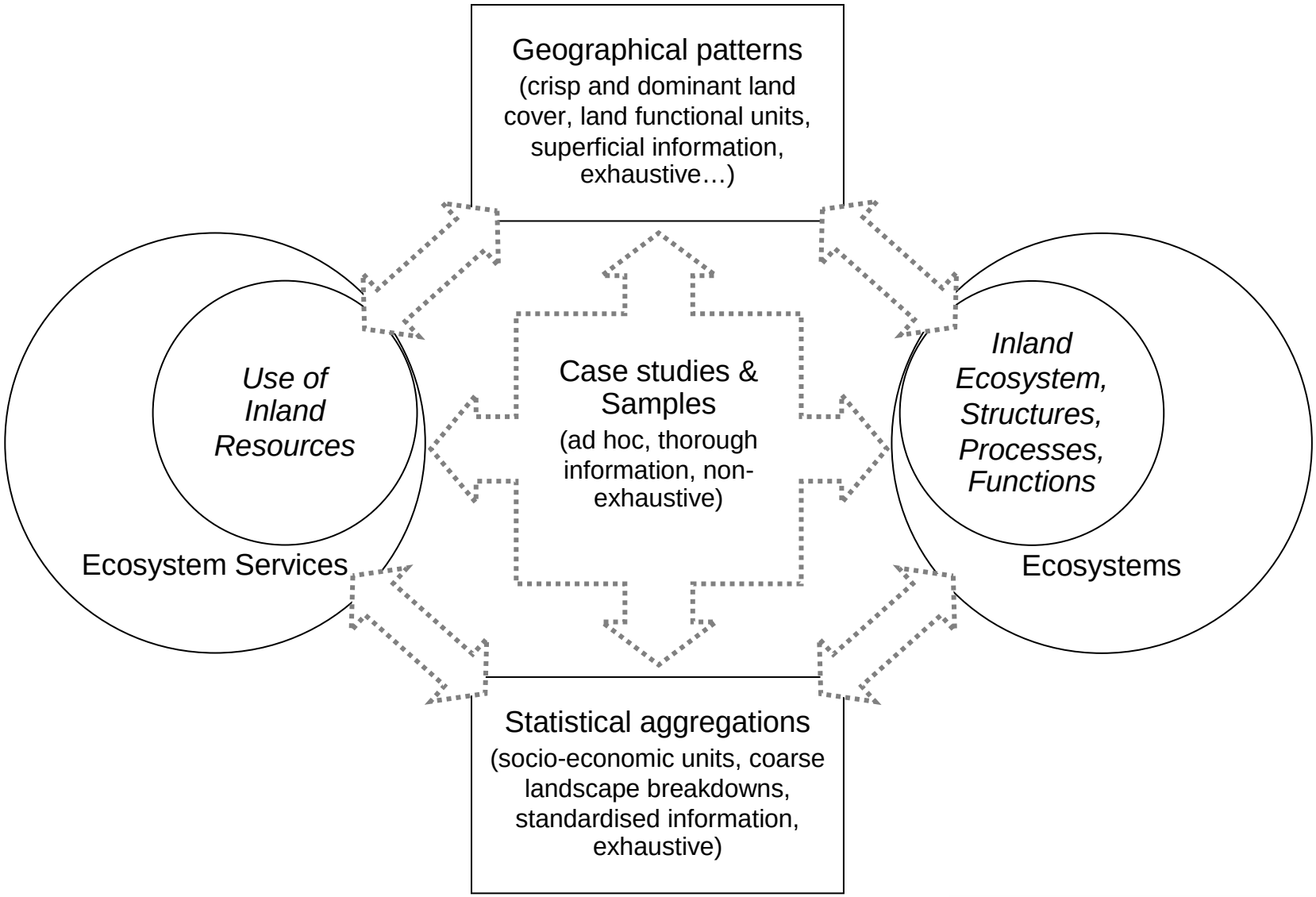
Quick Scan : when urban sprawl takes place in the countryside



Quick Scan : when urban sprawl takes place in the countryside



Data Integration for Ecosystem Accounting



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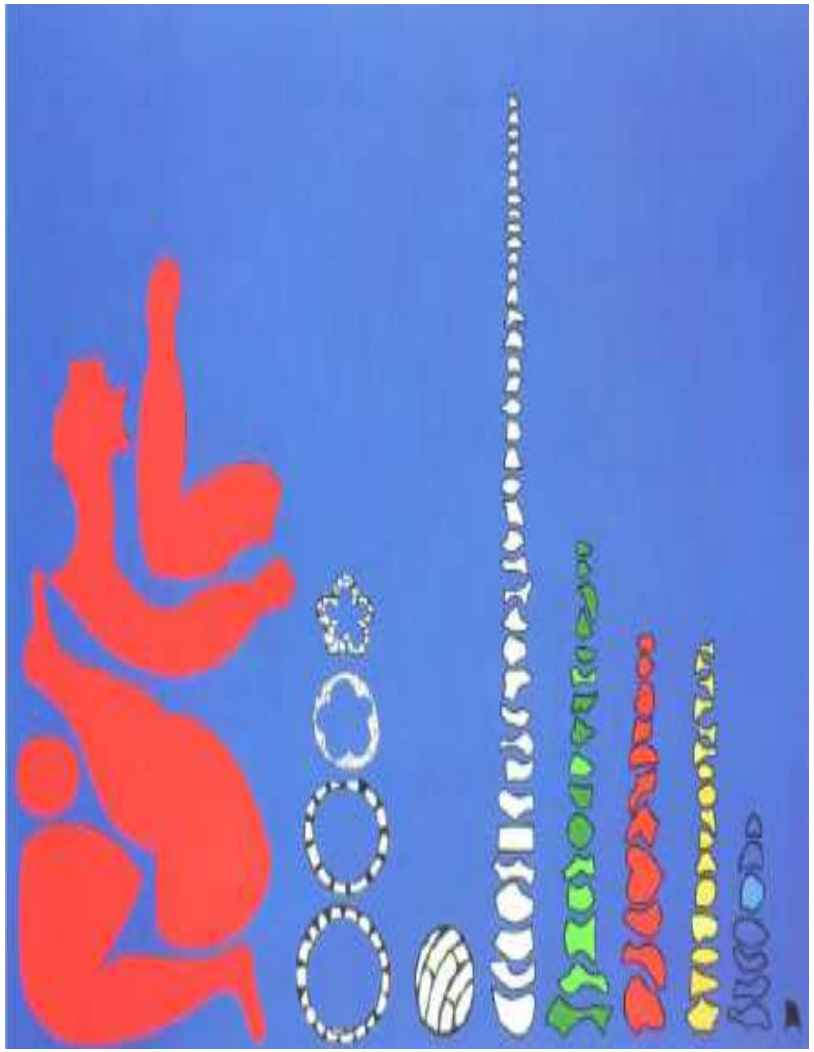
Statistics and geography: pieces into a picture



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Land: 4 main classifications (LG, Canberra 2009)

- Land Use
  - Main productive Land Use
  - Agriculture and Forest: existing FAO classification (access to 40 years of statistics)
  - Artificial uses: UNECE LU classification
  - Linkage to ISIC and CPC
- Land Cover
  - International standard limited to 15-20 classes
  - Translation of Corine land cover types into FAO LCCS rules
- Land Cover Flows (changes grouped by processes)
  - “consumption” & “formation” of land cover
  - To be finalised by EEA and FAO on the basis of existing similar presentations (resp. Land accounts in Europe and FAO-Africover)
- Land Functions
  - Multiple uses of a same piece of land, productive and not productive
  - Close linkage to Ecosystem Services

Land use and non-productive land functions: supply of ecosystem services by land cover types

Services / Land cover types	1.1 Food	1.2 Materials	1.3 Forest trees-related	1.4 Plant-related	1.5 Physical support	2.1 Amenity	2.2 Identity	2.3 Didactic	3.1 Cycling	3.2 Sink	3.3 Prevention	3.4 Refugium	3.5 Breeding
Artificial surfaces/ Urban													
Arable land & permanent crops													
Grassland & mixed farmland													
Forests & woodland shrub													
Heathland, sclerophylous veg.													
Open space with little/ no vegetation													
Wetlands													
Water bodies													

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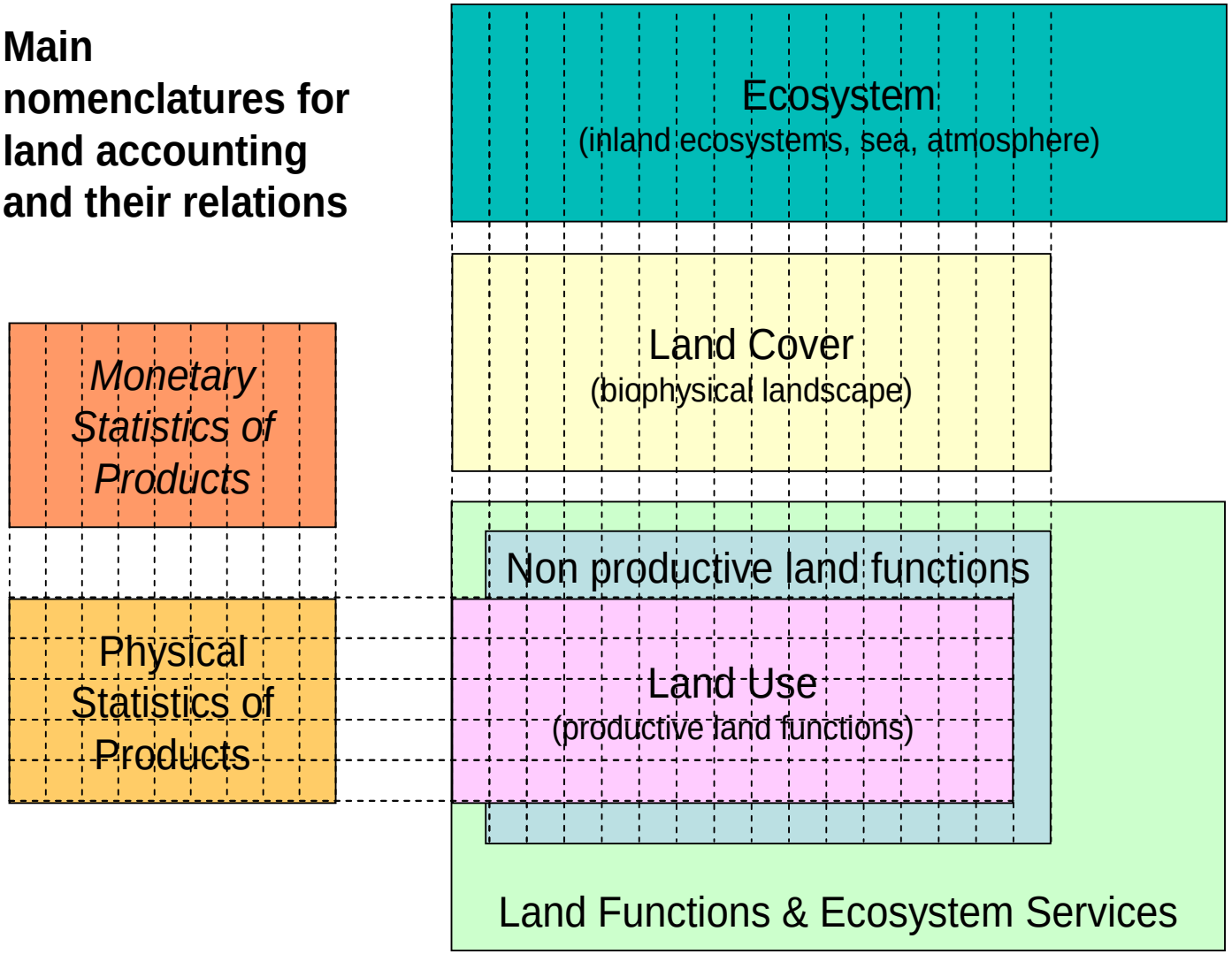
Correspondence between classifications

Main nomenclatures for land accounting and their relations



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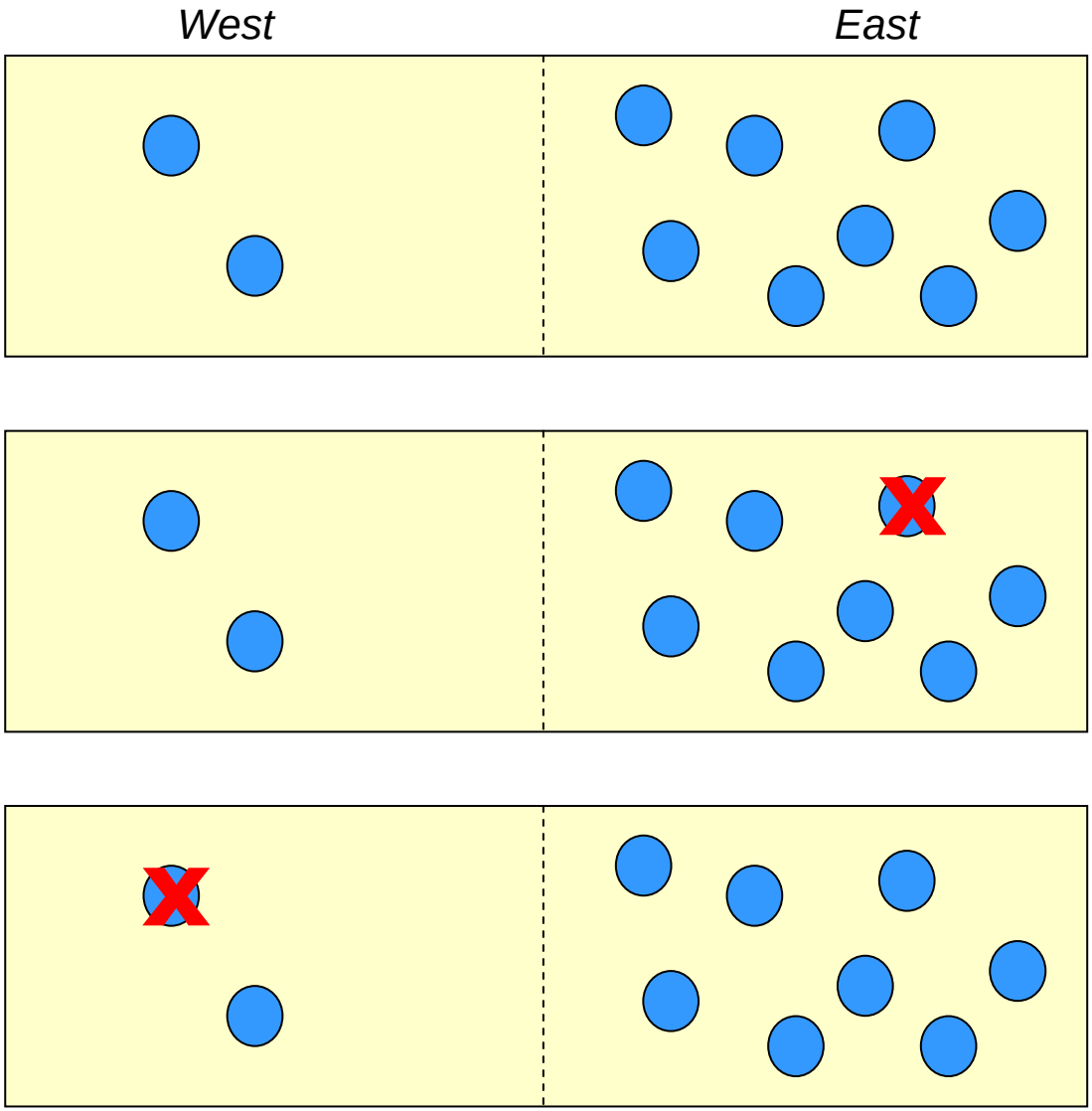
Importance of accounting by catchments – an example



The total water resource of the country **10 lakes** distributed over **2 catchments**. The western catchment with 2 lakes is close to a scarcity threshold while water resource is abundant in the eastern catchment (8 lakes).

Scenario A: 1 lake is lost in the east

Scenario B: 1 lake is lost in the west.

Resource loss of 1 lake in the **eastern** catchment

(a) Aggregated national loss (without catchments): (10-9)% = **10%**

(b) National average of loss by catchments: (2-2)% + (9-8)% = **5.5%**

2

Resource loss of 1 lake in the **western** catchment

(a) Aggregated national loss (without catchments): (10-9)% = **10%**

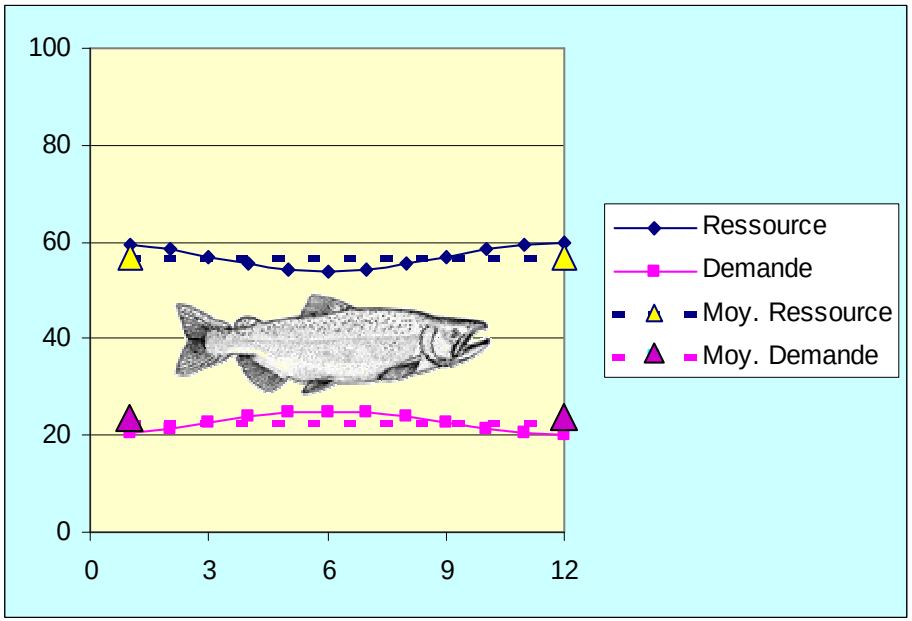
(b) National aggregation of loss by catchments: (2-1)% + (9-9)% = **25%**

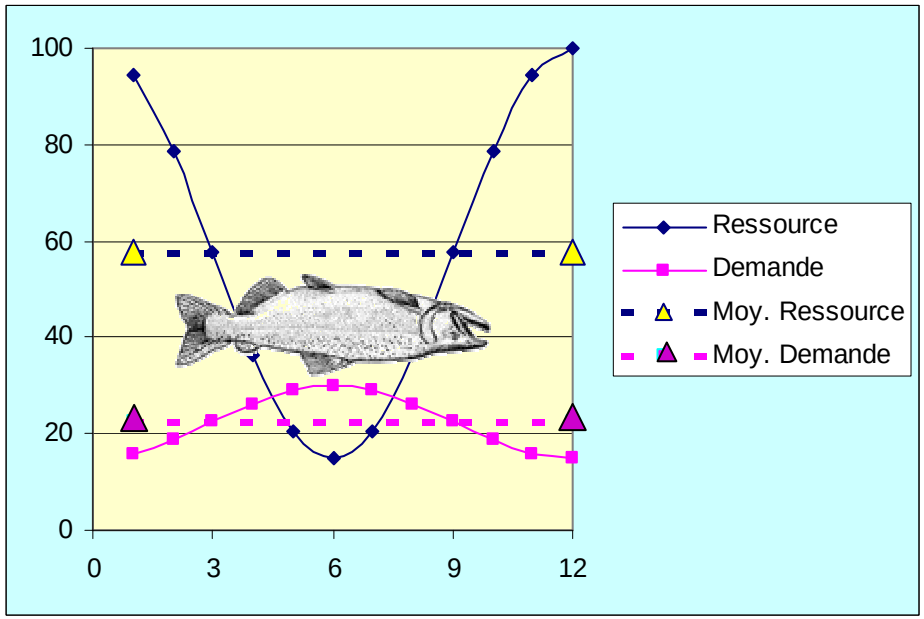
2

Time frame: e.g. water resource/demand

Mean annual values may tell the same stories for very different conditions

(e.g. no water shortage in this river in both cases)





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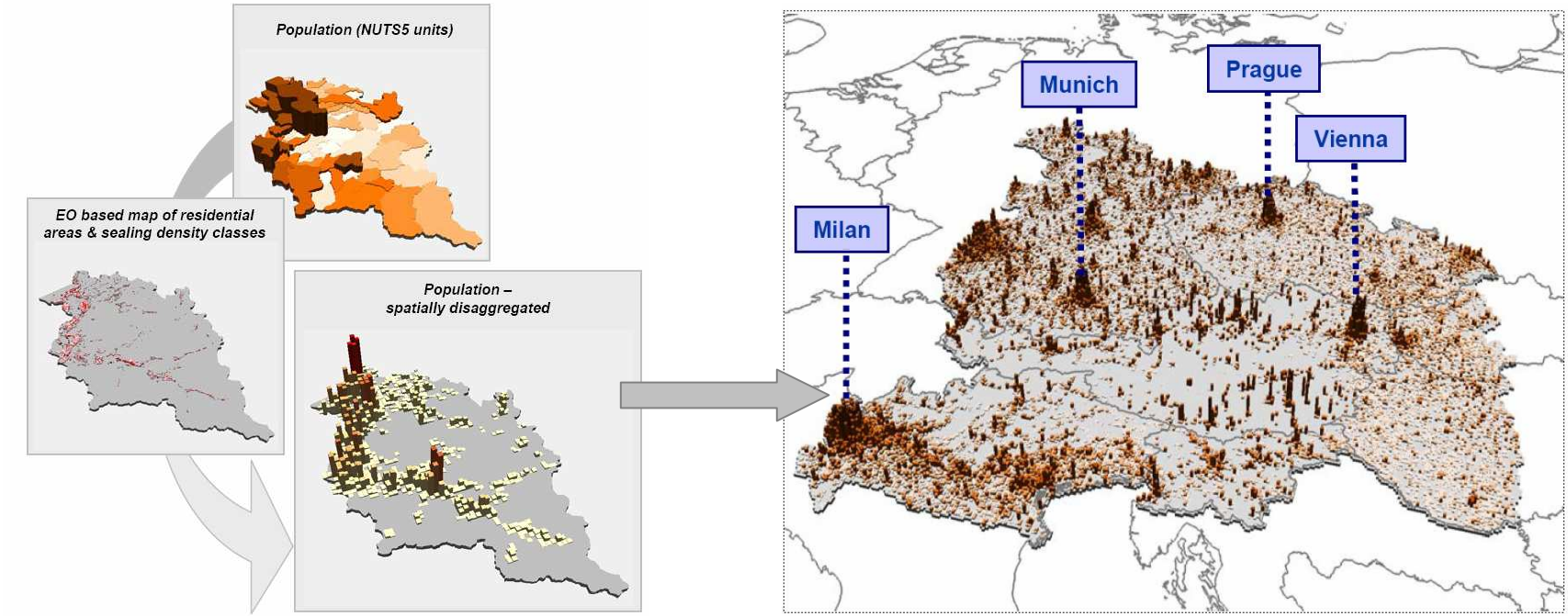
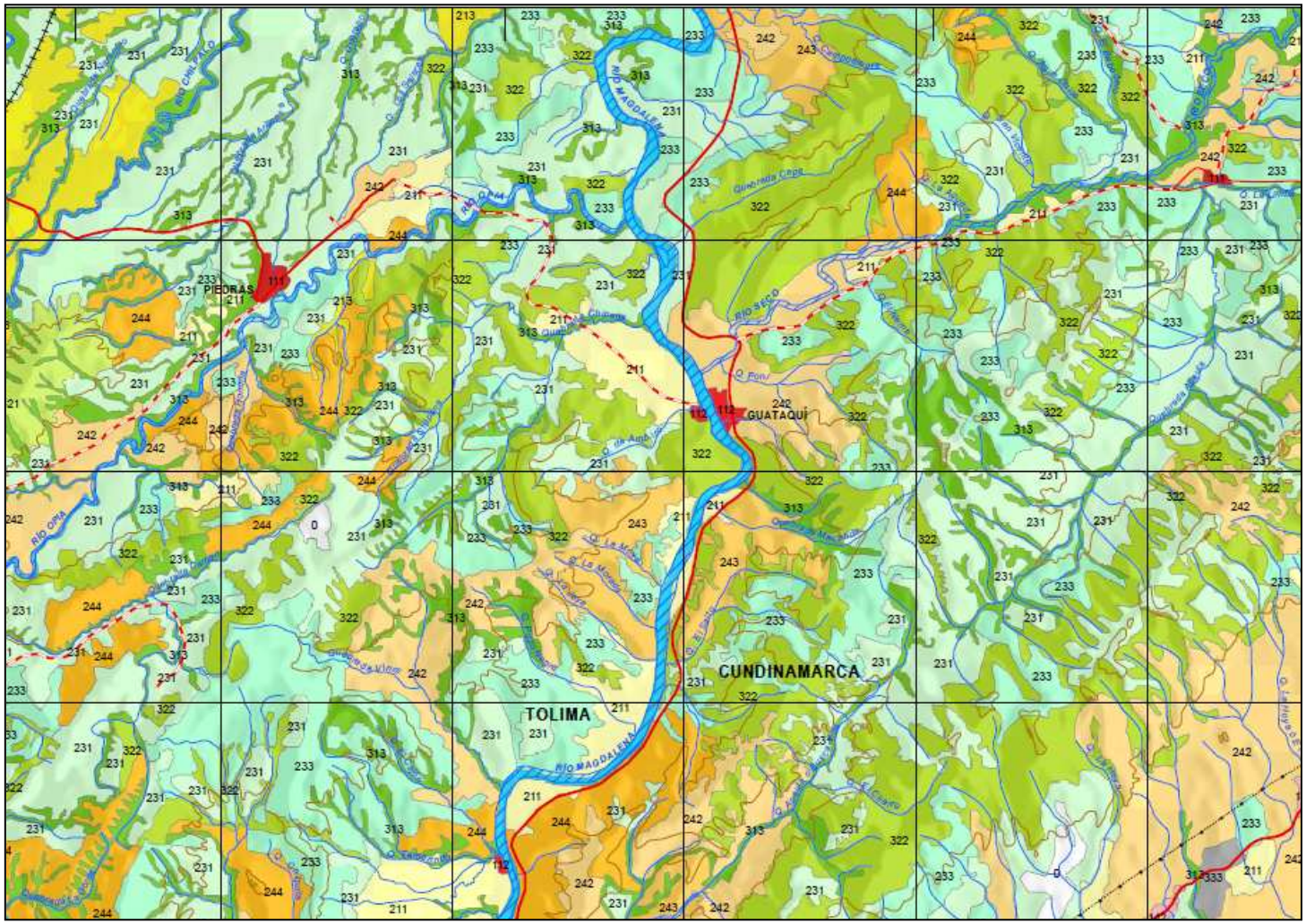
Possible use of spatial disaggregation

population data from NUTS5 disaggregated to CLC classes are provided by JRC for 1990 & 2000 (CLC time reference)



Source: GISAT for EEA; 2006

Snapshot of Corine Land Cover Colombia



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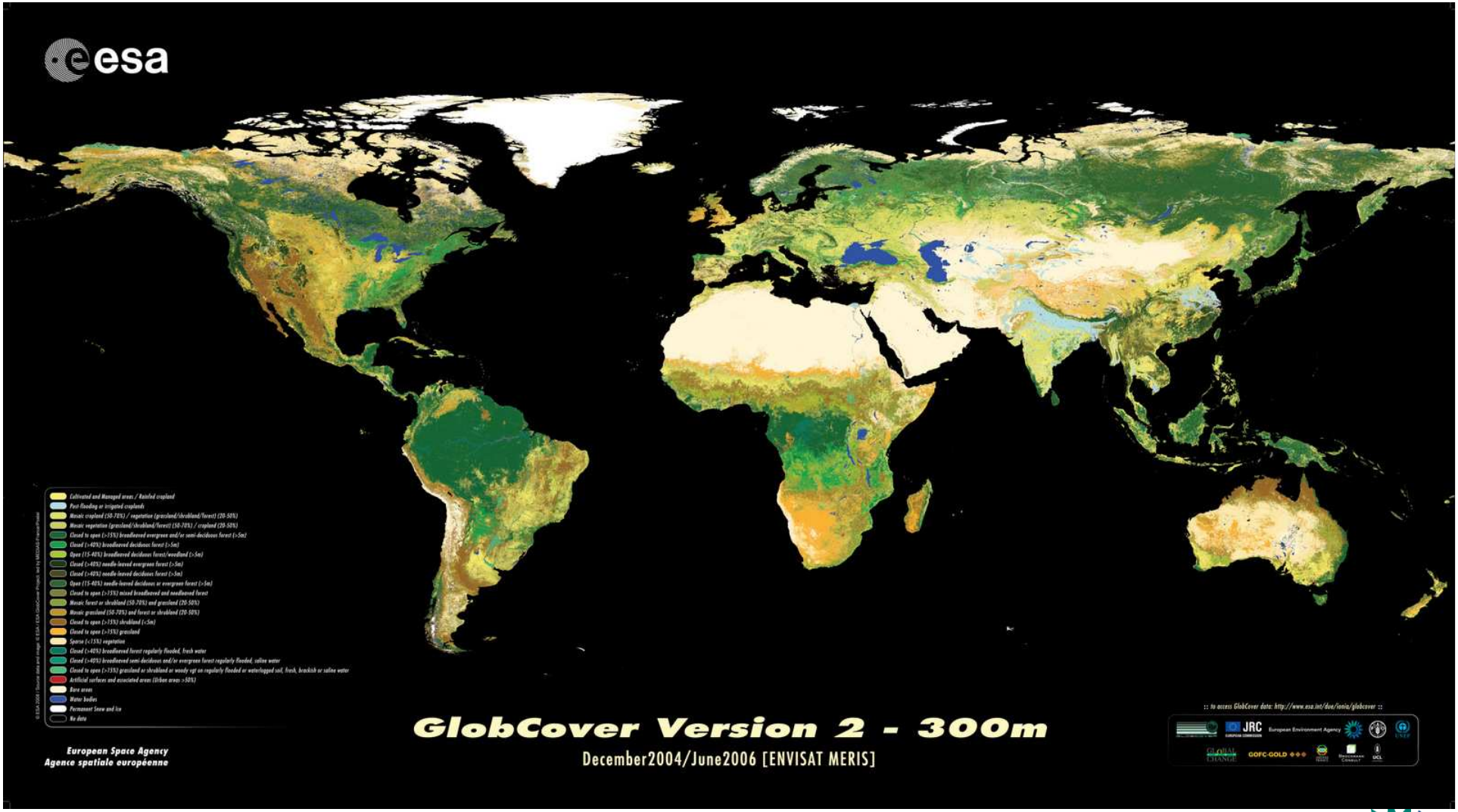
Short term: GlobCover/ GlobCorine



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