Joint Research Centre (JRC)

Ecosystem Service Accounting- the case of water purification

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Content

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- **The framework used**
- **The classification adopted**
- **The LEAC tables**
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- **The retention capacity**
- **Comments and limits of the approach**

Introduction on the work of RWER unit on ecosystem service: the rationale

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Demand by policy makers to think about the economic benefits that humans derive from ecosystem services and biodiversity (ES)

Little evidence of the spatially explicit estimation of ecosystem services and of the flow of benefits to near and distant human populations, neither in Europe, nor elsewhere

Spatial assessment of Europe's ecosystem services and biodiversity

1. Mapping the provision of ecosystem services
2. Analysis of spatial changes in ecosystem services and biodiversity as a function of drivers and pressures
3. Economical valuation of ecosystem services and biodiversity

The ongoing work of JRC-RWER on ecosystem services

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European Atlas of Ecosystem Services

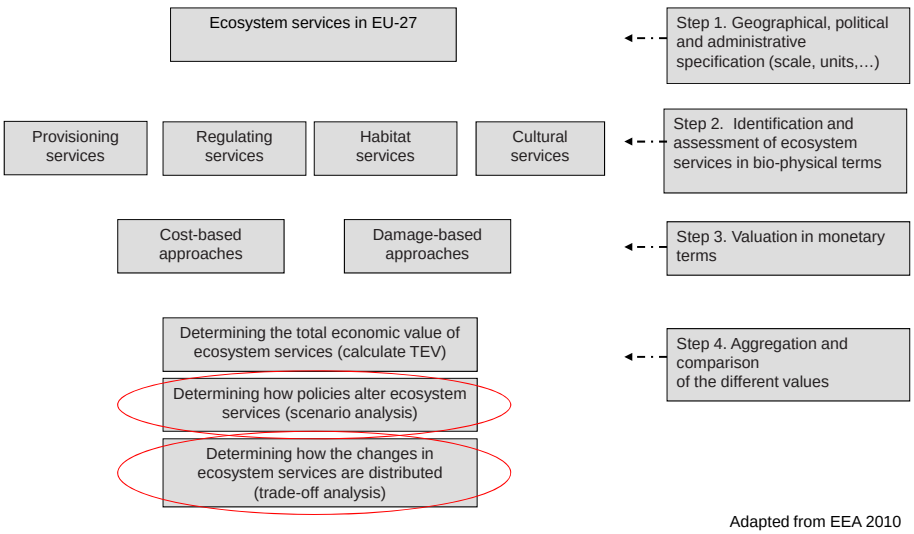
- Spatial assessments for evidence based decision making (PRESS WP2 and 3)
  - The spatial distribution of ecosystem services in biophyiscal units
  - The spatial distribution of received benefits and values
- Ensure consistency of multi-scale mapping of ecosystem services from local to continental scales and across countries (PRESS WP1)

Comparison of classifications of ecosystem services

	Main service-types
	PROVISIONING SERVICES
1	**Food** (e.g. fish, game, fruit)
2	**Water** (e.g. for drinking, irrigation, cooling)
3	**Raw materials** (e.g. fiber, timber, fuel wood, fodder, fertilizer)
4	**Genetic resources** (e.g. for crop improvement and medicinal purposes)
5	**Medicinal resources** (e.g. biochemical products, models & test organisms)
6	**Ornamental resources** (e.g. artisan work, decorative plants, pet animals, fashic
	REGULATING SERVICES
7	**Air quality regulation** (e.g. capturing (fine)dust, chemicals, etc.)
8	**Climate regulation** (incl. C-sequestration, influence of vegetation on rainfall, e
9	**Moderation of extreme events** (e.g. storm protection and flood prevention)
10	**Regulation of water flows** (e.g. natural drainage, irrigation and drought preven
11	**Waste treatment** (especially water purification)
12	**Erosion prevention**
13	**Maintenance of soil fertility** (incl. soil formation)
14	**Pollination**
15	**Biological control** (e.g. seed dispersal, pest and disease control)
	HABITAT SERVICES
16	**Maintenance of life cycles of migratory species** (incl. nursery service)
17	**Maintenance of genetic diversity** (especially gene pool protection)
	CULTURAL SERVICES
18	**Aesthetic information**
19	**Opportunities for recreation & tourism**
20	**Inspiration for culture, art and design**
21	**Spiritual experience**
22	**Information for cognitive development**

Provisioning	***Food***	**Hunting prays** **Food gathering** **Fishing** **Seafood** *Livestock* *Agriculture* *Aquiculture*
	Materials	*Fresh water* *Salt works* *Construction materials ("Arids")* *Fiber crops* *Tree plantati ons*
	Forest related	**Timber** **Fuel / wood** Cork Pines
	Plant related	**Genetic resources** **Medicinal & cosmetic plants**
	Physical support	*Communication* *Housing*
Cultural	***Amenity***	**Recreation** **Tourism/Ecotourism** **Landscape beauty**
	Identity	*Sens e of place* *Cultural heritage* *Religious / spiritual*
	Didactic	**Education / interpretation** **Scientific research** **Traditional Ecological Knowledge**
Regulating	***Cycling***	**Soil retention & Erosion control** **Hydrological regulation** *Saline equilibrium* **Pollination for useful plants** **Climate regulation**
	Sink	**Soil purification** **Waste treatment** **Water purification**
	Prevention	**Flood buffering** **Pest prevention** **Invasive species prevention** **Air quality**
	Refugium ***Breeding***	**Habitat maintenance** **Food web maintenance** **Nursery**

The procedure for economic valuation



Adapted from EEA 2010

The features of the study: the scale

EU scale perspective: ecosystem services can be identified differently according to the scale that is adopted

Different policy questions arise at different administrative levels and different stakeholders correspond to each level: at EU level we aim at creating a tool for environmental policy directions and not for environmental management

For the purpose of EU reporting we must chose databases and data sources which have a systematic and consistent coverage of the European community

What the EU scale implies

At EU scale most regulating ecosystem services have to be modelled: it would not be possible the direct observation/measurement of land function indicators

The JRC IES RWER unit built a model on nitrogen and phosphorus retention (GREEN): we use the output of this model to estimate the physical components of the water purification service

The pilot case study: the Mediterranean region

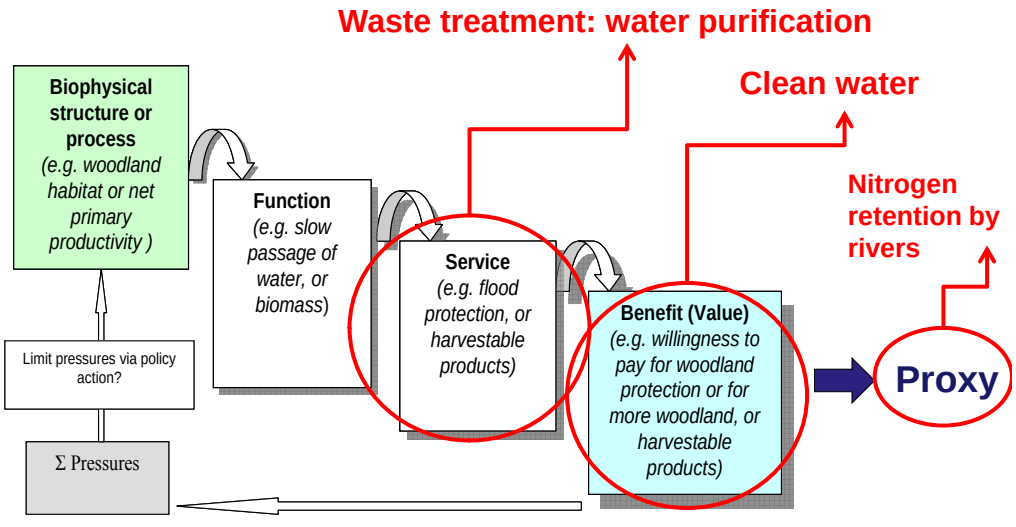
In order to test the feasibility of the valuation of ecosystem services a pilot study is undertaken

The Mediterranean Biogegraphical Region is the area chosen for the application

Based on the main characteristics of the area some ecosystem services are identified in order to be valued

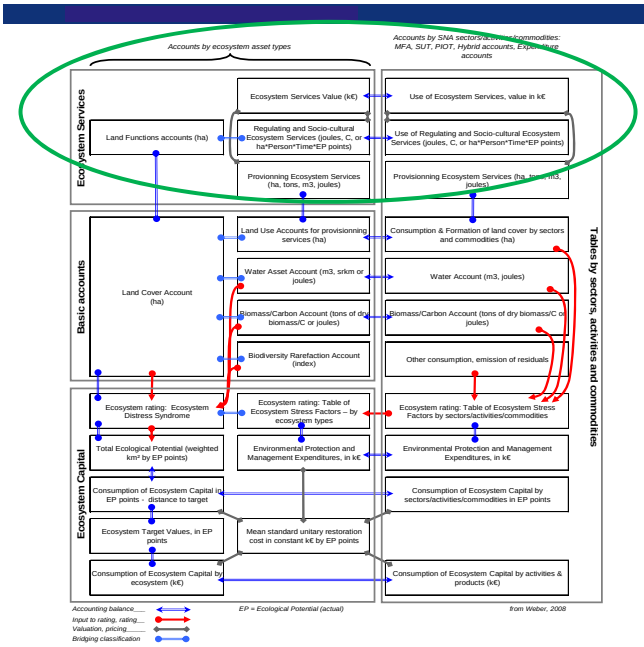
The purpose of the case study is to test the feasibility of the approach, to enhance methods and techniques, to finalise a procedure applicable for the whole EU to all ecosystem services

The ecosystem service 'cascade' framework



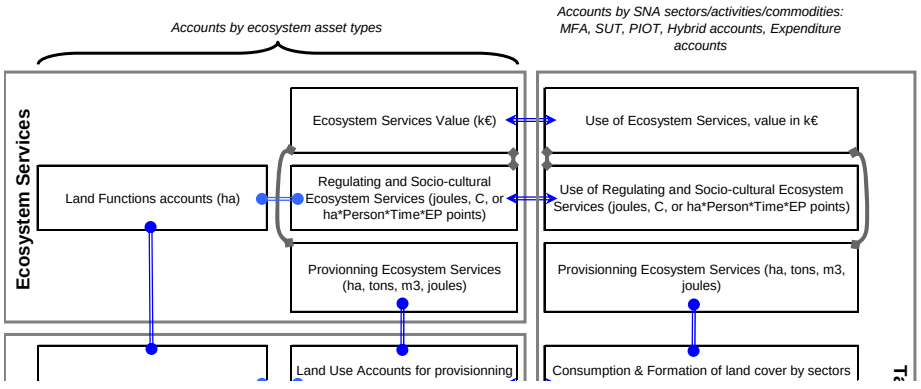
adapted from Haines-Young, R. & Potschin, M.

LEAC framework



Source: EEA 2009

LEAC: ecosystem services



Source: EEA 2009

LEAC tables/1

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Land Use & Ecosystem Services, in physical units (…)						
	Urban	Agriculture	Forest/Nature	Water bodies	Sea	
Marketed ecosystem services						
Provisioning services/ Primary goods & energy						
Recreational & Cultural / marketed services						
Recreational & Cultural / non marketed services						
Regulating ecosystem services						

Ecosystem Services Value in k€						
	Urban	Agriculture	Forest/Nature	Water bodies	Sea	Total
Marketed ecosystem services						
Provisioning services/ Primary goods & energy						
Recreational & Cultural / marketed services						
Recreational & Cultural / non marketed services						
Regulating ecosystem services						

Source: EEA 2009

LEAC tables/2

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Use of Land & Ecosystem Services, in physical units (tons of nitrogen retained)													
ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Final consumption	Total
Marketed ecosystem services													
Provisioning services/ Primary goods & energy													
Recreational & Cultural / marketed services													
Recreational & Cultural / non marketed services													
Regulating ecosystem services													

Use of Ecosystem Services, value in k€													
ISIC	* A - Agriculture, forestry and fishing	* B - Mining and quarrying	* C - Manufacturing	* D - Electricity, gas,..	* E - Water supply; sewerage, waste…	* F - Construction	*G – Trade	* O - Public administration …	…	* T - Households activities for own use	* R - Arts, entertainment and recreation	Final consumption	Total
Marketed ecosystem services													
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Recreational & Cultural / non marketed services													
Regulating ecosystem services													

Source: EEA 2009

The GREEN model

In the GREEN model diffuse sources are first reduced in the soil matrix and then once in the stream they undergo further reduction due to in-stream retention processes; point sources reach directly the stream and are thus reduced only by the stream retention process.

The region of study is divided into a number of sub-basins according to the monitoring points or any predefined scheme.

In each sub-basin the nutrient load is related to the sum of the different nitrogen sources reduced by the retention processes occurring in soils and rivers plus all the incoming nutrients from up-stream basins. During their travel along the channel network, the nutrients are reduced by the retention process.

The formula behind the model considers the sum of diffuse sources depending on the rainfall and point sources and upstream loads multiplied by the river length and lake area.

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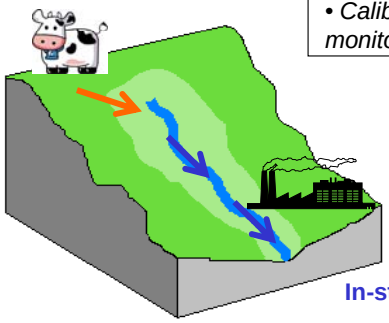
The GREEN model

- *Q, N, P 1985-2006*
- *33 000 sub-basins*
- *1200 monitoring points*
- *Calibrated against monitored data for year 2000*

DIFFUSE SOURCES

Mineral fertilisers
Manure
Atmospheric deposition
Scattered dwellings



POINT SOURCES

WWTP
Industries
Paved areas

Diffuse losses

- crop uptake
- soil storage
- atmospheric losses

In-stream losses

- plant growth
- atmospheric losses
- nutrient settling

$$Load = (DS * B * R + PS * R)$$

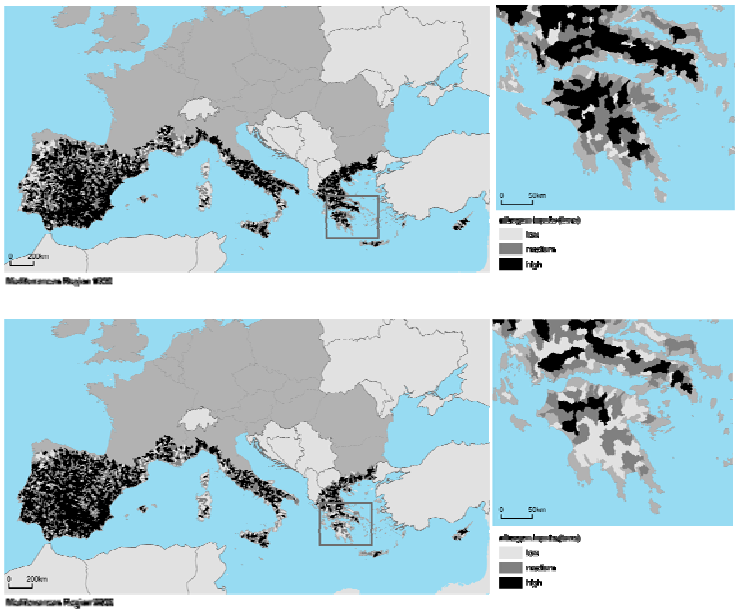
B = *f*(Precipitation)

R = *f*(river length)

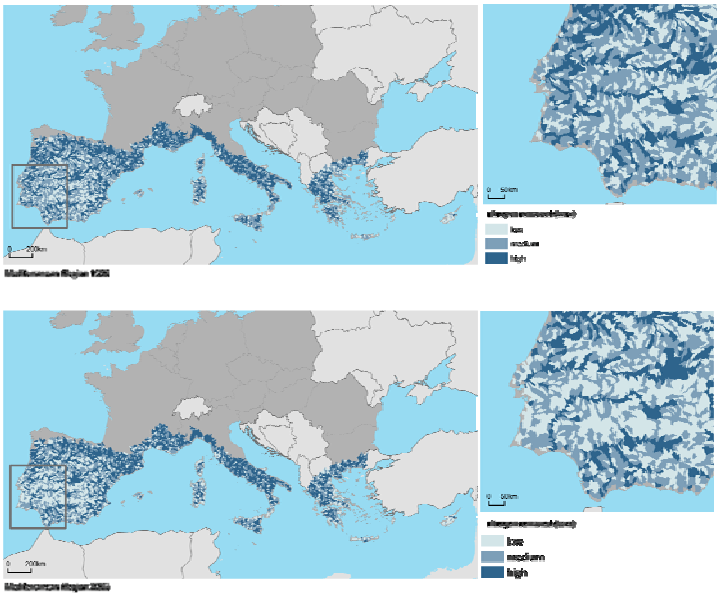
Application of an interdisciplinary approach

The results from the GREEN model are used to spatially attribute kg of N retained per hectare; a monetary value in terms of replacement costs (specifically referring to constructed wetlands) are attributed per hectare based on the quantity of N and P retained.

The monetary cost is taken from a ‘User’s handbook’ published in UK (within the COST Action 869, an international project related to nutrients’ control in Europe) summarizing all the methods to reduce nitrogen in rivers. We chose constructed wetlands: the value is not calculated but just adapted.



Nitrogen retained by water bodies



LEAC- Ecosystem Services

ISIC	* A - Agriculture, forestry and fishing	* C - Manufacturing	* E - Water supply; sewerage, waste…	…	* T - Households activities for own use
Provisioning services					
Recreational & Cultural services					
Habitat services					
Regulating services					
Water purification					
1990					
N retained by the river	15		150		
N retained by the basin	12,700				
2005					
N retained by the river	14		160		
N retained by the basin	10,100				

(1,000 Tons/year)

ISIC	* A - Agriculture, forestry and fishing	* C - Manufacturing	* E - Water supply; sewerage, waste…	…	* T - Households activities for own use
Provisioning services					
Recreational & Cultural services					
Habitat services					
Regulating services					
Water purification					
(constant year 2000)					
1990					
N retained by the river	5.8		57		
2005					
N retained by the river	4.3		42		

(million €/year)

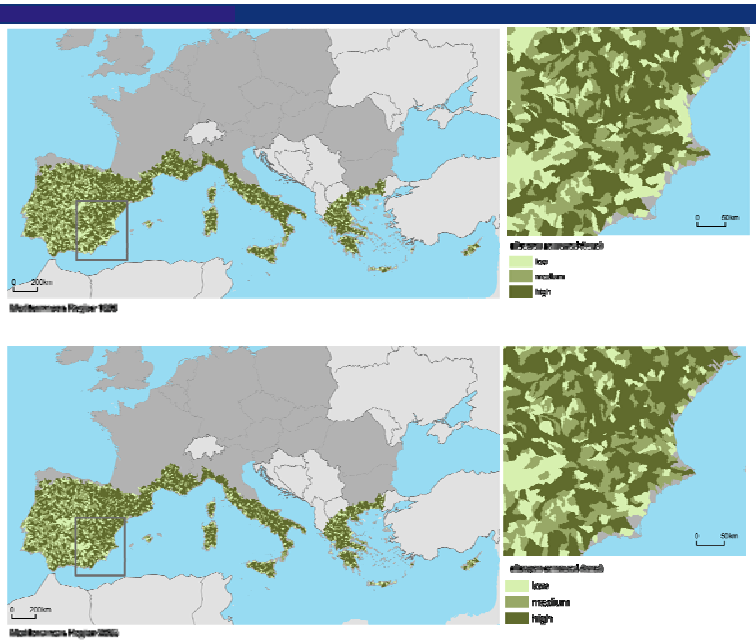
Data drafted for illustrative purpose

Application of a transdisciplinary approach

Increasing nitrogen input may impair the capacity of freshwater ecosystem to remove nitrogen. A weighting function is built on the retention data assuming a negative effect of nitrogen input on the capacity of freshwater system to retain nitrogen

The monetary value is attributed based on the replacements cost technique: the construction and O&M costs for constructed wetlands are calculated:

- according to the category of pollution sources:
  - Above-ground water - Free Water surface (FW) for diffuse emission sources
  - Below-ground water – Sub Surface Flow (SSF) for point emission sources
- different works (with different prices and different length of time) will be applied to different macro-areas according to:
  - The country where they are applied
  - The degree of efficiency at which the retention capacity works
  - The size of the reference basin



LEAC- Ecosystem Services

	Urban	*Agriculture*	*Forest/ Nature*	*Water bodies*	*Sea*	
Provisioning services						
Recreational & Cultural services						
Habitat services						
Regulating services						
Water purification through river retention retention capacity (%)						
1990				1.67		
2005				1.68		

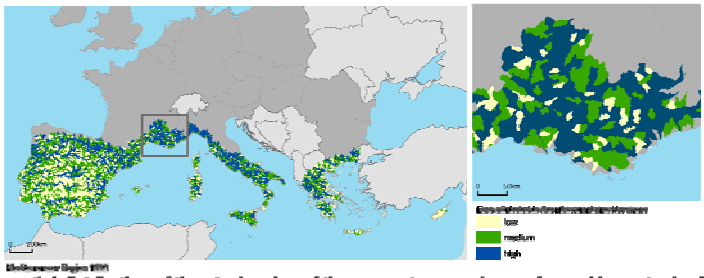
	Urban	*Agriculture*	*Forest/ Nature*	*Water bodies*	*Sea*	*€ Tot*
Provisioning services						
Recreational & Cultural services						
Habitat services						
Regulating services						
Water purification through river retention (constant year 2000)						
1990				2,430		
2005				3,030		

(millon €/year)

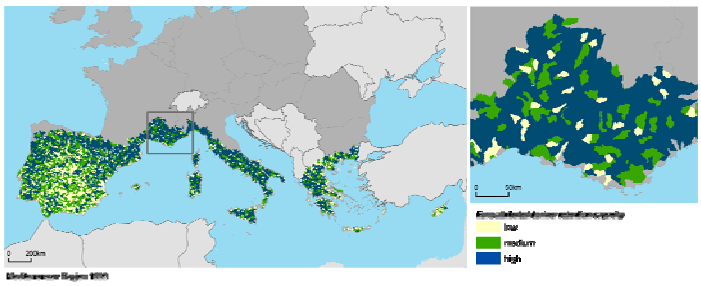
Data drafted for illustrative purpose

Monetary valuation 1990

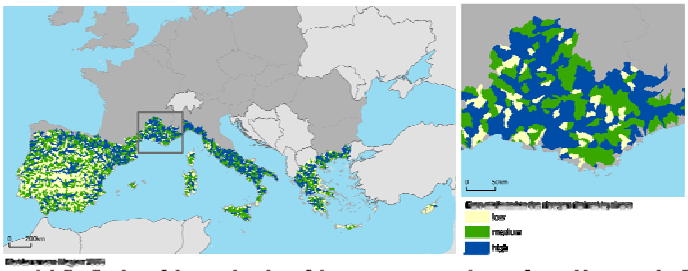
spatial distribution of the flow value of the ecosystem service performed by water bodies



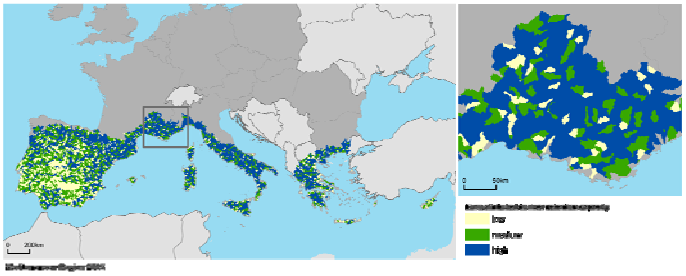
spatial distribution of the stock value of the ecosystem service performed by water bodies



spatial distribution of the flow value of the ecosystem service performed by water bodies



spatial distribution of the stock value of the ecosystem service performed by water bodies



- The ecosystem service section of the LEAC framework does not assess the 'stock' of the *ecosystem* but its functional capacity related to each ecosystem services (what we called the stock value of *ecosystem services*)
- The functional capacity of ecosystems is not assessed as a whole (like it happens for the ecosystem capital) but ecosystem service by ecosystem service
- In the case of the stock value of ecosystem services we assess features like quality, health status, integrity and capacity of ecosystems to provide that specific benefit to society

Comments on ecosystem accounts: a different concept of balance

- The accounting balance can be performed on the physical side because of the inner consistency of the model that originates all the results in terms of stock and flows
- The accounting balance cannot be performed in monetary terms because different valuation procedures have been applied to the ecosystem capacity and the flow of ecosystem services
- In the perspective of trade-off analysis, only the tables expressed in monetary terms can guarantee aggregation/ comparison/etc. of all the different ecosystem services
- The two sides are thus critical and interdependent

Limits of this study

- This was only a test pilot study to check the feasibility and potential utility of this kind of assessments and their compatibility and consistency with LEAC
- The monetary approach must be refined: more CW applications must be included in order to appropriately define both the construction and O&M costs, to improve the economy of scale function and to better off the linkage with some territorial features
- The model is essentially physical: no biological characteristics are included. For the purpose of the valuation, further integration on physical mapping would be necessary