

21-28 JULY 2019

# SUMMER UNIVERSITY ON "INTEGRATED MANAGEMENT, SUSTAINABLE TOURISM AND PROMOTION OF BIOSPHERE RESERVES"

# Biosphere reserves and ecosystem services


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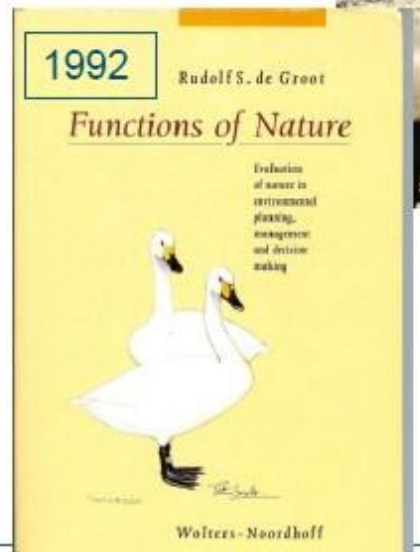
# Content

1. The concept of ecosystem services
2. Mapping and assessment of ES
3. Implementation of ES in BR
4. Some practical aspects and exercise

# The concept of ecosystem services

1980 Ecology of Owls
In Galapagos

(pot) conflict Ecology - Economy




## The beginning

Functions of nature
(R. de Groot)

# The concept of ecosystem services

| ECOSYSTEM SERVICES | ECOSYSTEM FUNCTIONS |
|---|---|
| Gas regulation | Regulation of atmospheric chemical composition. |
| Climate regulation | Regulation of global temperature, precipitation, and other biologically mediated climatic processes at global, regional, or local levels. |
| Disturbance regulation | Capacitance, damping and integrity of ecosystem response to environmental fluctuations. |
| Water regulation | Regulation of hydrological flows. |
| Water supply | Storage and retention of water. |
| Erosion control and sediment retention | Retention of soil within an ecosystem. |
| Soil formation | Soil formation processes. |
| Nutrient cycling | Storage, internal cycling, processing, and acquisition of nutrients. |
| Waste treatment | Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds. |
| Pollination | Movement of floral gametes. |
| Biological control | Trophic-dynamic regulations of populations. |
| Refugia | Habitat for resident and transient populations. |
| Food production | That portion of gross primary production extractable as food. |
| Raw materials | That portion of gross primary production extractable as raw materials. |
| Genetic resources | Sources of unique biological materials and products. |
| Recreation | Providing opportunities for recreational activities. |
| Cultural | Providing opportunities for non-commercial uses. |

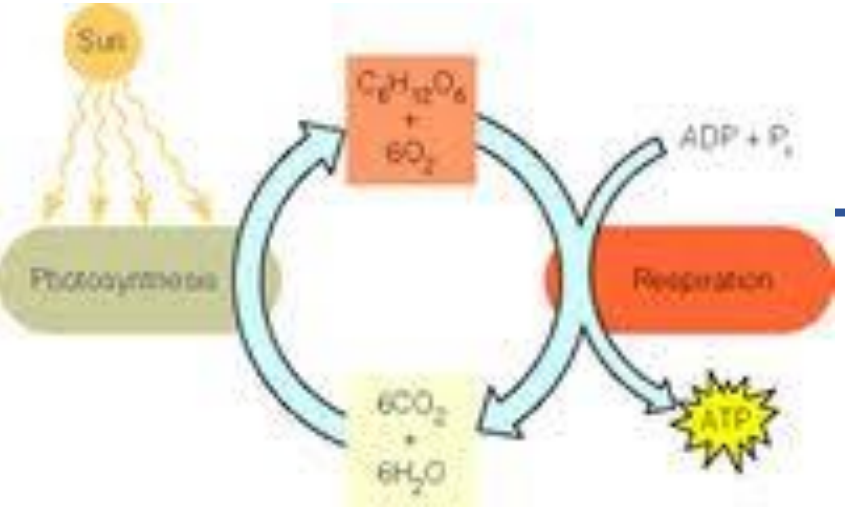
Ecosystem Functions: „Capacity of ecosystem components and processes to provide goods and services that satisfy human needs (directly and indirectly)“

De Groot et al, 2002)

- Production function
- Regulation function
- Habitat function
- Information function

# The concept of ecosystem services

## Function




**Primary production**

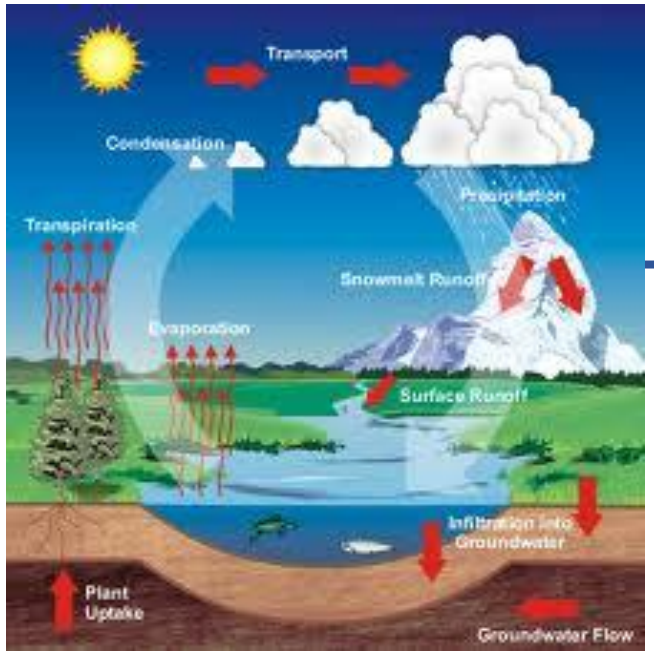
**forest ecosystem**

## Provisioning service

**Timber**

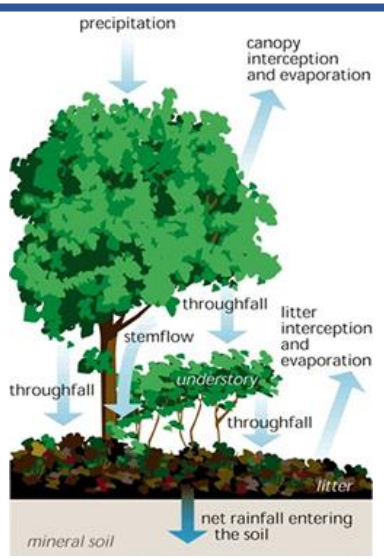
# The concept of ecosystem services

## Function




forest ecosystem

Water flow regulation




## Regulation service

Flood mitigation

# The concept of ecosystem services

## Definitions

**Ecosystem goods**

Physical elements that are directly or indirectly consumed by humans

**Ecosystem (goods and) services**

**Ecosystem services**

The benefits people obtain from ecosystems and also the processes that support the production of ecosystem goods

# The concept of ecosystem services

## Definitions

"the benefits of nature to households, communities, and economies"

(Daily, 1997)

"Ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being"

(Boyd and Banzhaf2006)

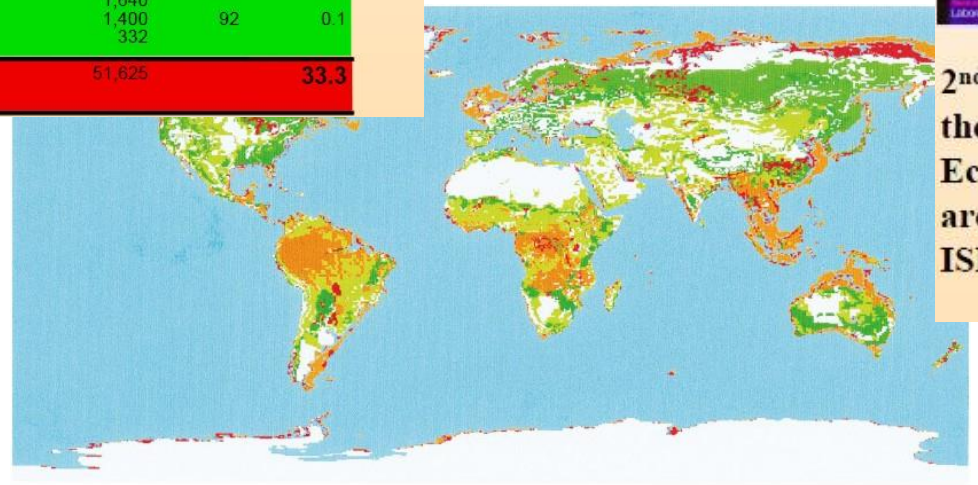
"the benefits human populations derive, directly or indirectly, from ecosystem functions"

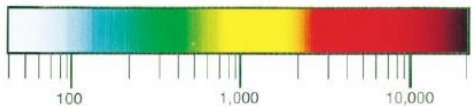
(Costanza et al. , 1997)

# The concept of ecosystem services

Summary of global values of annual ecosystem services (From: Costanza et al. 1997)

| Biome | Area (e6 ha) | Value per ha ($/ha/yr) | Global Flow Value (e12 $/yr) |
|---|---|---|---|
| **Marine** | **36,302** | **577** | **20.9** |
| Open Ocean | 33,200 | 252 | 8.4 |
| Coastal | 3,102 | 4052 | 12.6 |
| Estuaries | 180 | 22832 | 4.1 |
| Seagrass/Algae Beds | 200 | 19004 | 3.8 |
| Coral Reefs | 62 | 6075 | 0.3 |
| Shelf | 2,660 | 1610 | 4.3 |
| **Terrestrial** | **15,323** | **804** | **12.3** |
| Forest | 4,855 | 969 | 4.7 |
| Tropical | 1,900 | 2007 | 3.8 |
| Temperate/Boreal | 2,955 | 302 | 0.9 |
| Grass/Rangelands | 3,898 | 232 | 0.9 |
| Wetlands | 330 | 14785 | 4.9 |
| Tidal Marsh/Mangroves | 165 | 9990 | 1.6 |
| Swamps/Floodplains | 165 | 19580 | 3.2 |
| Lakes/Rivers | 200 | 8498 | 1.7 |
| Desert | 1,925 | | |
| Tundra | 743 | | |
| Ice/Rock | 1,640 | | |
| Cropland | 1,400 | 92 | 0.1 |
| Urban | 332 | | |
| **Total** | 51,625 | | **33.3** |







**2nd most cited article in the last 10 years in the Ecology/Environment area according to the ISI Web of Science.**

NATURE |VOL 387 | 15 MAY 1997 253

article

## The value of the world's ecosystem services and natural capital

**Robert Costanza*†, Ralph d'Arge‡, Rudolf de Groot§, Stephen Farberk, Monica Grasso†, Bruce Hannon¶, Karin Limburg#, Shahid Naeem**, Robert V. O'Neill††, Jose Paruelo‡‡, Robert G. Raskin§§, Paul Suttonkk & Marjan van den Belt¶¶**

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*†† Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*

*‡‡ Department of Ecology, Faculty of Agronomy, University of Buenos Aires, Av. San Martin 4453, 1417 Buenos Aires, Argentina*

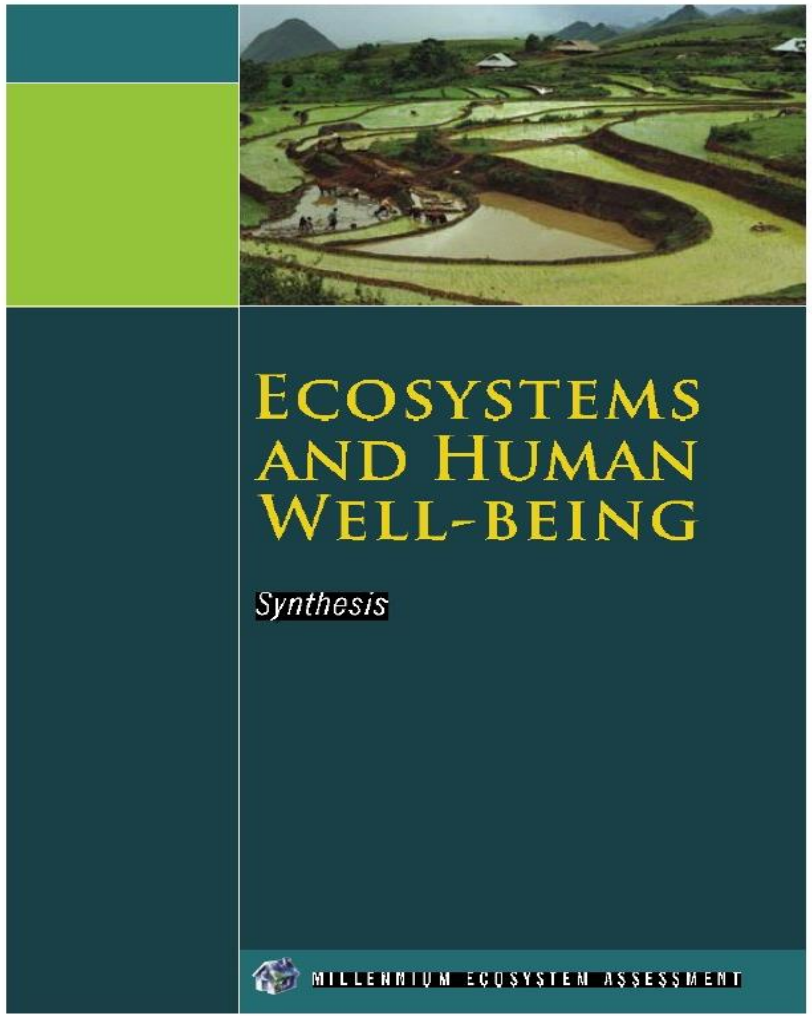
*§§ Jet Propulsion Laboratory, Pasadena, California 91109, USA*

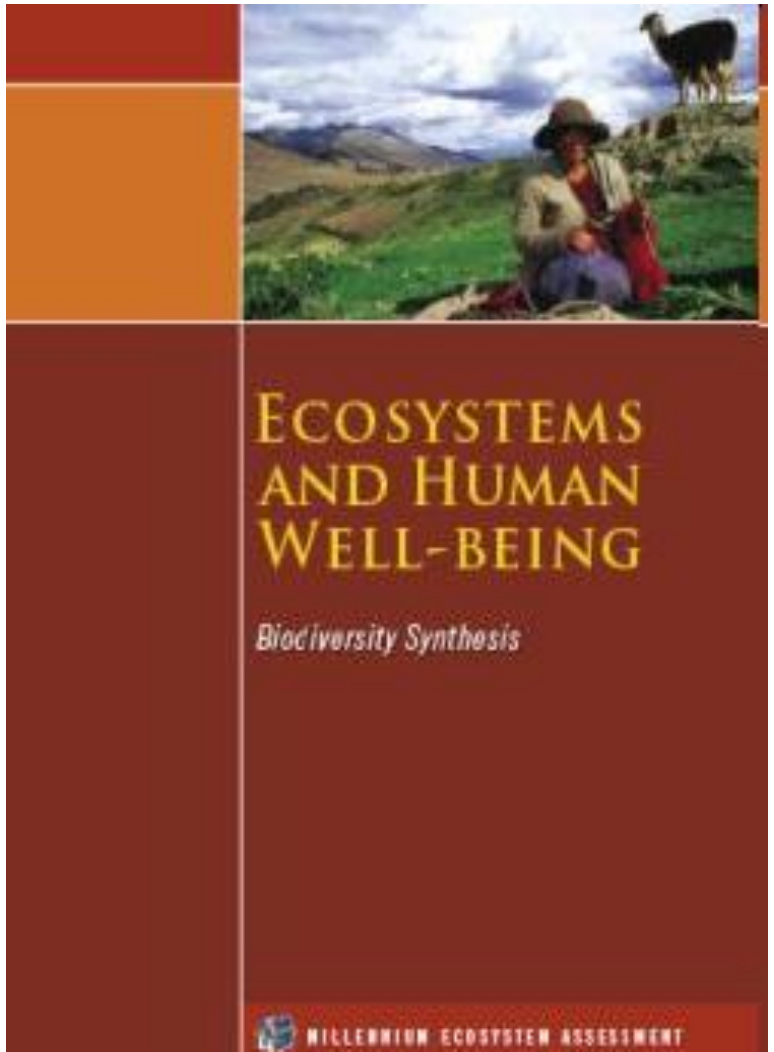
*kkNational Center for Geographic Information and Analysis, Department of Geography, University of California at Santa Barbara, Santa Barbara, California 93106, USA*

*¶¶ Ecological Economics Research and Applications Inc., PO Box 1589, Solomons, Maryland 20688, USA*

**The services of ecological systems and the natural capital stocksthat produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet.We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16–54 trillion ($10^{12}$) per year, with an average of US$33trillion per year. Because of the nature of the uncertainties, thismust be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.**

# The concept of ecosystem services




**Millennium Ecosystem Assessment 2005**

# The concept of ecosystem services

ESP

## The Ecosystem Services Partnership

Worldwide Network to enhance the Science and practical Application of ecosystem services assessment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- Home
- About the Partnership
- Become a member
- ESP Services
- ESP Working groups
- ESP Regional Chapters & National Networks
- ESP Conferences
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- Networking & Outreach
- Case studies & Showcases
- Data & Knowledge sharing
- New Publications
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- Guidelines & Toolkits
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- Young ES Specialists

- Contact
- Support & FAQ
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- Steering Committee

- Become a Member

### ESP Working Groups, Regional Chapters and National Networks

- Thematic Working Groups
- Biome Working Groups
- Sectoral Working Groups
- Regional Chapters National Networks

**Millennium Ecosystem Assessment 2005**

# The concept of ecosystem services

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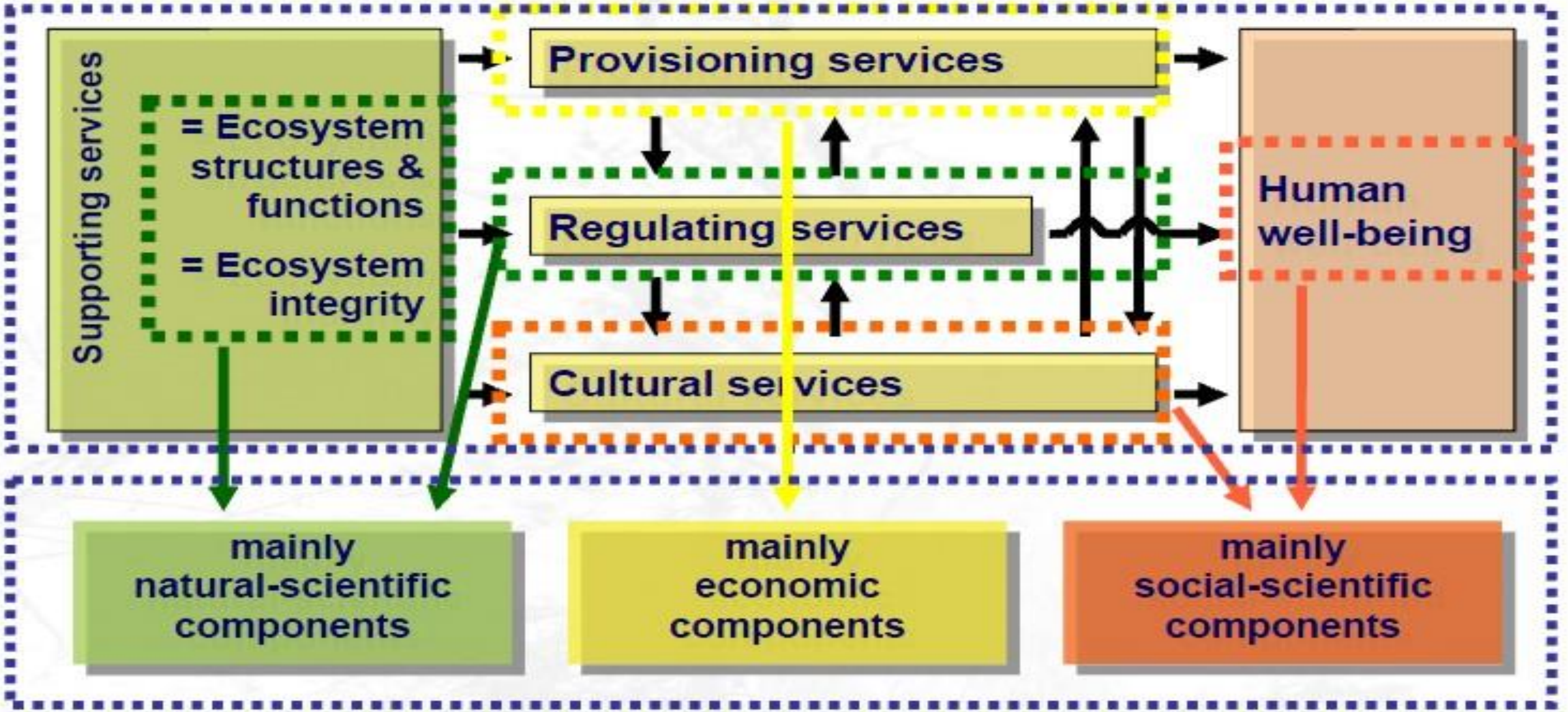
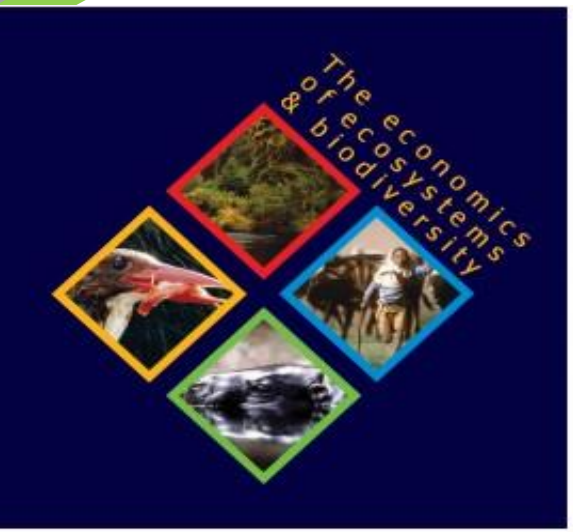
Become a Member

**ESP Working Groups, Regional Chapters and National Networks**

# The concept of Ecosystem Goods and Services



# The concept of ecosystem services

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## The Economics of Ecosystems and Biodiversity (TEEB)

- Home
- About TEEB
- Information Material
- Ecological and Economic Foundation
- For Policymakers
- For Local and Regional Policy
- For Business
- For Citizens

**The Economics of Ecosystems and Biodiversity (TEEB) study** is a major international initiative to draw attention to the global economic benefits of biodiversity, to highlight the growing costs of biodiversity loss and ecosystem degradation, and to draw together expertise from the fields of science, economics and policy to enable practical actions moving forward.

To join the TEEB community, follow us on Twitter and Facebook:

Join us on Facebook

Follow us on Twitter

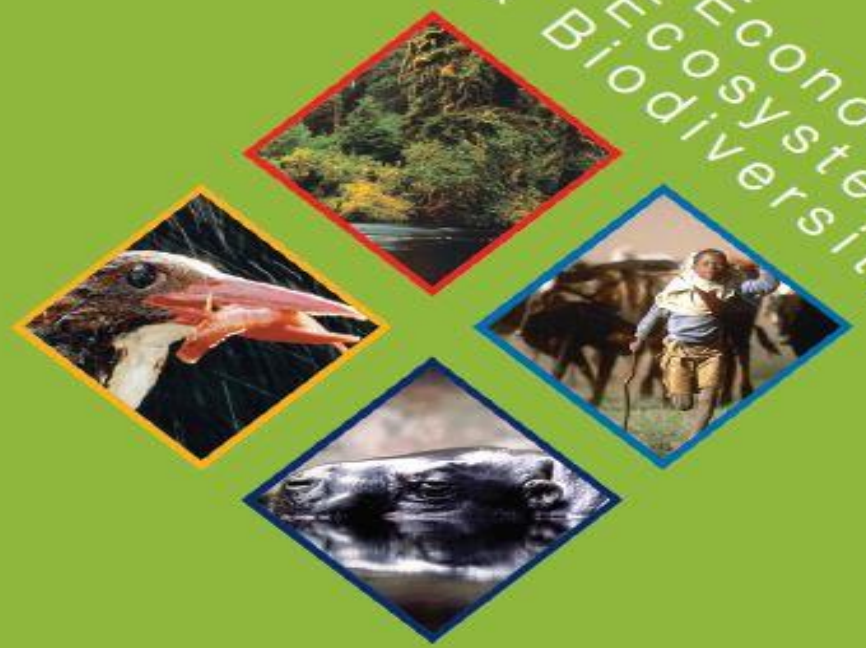
We took 10,000 years

### TEEB for Citizens


TEEB has launched the Bank of Natural Capital, a website designed to communicate the TEEB Study findings to citizens.

Visit it here: http://bankofnaturalcapital.com

Released February 2011



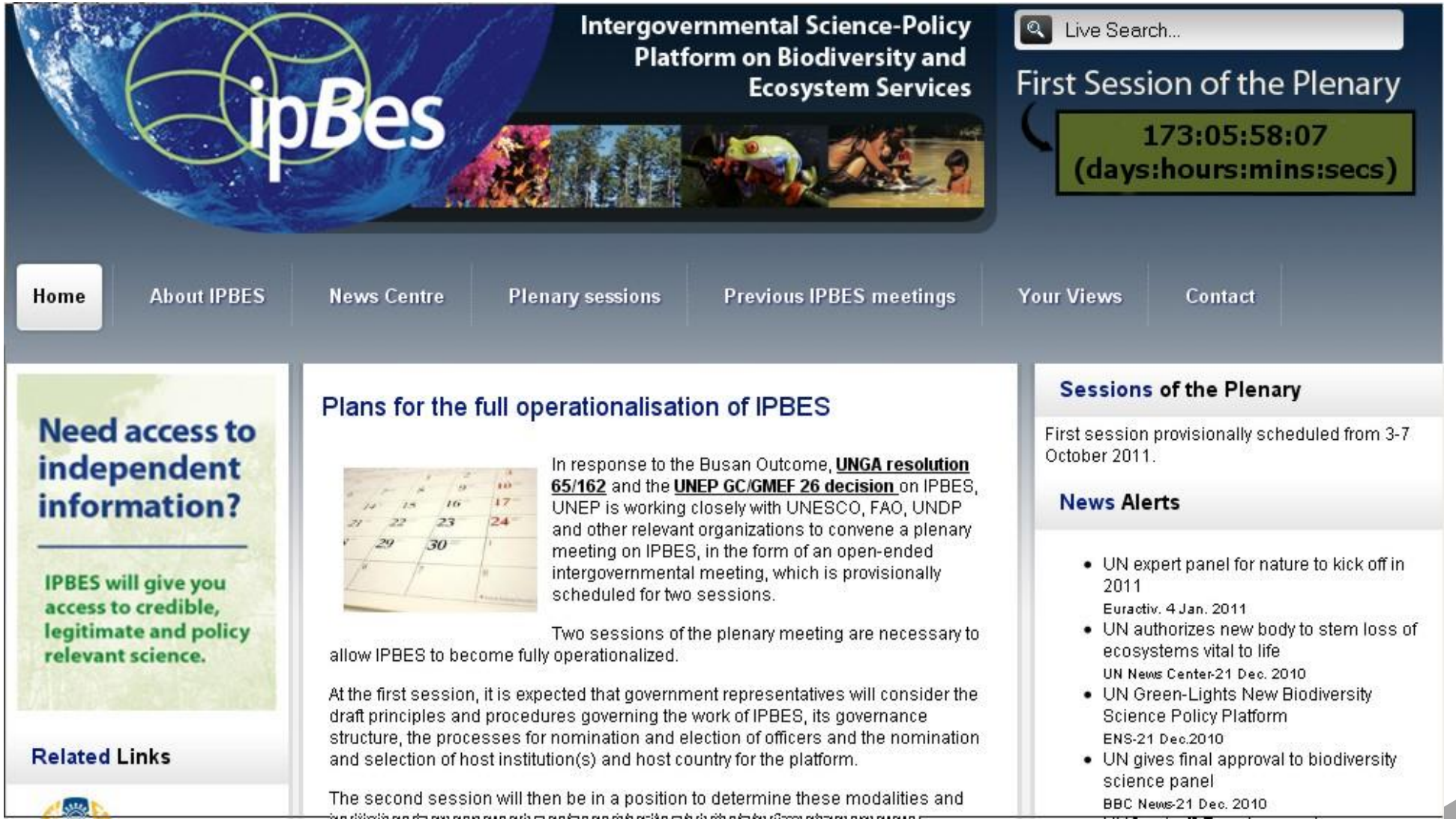

MAINSTREAMING THE ECONOMICS OF NATURE

A SYNTHESIS OF THE APPROACH, CONCLUSIONS AND RECOMMENDATIONS OF TEEB

| | TEEB classification |
|---|---|
| | **PROVISIONING** |
| 1 | Food |
| 2 | Water (2 |
| 3 | Raw materials |
| 4 | Genetic resources |
| 5 | Medicinal resources |
| 6 | Ornamental resources |
| | **REGULATING** |
| 7 | Air purification |
| 8 | Climate regulation (incl. C-sequestration) |
| 9 | Disturbance prevention or moderation |
| 10 | Regulation of water flows |
| 11 | Waste treatment (esp. water purification) |
| 12 | Erosion prevention |
| 13 | Maintaining soil fertility |
| 14 | Pollination |
| 15 | Biological control |

| | |
|---|---|
| | **HABITAT** |
| 16 | Lifecycle maintenance |
| 17 | Gene pool protection |
| | **CULTURAL** |
| 18 | Aesthetic information |
| 19 | Recreation & tourism |
| 20 | Inspiration for culture, art and design |
| 21 | Spiritual experience |
| 22 | Information for cognitive development |

# The concept of ecosystem services



# The concept of ecosystem services

European Environment Agency

Topics | Data and maps | Indicators | Publications

You are here: Home / SOER 2015 — The European environment — state and outlook 2015 / European briefings / Natural capital and ecosystem services

## Natural capital and ecosystem services

**Briefing** Published 18 Feb 2015 Last modified 09 Mar 2015, 04:03 PM

Topics: Natural resources | Biodiversity

PDF ePub

## Ecosystem services in the EU

**Page** — expired Last modified 31 Jul 2015, 11:39 AM

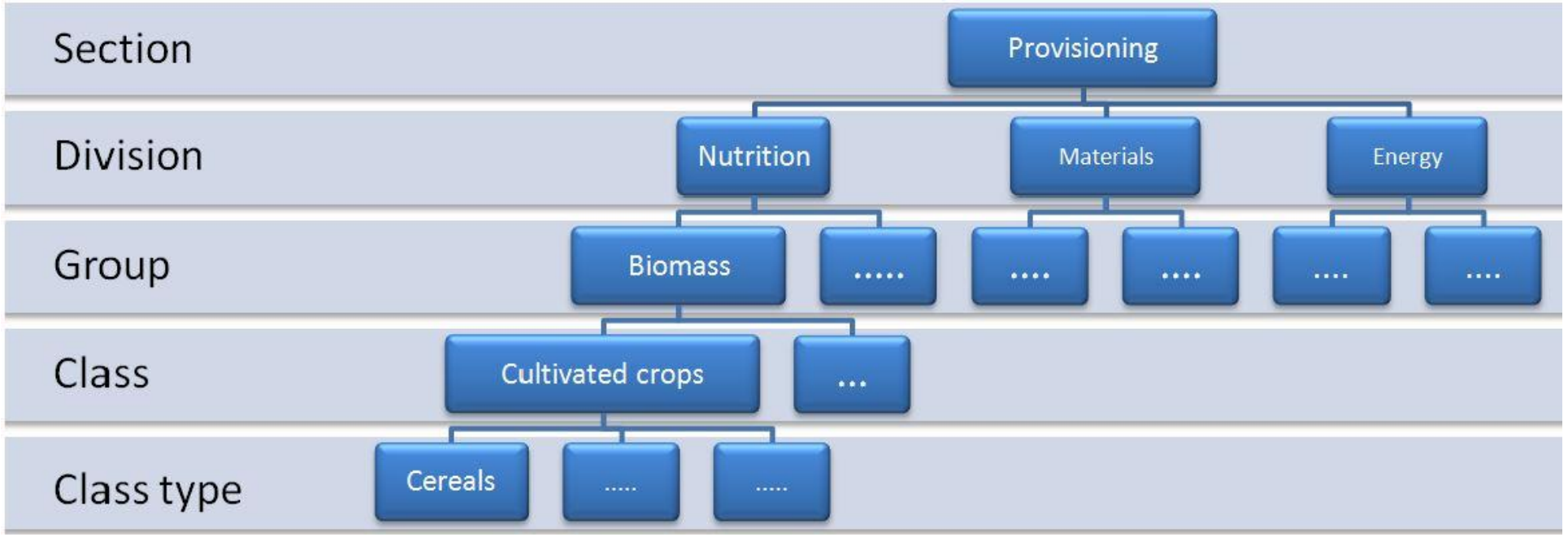
PDF

### Ecosystem services still degrading

Most of the ecosystem services in Europe are judged to be 'degraded' — no longer able to deliver the optimal quality and quantity of basic services such as crop pollination, clean air and water, and control of floods or erosion (RUBICODE project 2006–2009; marine ecosystems not included).

| Ecosystems / Services | Agro ecosystems | Forests | Grasslands | Heath and scrubs | Wetlands | Lakes and rivers |
|---|---|---|---|---|---|---|
| **Provisioning** | | | | | | |
| Crops/timber | ↓ | ↑ | | | ↓ | |
| Livestock | ↓ | = | = | = | ↓ | |
| Wild Foods | = | ↓ | ↓ | | = | |
| Wood fuel | | = | | = | | |
| Capture fisheries | | | | | = | = |
| Aquaculture | | | | | ↓ | ↓ |
| Genetic | = | ↓ | ↓ | = | = | |
| Fresh water | | ↓ | | | ↑ | ↑ |
| **Regulating** | | | | | | |
| Pollination | ↑ | ↓ | = | | | |
| Climate regulation | | ↑ | | = | = | = |
| Pest regulation | ↑ | | = | | | |
| Erosion regulation | | = | = | = | | |
| Water regulation | | = | | ↑ | ↑ | = |
| Water purification | | | | | = | = |
| Hazard regulation | | | | | | |

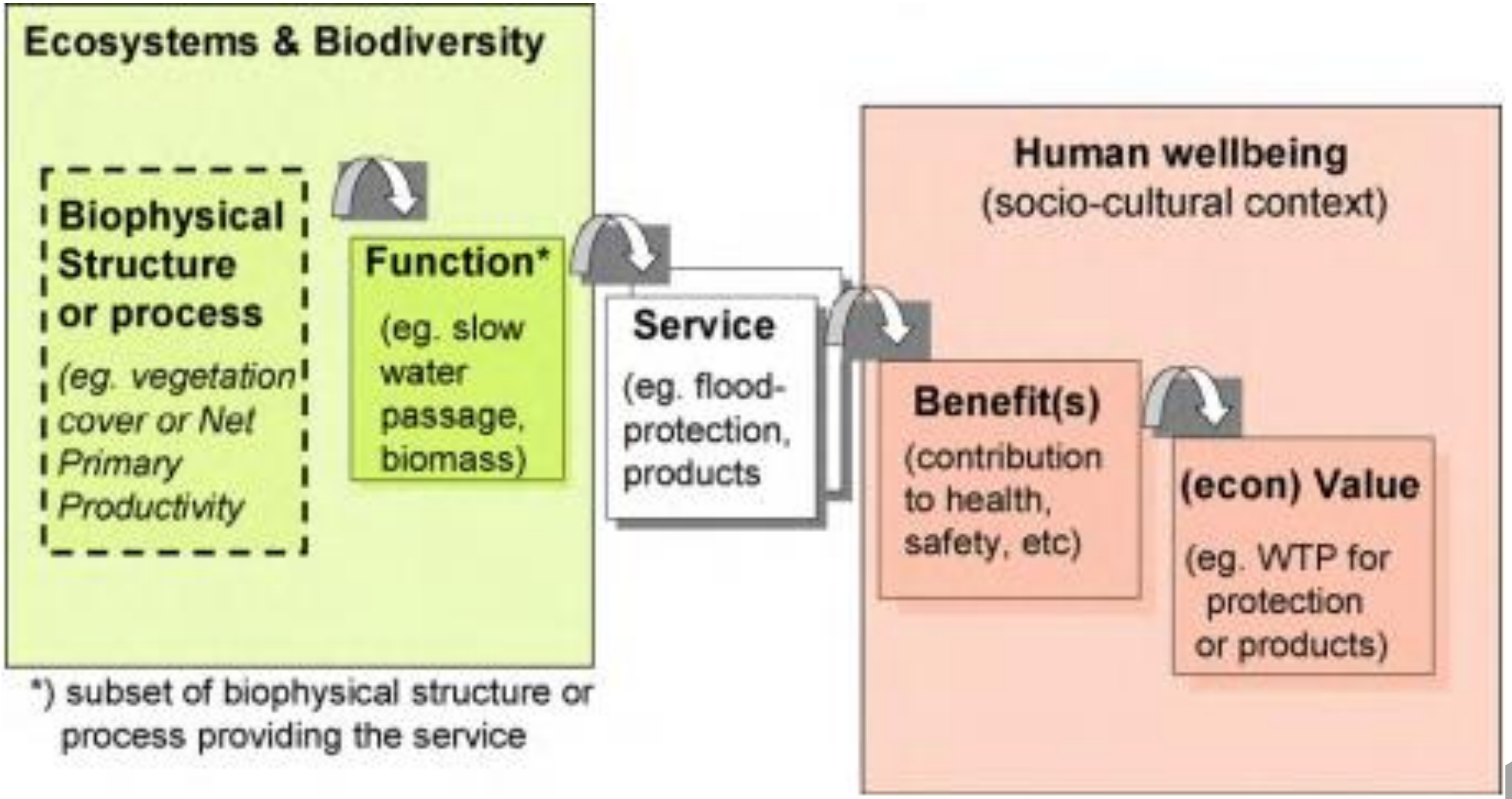
# The concept of ecosystem services


**Section – 3**
**Division – 8**
**Group – 20**
**Class - 48**

| Section | Division | Group |
|---|---|---|
| **Provisioning** | Nutrition | Biomass |
| | | Water |
| | Materials | Biomass, fibre |
| | | Water |
| | Energy | Biomass-based energy sources |
| | | Mechanical energy |
| **Regulation &** | Mediation of waste, toxics and other nuisances | Mediation by biota |
| | | Mediation by ecosystems |
| | Mediation of flows | Mass flows |
| | | Liquid flows |
| | | Gaseous / air flows |
| | Maintenance of physical, chemical, biological conditions | Lifecycle maintenance, habitat and gene pool protection |
| | | Pest and disease control |
| | | Soil formation and composition |
| | | Water conditions |
| | | Atmospheric composition and climate regulation |
| **Cultural** | Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings] | Physical and experiential interactions |
| | | Intellectual and representative interactions |
| | Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings] | Spiritual and/or emblematic |
| | | Other cultural outputs |

# The concept of ecosystem services



# Content

1. The concept of ecosystem services

**2. Mapping and assessment of ES**

3. Implementation of ES in BR

4. Some practical aspects

# Assessment of ecosystem services

Ecosystem services assessment - a process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers

Methods:

- Biophysical
- Social
- Economic

# Mapping of ecosystem services

Global efforts to conserve biodiversity have the potential to deliver economic benefits to people (i.e., ‘‘ecosystem services’’)

However, regions for which conservation benefits both biodiversity and ecosystem services cannot be identified unless ecosystem services can be quantified and valued and their areas of production **mapped**

Naidoo et al. 2008

# Mapping of ecosystem services

To effectively integrate ecosystem services into landscape planning and conservation programs, the **spatial concordance** between areas that support ecosystem functions and biodiversity and those that supply ecosystem services **have to be identified** and more broadly evaluated

**ES maps** constitute a very important tool to bring ES into practical application. Maps can efficiently communicate **complex spatial information** and people generally prefer to look at maps and to explore their content and practical applicability.

# Mapping of ecosystem services

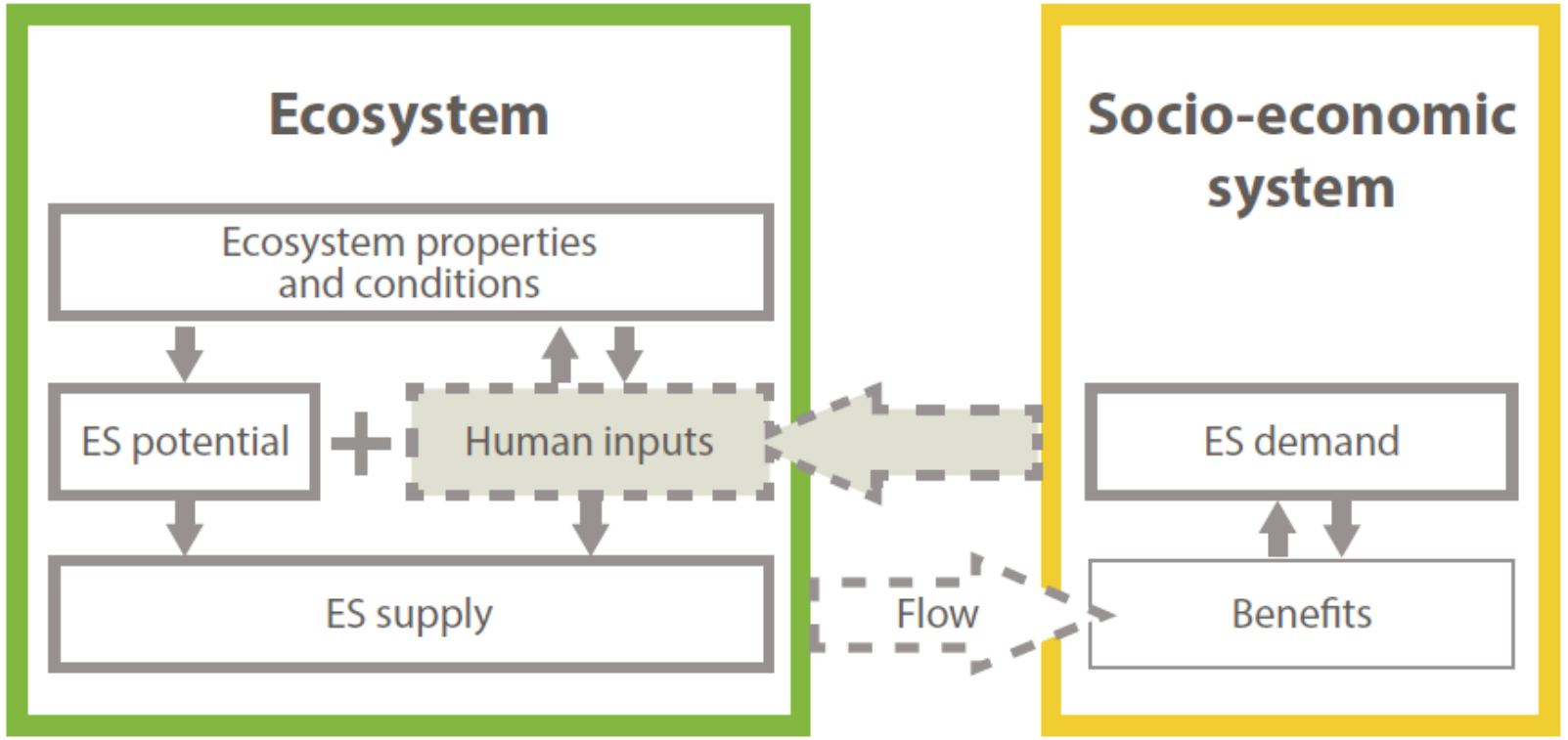
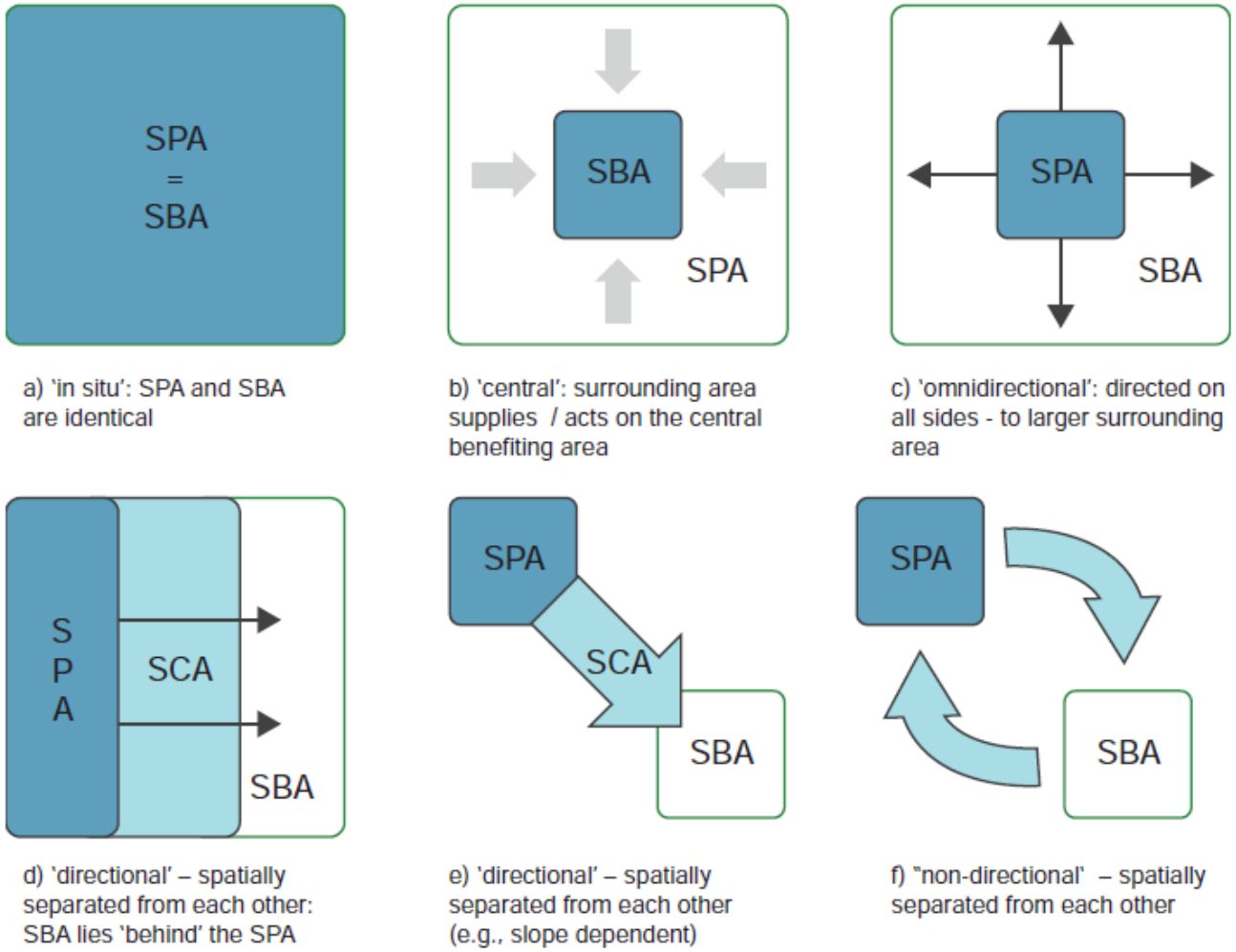



**Figure 1.** Mapping aspects of ES (own illustration, adapted version of the the ES cascade by Haines-Young & Potschin (see Chapter 2.3), Wolff et al. 2015, Bastian et al. 2013). Bold grey: subjects relevant for mapping; dashed: may be mapped; thin: additional aspects for which mapping could be developed.

(After Burkhard and Maes, 2017)

What to map?

# Mapping of ecosystem services




a) 'in situ': SPA and SBA are identical

b) 'central': surrounding area supplies / acts on the central benefiting area

c) 'omnidirectional': directed on all sides - to larger surrounding area

d) 'directional' – spatially separated from each other: SBA lies 'behind' the SPA

e) 'directional' – spatially separated from each other (e.g., slope dependent)

f) "non-directional' – spatially separated from each other

**Figure 1.** Types of spatial relations of Service Providing Areas (SPA), Service Benefiting Areas (SBA) and Service Connecting Areas (SCA) (adapted and extended from Fisher et al. 2009; Syrbe & Walz 2012).

## What to map?

(After Burkhard and Maes, 2017)

# Mapping of ecosystem services

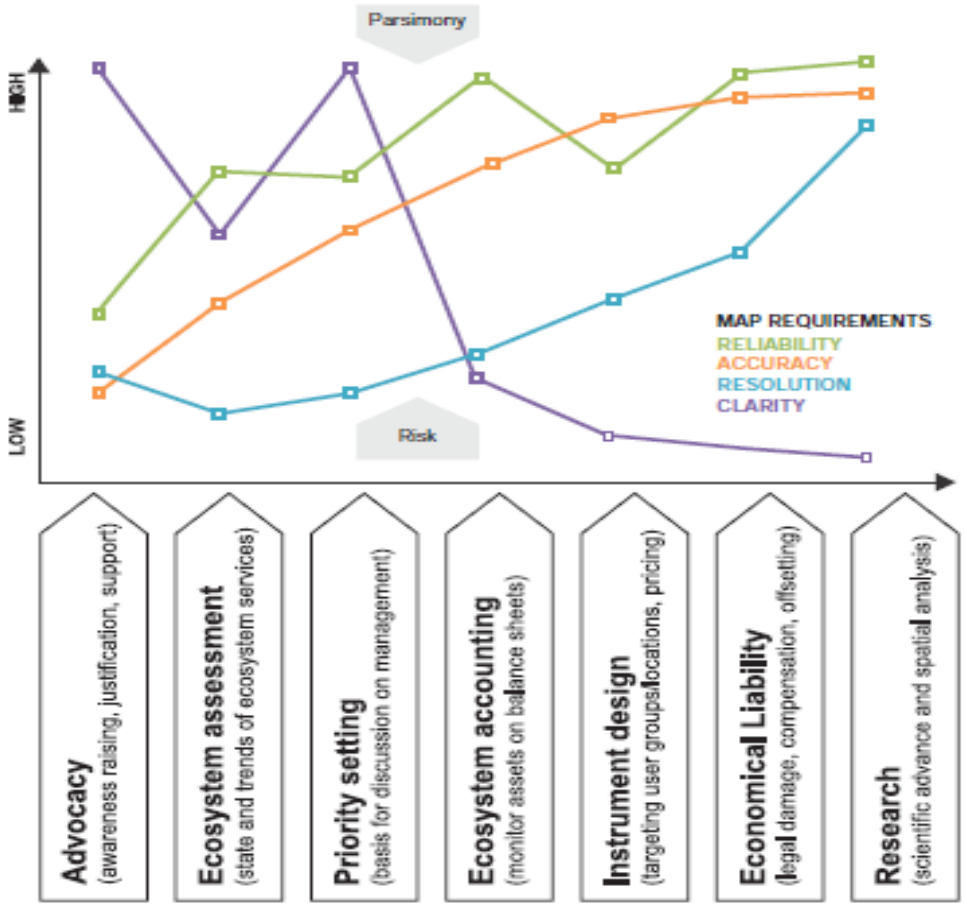
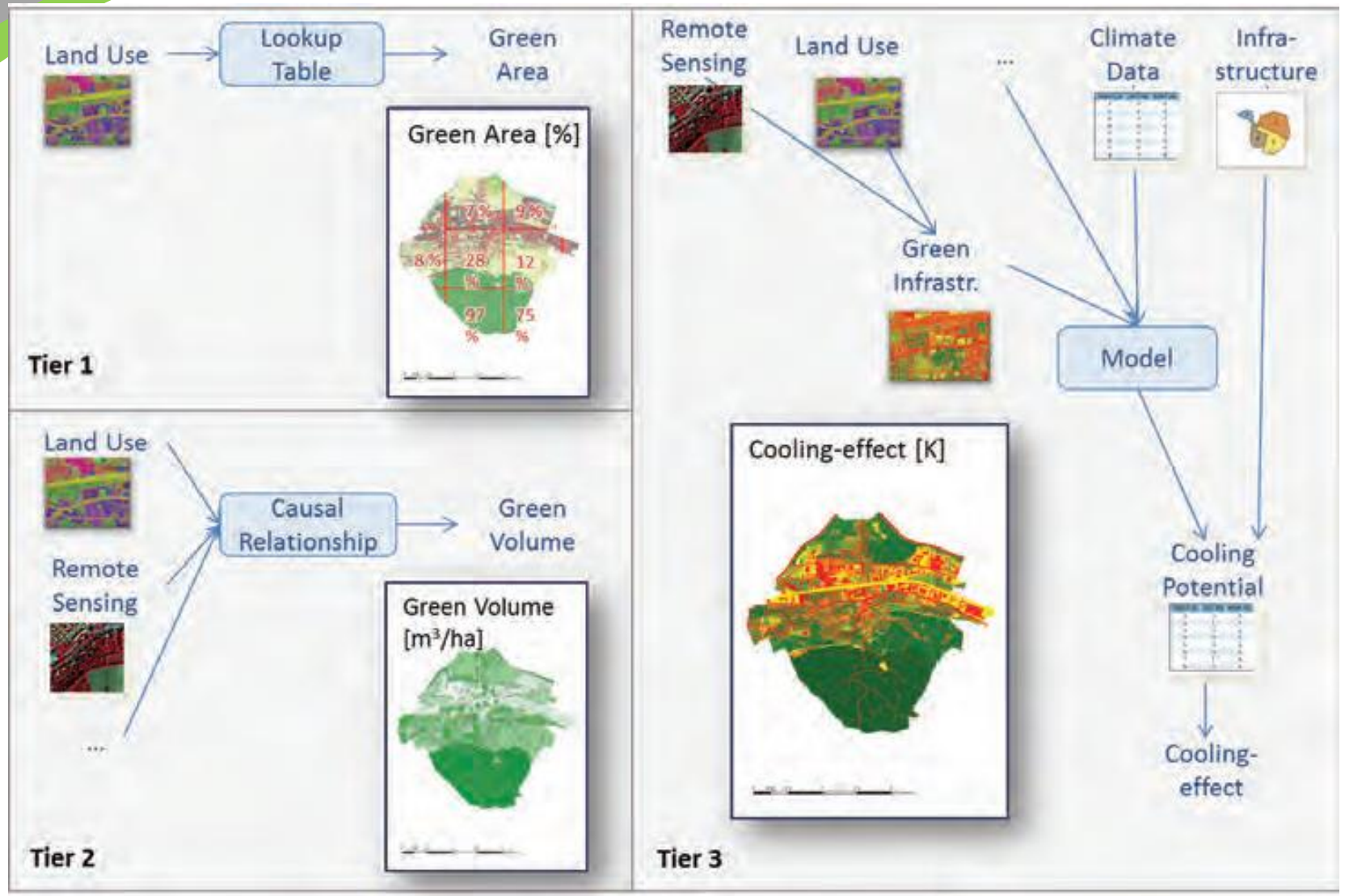



**Figure 1.** Ecosystem services mapping requirements according to purpose.

## Why to map?

(After Burkhard and Maes, 2017)

# Mapping of ecosystem services




## Tiered approach to ES mapping

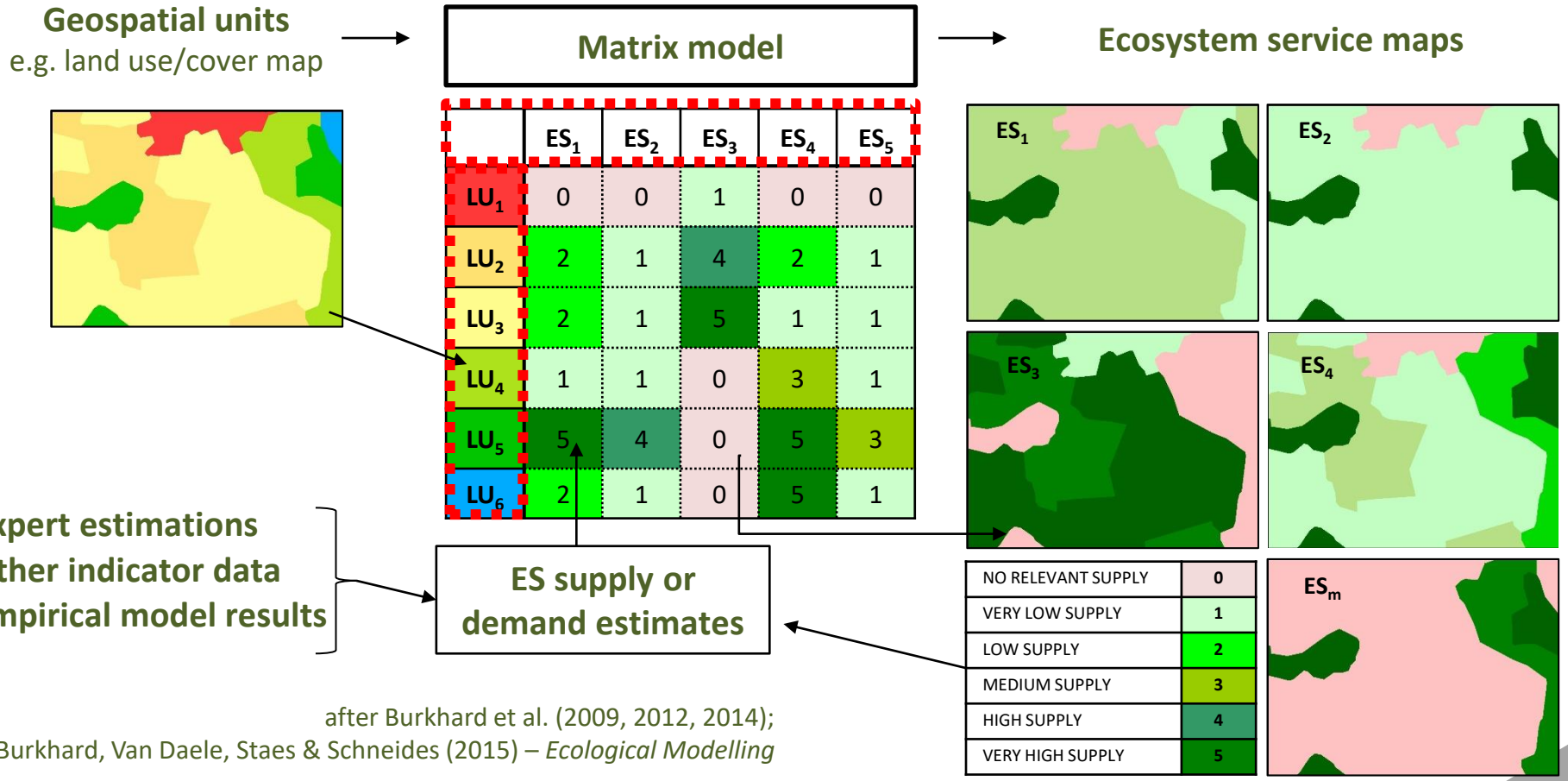
- ★ **Tier 1:** rather simple, e.g. land cover-based
- ★ **Tier 2:** more complex, e.g. statistics-based
- ★ **Tier 3:** complex, e.g. model-based

(After Burkhard and Maes, 2017)

# Mapping of ecosystem services

## Tier 1

### The Ecosystem Service "Matrix"

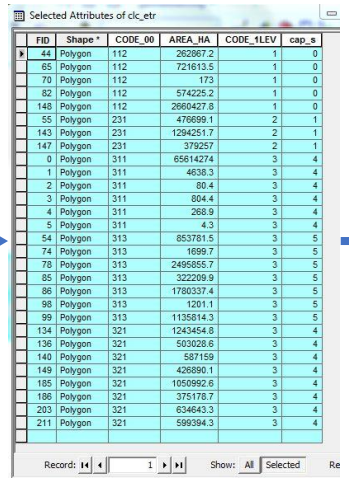


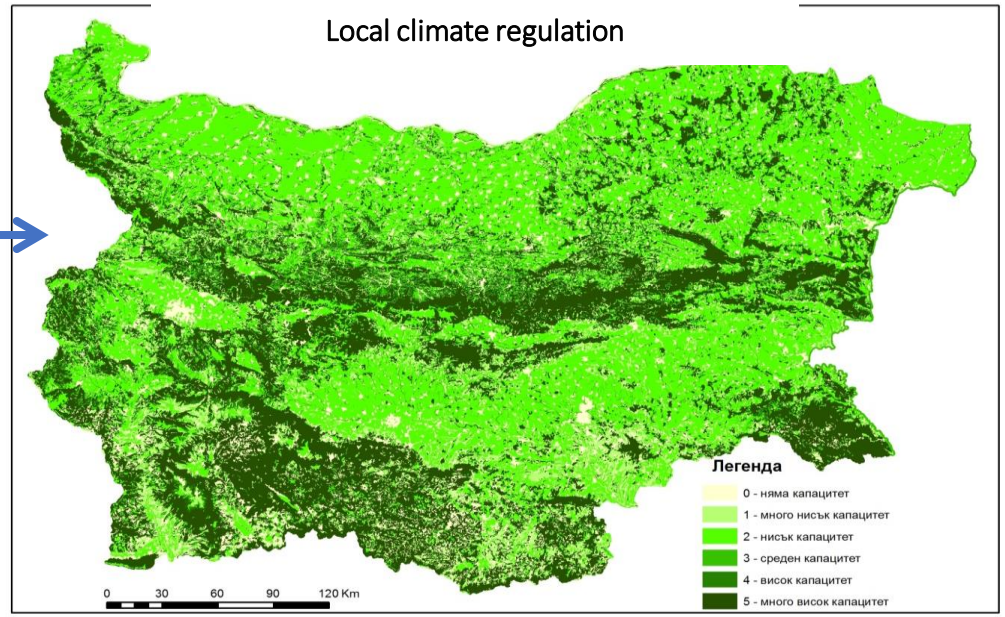

after Burkhard et al. (2009, 2012, 2014);
Jacobs, Burkhard, Van Daele, Staes & Schneides (2015) – *Ecological Modelling*

# Mapping of ecosystem services

## Tier 1

| | Ecological Integrity Σ | Abiotic heterogeneity | Biodiversity | Biotic waterflows | Metabolic efficiency | Exergy Capture (Radiation) | Reduction of Nutrient loss | Storage capacity (SOM) | Provisioning services Σ | Crops | Livestock | Fodder | Capture Fisheries | Acquaculture | Wild Foods | Timber | Wood Fuel | Energy | Biochemicals / Medicine | Freshwater | Regulating services Σ | Local climate regulation | Global climate regulation | Flood protection | Groundwater recharge | Air Quality Regulation | Erosion Regulation | Nutrient regulation | Water purification | Pollination | Cultural services Σ | Recreation & Aesthetic Values | Intrinsic Value of Biodiversity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Continuous urban fabric | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Discontinuous urban fabric | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial or commercial units | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Road and rail networks | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Port areas | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Airports | 7 | 1 | 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mineral extraction sites | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dump sites | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction sites | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green urban areas | 18 | 3 | 3 | 2 | 1 | 4 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 11 | 2 | 1 | 0 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | 0 |
| Sport and leasure facilities | 16 | 2 | 2 | 2 | 1 | 4 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 0 |
| Non-irrigated arable land | 22 | 3 | 2 | 3 | 4 | 5 | 1 | 4 | 21 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 5 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Permanently irrigated land | 21 | 3 | 2 | 5 | 2 | 5 | 1 | 3 | 18 | 5 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 5 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Ricefields | 20 | 3 | 2 | 5 | 1 | 5 | 1 | 3 | 7 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Vineyards | 14 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 5 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 |
| Fruit trees and berries | 21 | 4 | 3 | 4 | 2 | 3 | 2 | 3 | 13 | 5 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 0 | 0 | 19 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 5 | 5 | 5 | 0 |
| Olive groves | 17 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 12 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 0 | 0 | 7 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 5 | 5 | 0 |
| Pastures | 24 | 2 | 2 | 4 | 5 | 5 | 2 | 4 | 10 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 | 1 | 1 | 1 | 1 | 0 | 4 | 0 | 0 | 0 | 3 | 3 | 0 |
| Annual and permanent crops | 18 | 2 | 2 | 3 | 2 | 4 | 2 | 3 | 20 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 7 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| Complex cultivation patterns | 20 | 4 | 3 | 3 | 2 | 4 | 1 | 3 | 9 | 4 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 5 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 |
| Agriculture& natural vegetation | 19 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 21 | 3 | 3 | 2 | 0 | 0 | 3 | 3 | 3 | 2 | 1 | 0 | 13 | 3 | 2 | 1 | 2 | 1 | 3 | 0 | 1 | 0 | 5 | 2 | 3 |
| Agro-forestry areas | 27 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 14 | 3 | 3 | 2 | 0 | 0 | 0 | 3 | 3 | 2 | 0 | 0 | 13 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 0 |
| Broad-leaved forest | 31 | 3 | 4 | 5 | 4 | 5 | 5 | 5 | 21 | 0 | 0 | 1 | 0 | 0 | 5 | 5 | 5 | 1 | 5 | 0 | 39 | 5 | 4 | 3 | 2 | 5 | 5 | 5 | 5 | 5 | 10 | 5 | 5 |
| Coniferous forest | 30 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 21 | 0 | 0 | 1 | 0 | 0 | 5 | 5 | 5 | 1 | 5 | 0 | 39 | 5 | 4 | 3 | 2 | 5 | 5 | 5 | 5 | 5 | 10 | 5 | 5 |
| Mixed forest | 32 | 3 | 5 | 5 | 4 | 5 | 5 | 5 | 21 | 0 | 0 | 1 | 0 | 0 | 5 | 5 | 5 | 1 | 5 | 0 | 39 | 5 | 4 | 3 | 2 | 5 | 5 | 5 | 5 | 5 | 10 | 5 | 5 |
| Natural grassland | 30 | 3 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 22 | 2 | 3 | 1 | 1 | 0 | 5 | 5 | 5 | 0 | 6 | 3 | 3 |
| Moors and heathland | 30 | 3 | 4 | 4 | 5 | 4 | 5 | 5 | 10 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 20 | 4 | 3 | 2 | 2 | 0 | 0 | 3 | 4 | 2 | 10 | 5 | 5 |
| Sclerophyllous vegetation | 21 | 3 | 4 | 2 | 3 | 3 | 4 | 2 | 8 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 7 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 6 | 2 | 4 |
| Transitional woodland shrub | 21 | 3 | 4 | 2 | 3 | 3 | 4 | 2 | 5 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 2 | 2 |
| Beaches, dunes and sand plains | 10 | 3 | 3 | 1 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 0 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 2 |
| Bare rock | 6 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 4 | 4 | 0 |
| Sparsely vegetated areas | 9 | 2 | 3 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Burnt areas | 6 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glaciers and perpetual snow | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 10 | 3 | 3 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 |
| Inland marshes | 25 | 3 | 2 | 4 | 4 | 4 | 3 | 5 | 7 | 0 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 2 | 2 | 4 | 2 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| Peatbogs | 29 | 3 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 24 | 4 | 5 | 3 | 3 | 0 | 0 | 3 | 4 | 2 | 8 | 4 | 4 |
| Salt marshes | 23 | 2 | 3 | 4 | 3 | 3 | 3 | 5 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 1 | 0 | 5 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 3 | 0 |
| Salines | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 |
| Intertidal flats | 13 | 2 | 3 | 0 | 2 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 7 | 1 | 0 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 4 | 0 |
| Water courses | 18 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 12 | 0 | 0 | 0 | 3 | 0 | 4 | 0 | 0 | 3 | 0 | 5 | 10 | 1 | 0 | 2 | 1 | 0 | 0 | 3 | 3 | 0 | 10 | 5 | 5 |
| Water bodies | 23 | 4 | 4 | 0 | 4 | 4 | 3 | 4 | 12 | 0 | 0 | 0 | 3 | 0 | 4 | 0 | 0 | 0 | 0 | 5 | 7 | 2 | 1 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 9 | 5 | 4 |
| Coastal lagoons | 25 | 4 | 4 | 0 | 5 | 5 | 3 | 4 | 16 | 0 | 0 | 0 | 4 | 5 | 4 | 0 | 0 | 1 | 0 | 0 | 5 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 5 | 4 |
| Estuaries | 21 | 3 | 3 | 0 | 5 | 5 | 3 | 2 | 17 | 0 | 0 | 0 | 5 | 5 | 4 | 0 | 0 | 2 | 0 | 0 | 9 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 3 | 0 | 7 | 4 | 3 |
| Sea and ocean | 15 | 2 | 2 | 0 | 3 | 3 | 4 | 1 | 11 | 0 | 0 | 1 | 5 | 5 | 0 | 0 | 0 | 3 | 0 | 0 | 13 | 3 | 5 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 6 | 4 | 2 |




scale for assessing capacities:

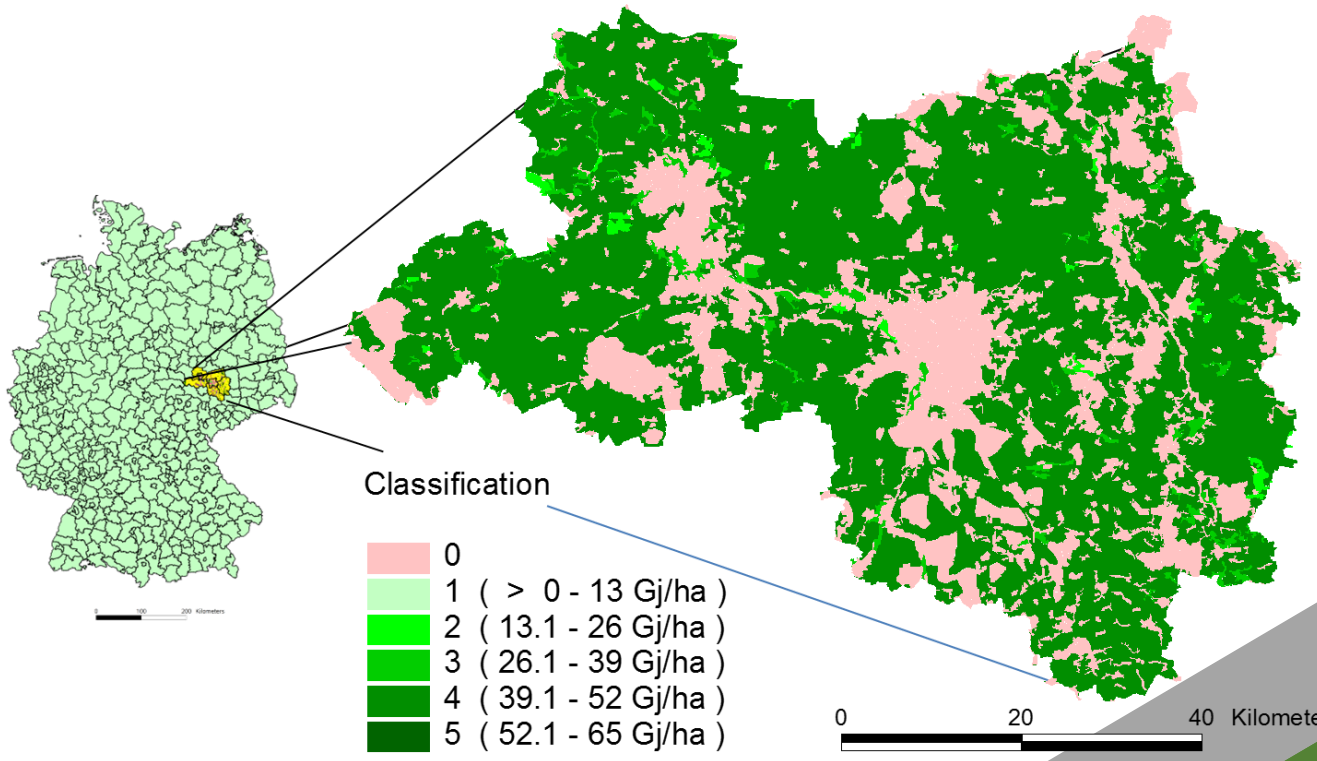
0 = no relevant capacity
1 = low relevant capacity
2 = relevant capacity
3 = medium relevant capacity
4 = high relevant capacity
5 = very high relevant capacity

# Mapping of ecosystem services

## Tier 2

- no relevant capacity
- low relevant capacity
- relevant capacity
- medium relevant capacity
- high relevant capacity
- very high relevant capacity

| Land cover class | Unit | Year | Crops | Fodder | Livestock | Capture Fisheries & Aquaculture | Wild Foods | Food provision (weighted aggregation) |
|---|---|---|---|---|---|---|---|---|
| | | | Classification | | | | | |
| Non-irrigated arable land | | 1990 | 43,7 | 183 | 0 | 0 | 0 | 38 |
| | | 2000 | 59,9 | 200,6 | 0 | 0 | 0 | 49,2 |
| Fruit trees and berry plantations | | 1990 | 25,5 | 0 | 0 | 0 | 0 | 25,5 |
| | | 2000 | 70 | 0 | 0 | 0 | 0 | 70 |
| Pastures | | 1990 | 0 | 0 | 9,4 | 0 | 0 | 9,4 |
| | | 2000 | 0 | 0 | 14 | 0 | 0 | 14 |
| Complex cultivation pattern | Gj/ha | 1990 | 22 | 45,7 | 0 | 0 | 0 | 21,1 |
| | | 2000 | 37,7 | 50,1 | 0 | 0 | 0 | 30 |
| Arable land and natural vegetation | | 1990 | 32,8 | 137 | 0 | 0 | 0 | 28,8 |
| | | 2000 | 44,9 | 150 | 0 | 0 | 0 | 36,8 |
| Water bodies | | 1990 | 0 | 0 | 0 | 1,3 | 0 | 1,3 |
| | | 2000 | 0 | 0 | 0 | 0,5 | 0 | 0,5 |
| Forests | | 1990 | 0 | 0 | 0 | 0 | 0,01 | 0,01 |
| | | 2000 | 0 | 0 | 0 | 0 | 0,02 | 0,02 |




**Case study**
**Leipzig-Halle**

Provisioning ES
“Food / crops“
1990 and 2000

**After Burkhard et al. 2012**

# Mapping of ecosystem services

## Tier 3

**Watershed modeling**
(AGWA/KINEROS)

↓

**Capacity assessment based of the model results**
(Assessment matrix)

↓

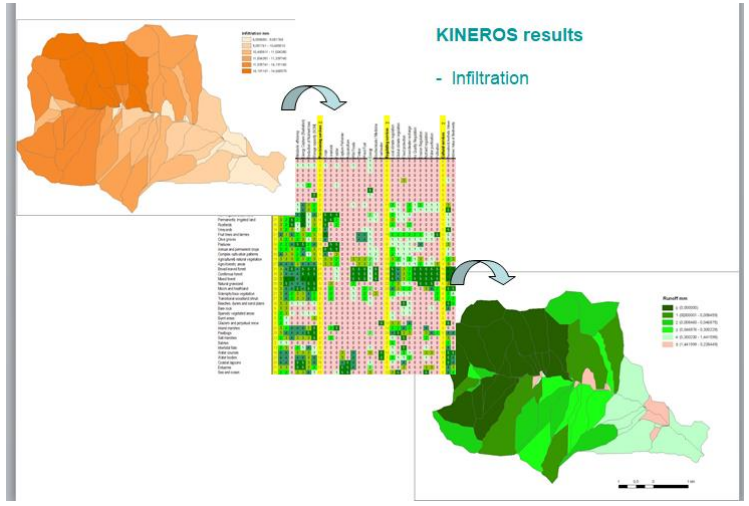
**Spatial analyses - model results/land cover/soil data**
(ArcGIS Spatial Analyst)

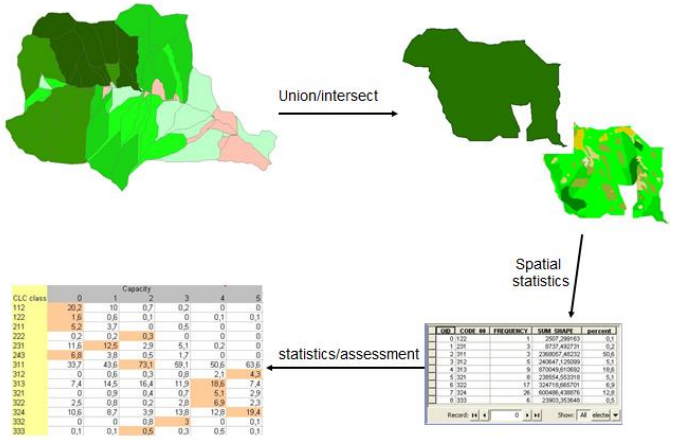
↓

**Capacity assessment based on land cover and soil data**
(Assessment matrix)

↓

**Mapping of flood regulation Ecosystem Servises**
(ArcGIS)

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Flood regulating ecosystem services—Mapping supply and demand, in the Etropole municipality, Bulgaria

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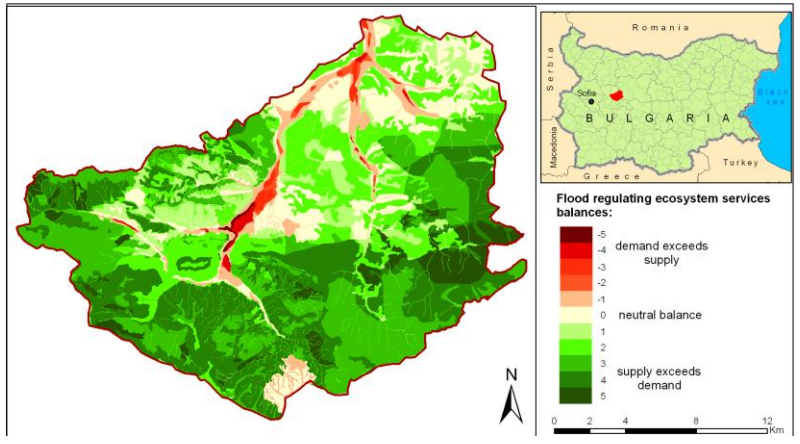
ARTICLE INFO

*Keywords:*
Ecosystem services
Flood regulation
GIS
CORINE land cover
Hydrological model KINEROS

ABSTRACT

Floods exert significant pressure on human societies. Assessments of an ecosystem's capacity to regulate and to prevent floods relative to human demands for flood regulating ecosystem services can provide important information for environmental management. In this study, the capacities of different ecosystems to regulate floods were assessed through investigations of water retention functions of the vegetation and soil cover. The use of the catchment based hydrologic model KINEROS and the GIS AGWA tool provided data about peak rivers' flows and the capability of different land cover types to "cap-



# Content

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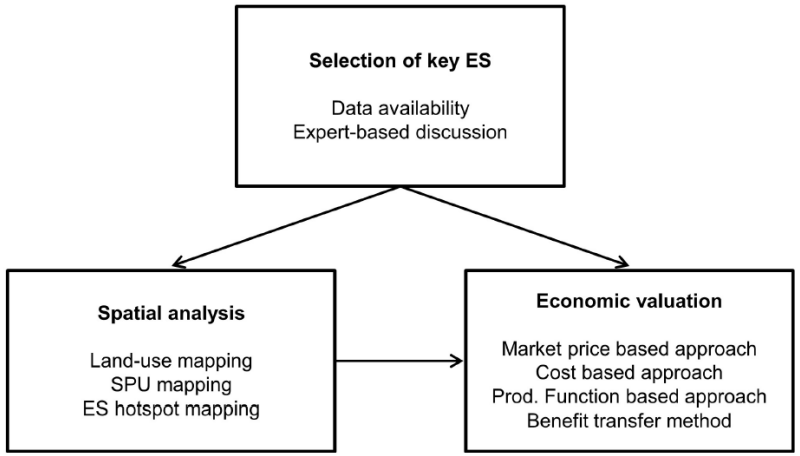


RESEARCH ARTICLE

# Coupling spatial analysis and economic valuation of ecosystem services to inform the management of an UNESCO World Biosphere Reserve

**Charlène Kermagoret☯, Jérôme Dupras☯***

Département des sciences naturelles, Université du Québec en Outaouais, Ripon, Québec, Canada

☯ These authors contributed equally to this work.
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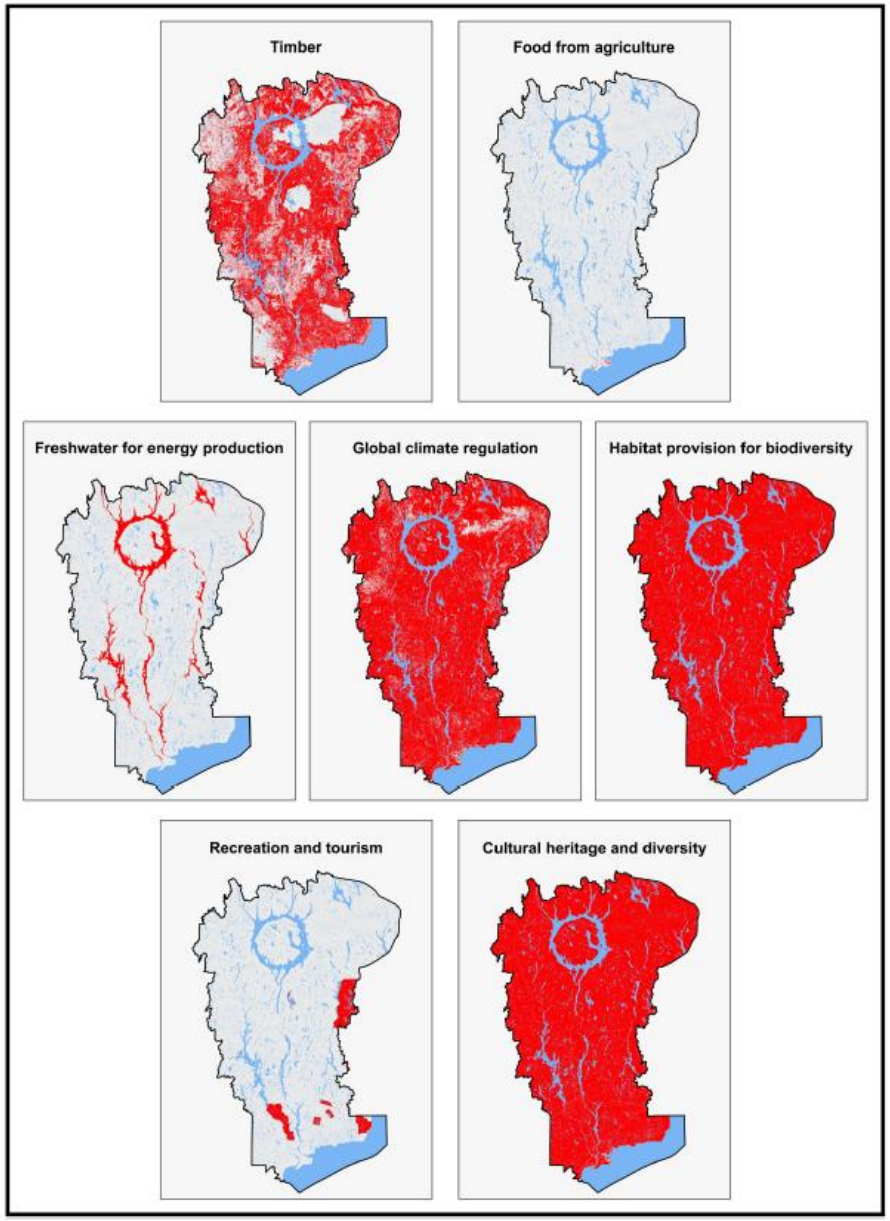
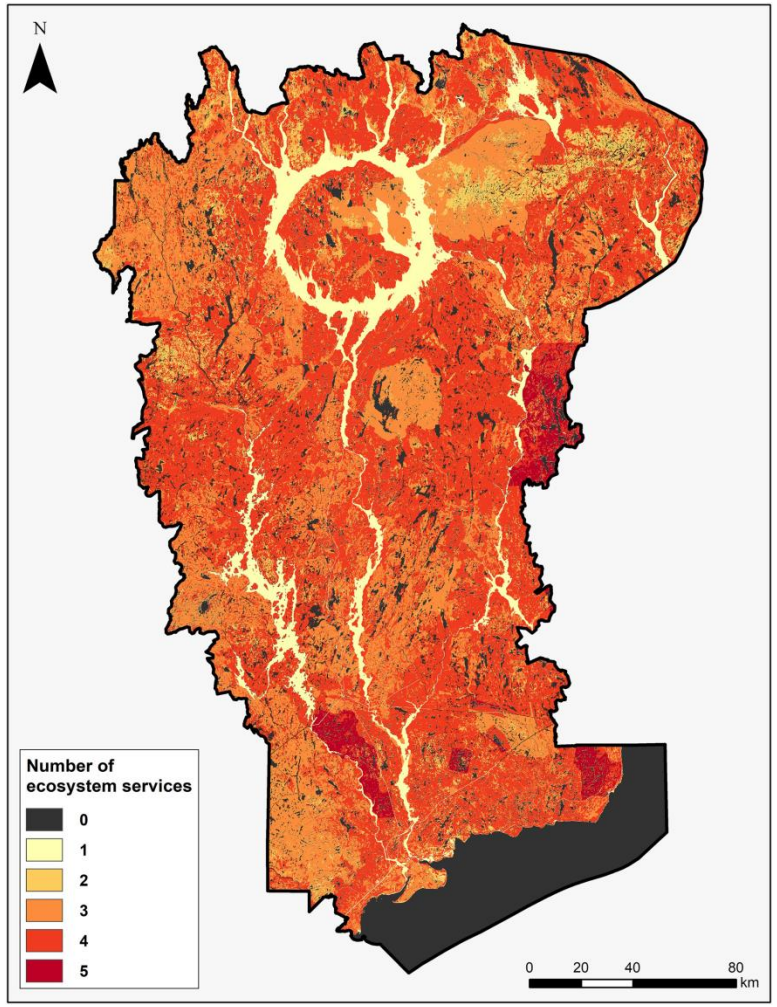
| Culture | Surface (ha) | Production value (CAN$/ha/year) | Total value of the production (million CAN$ per year) |
|---|---|---|---|
| *Oats* | 77 | 902 | 69.5 |
| *Corn* | 7 | 1206 | 8.4 |
| *Cranberries* | 29 | 2771 | 80.4 |
| *Canola / Rapeseed* | 6 | 3630 | 21.8 |
| *Barley* | 261 | 500 | 130.5 |
| *Potatoes* | 70 | 5111 | 357.8 |
| *Prairie* | 22 | 116 | 2552.0 |
| *Vineyards* | 24 | 3630 | 87.1 |
| *Perennial crops and pastures* | 876 | 116 | 145.4 |
| *Undifferentiated Agriculture* | 738 | 0 | 0 |
| **Total** | **2 109** | / | **3452.9** |




PLOS ONE

RESEARCH ARTICLE

## Coupling spatial analysis and economic valuation of ecosystem services to inform the management of an UNESCO World Biosphere Reserve

**Charlène Kermagoret, Jérôme Dupras**

Département des sciences naturelles, Université du Québec en Outaouais, Ripon, Québec, Canada

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# Mapping of ecosystem services in Central Balkan area

ESMERALDA

**CASE STUDY BOOKLET**

(Picture by Petar Nikolov)

**Mapping and assessment of ES in Central Balkan area in Bulgaria at multiple scales**

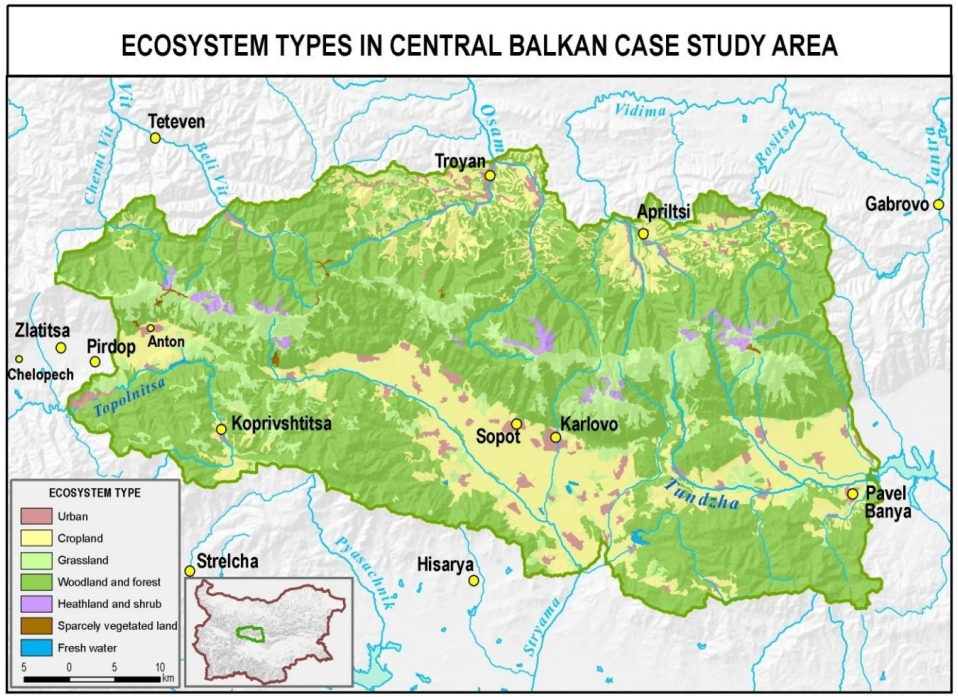
June 2018

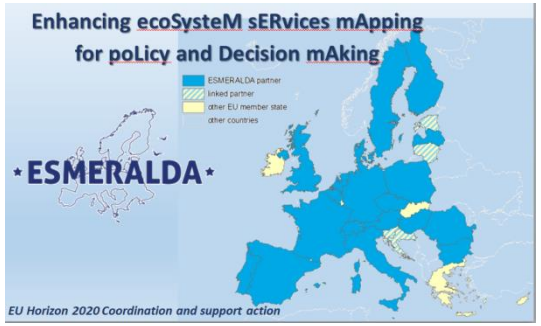
**ESMERALDA partner:** National Institute of Geophysics, Geodesy and Geography (NIGGG), BAS

**Case Study Coordinators:** Stoyan Nedkov, Bilyana Borisova

ESMERALDA

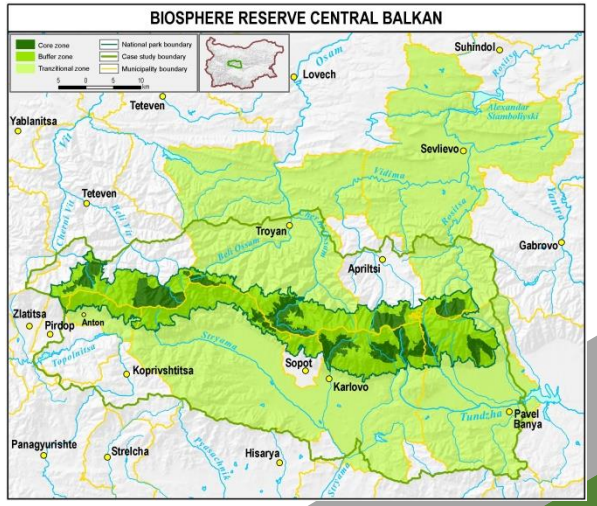
Enhancing ecosystem services mapping for policy and decision making



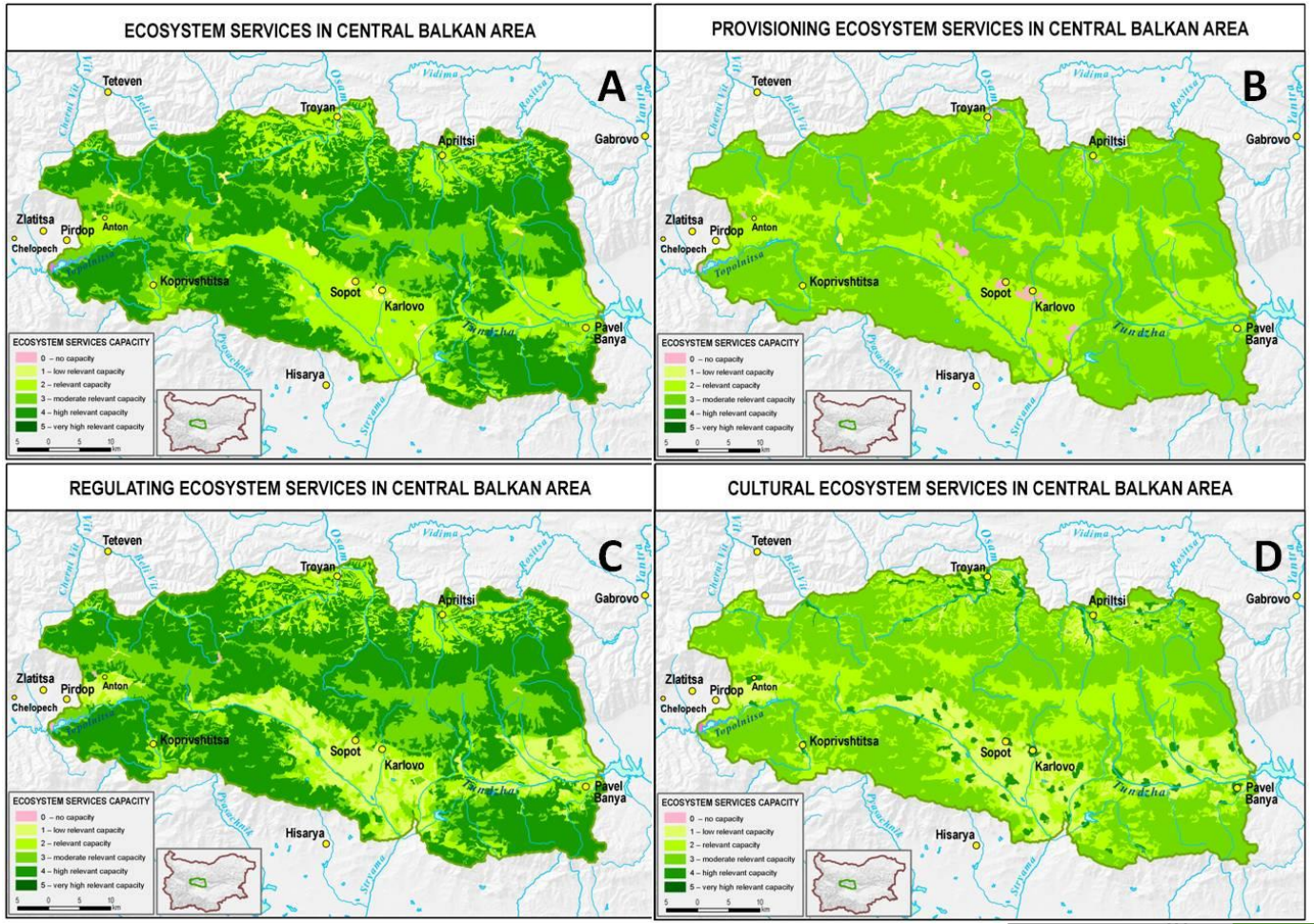

| Ecosystem Service selected for mapping and assessment | B | S | E |
|---|---|---|---|
| 1.1.2.1 Surface water for drinking* | x | | |
| 1.2.2.1 Surface water for non-drinking purposes | x | | |
| 2.2.2.2 Flood regulation | x | | |
| 2.3.5.1 Global climate regulation | x | | |
| 2.3.5.2 Micro and regional climate regulation | x | | |
| 3.1.1.1 Experiential use of plants, animals and land/seascapes | | | x |
| 3.1.2.5 Aesthetic* | | x | |

* ES selected for further discussion during ESMERALDA workshops 5 in Madrid;
B = biophysical methods; S = socio-cultural methods; E = economic methods.



# Mapping of ecosystem services in Central Balkan area

| CLC classess | Cultivated crops | Reared animals | Wild plants | Wild animals | Water | Fibres and other materials | Genetic resources | **Average Provisioning** | Regulation of pollution | Erosion regulation | Water flow regulation | Flood regulation | Polination | Maintenance of habitats | Desease control | Local climate regulation | Global climate regulation | **Average Regulation** | Recreation | Science and education | Cultural heritage | Aesthetic and spiritual | **Average Cultural** | **Average all services** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discontinuous urban fabric | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2,1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2,1 | 4 | 3 | 4 | 3 | 3,6 | 2,40 |
| Industrial or commercial | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0,3 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0,5 | 1 | 1 | 1 | 0 | 0,7 | 0,51 |
| Dump sites | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,1 | 0 | 0 | 0 | 0 | 0,0 | 0,05 |
| Green urban areas | 0 | 1 | 2 | 1 | 2 | 2 | 2 | 1,5 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 2 | 3,0 | 4 | 2 | 2 | 4 | 3,0 | 2,48 |
| Sport and leisure facilities | 0 | 0 | 1 | 1 | 2 | 1 | 1 | 1,1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 1,7 | 4 | 2 | 1 | 3 | 2,6 | 1,64 |
| Non-irrigated arable land | 5 | 2 | 0 | 2 | 2 | 1 | 2 | 1,9 | 2 | 1 | 1 | 1 | 3 | 2 | 2 | 1 | 0 | 1,3 | 0 | 1 | 1 | 1 | 0,9 | 1,43 |
| Vineyards | 4 | 1 | 1 | 1 | 2 | 1 | 2 | 1,6 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 0 | 1,7 | 2 | 2 | 1 | 2 | 1,4 | 1,62 |
| Fruit trees and berries | 5 | 2 | 2 | 1 | 2 | 2 | 3 | 2,3 | 3 | 3 | 3 | 3 | 4 | 3 | 2 | 3 | 1 | 2,7 | 1 | 2 | 1 | 2 | 1,3 | 2,28 |
| Pastures | 1 | 4 | 2 | 2 | 2 | 1 | 3 | 2,3 | 2 | 3 | 2 | 2 | 4 | 4 | 3 | 2 | 1 | 2,5 | 2 | 1 | 0 | 2 | 1,4 | 2,20 |
| Complex cultivation patterns | 4 | 3 | 2 | 2 | 2 | 1 | 2 | 2,2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 1,9 | 1 | 1 | 0 | 2 | 0,9 | 1,82 |
| Agro-forestry | 4 | 3 | 3 | 2 | 2 | 2 | 3 | 2,7 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2,4 | 1 | 1 | 0 | 2 | 1,2 | 2,25 |
| Broad-leaved forest | 0 | 1 | 4 | 5 | 4 | 5 | 4 | 3,2 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 5 | 3 | 4,2 | 4 | 3 | 1 | 5 | 3,1 | 3,66 |
| Coniferous forest | 0 | 1 | 3 | 4 | 4 | 5 | 3 | 2,8 | 5 | 4 | 5 | 5 | 3 | 4 | 3 | 5 | 3 | 4,1 | 4 | 3 | 1 | 4 | 3,0 | 3,44 |
| Mixed forest | 0 | 1 | 4 | 5 | 4 | 5 | 4 | 3,2 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 5 | 4 | 4,3 | 4 | 3 | 1 | 5 | 3,1 | 3,68 |
| Natural grasslands | 1 | 4 | 2 | 3 | 2 | 1 | 3 | 2,3 | 2 | 3 | 3 | 2 | 4 | 4 | 4 | 3 | 1 | 2,7 | 3 | 2 | 0 | 3 | 2,1 | 2,47 |
| Moors and heathland | 1 | 3 | 2 | 3 | 2 | 1 | 3 | 2,1 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 1 | 2,7 | 2 | 2 | 0 | 3 | 1,7 | 2,33 |
| Transitional woodland-shrub | 0 | 2 | 4 | 3 | 3 | 3 | 3 | 2,6 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 2 | 3,1 | 3 | 2 | 0 | 3 | 2,0 | 2,72 |
| Bare rocks | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0,2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0,1 | 1 | 2 | 0 | 3 | 1,4 | 0,41 |
| Sparsely vegetated areas | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0,8 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0,7 | 1 | 1 | 0 | 2 | 0,9 | 0,81 |
| Water bodies | 0 | 1 | 1 | 4 | 5 | 1 | 3 | 2,0 | 3 | 0 | 2 | 2 | 1 | 4 | 2 | 4 | 2 | 2,1 | 4 | 3 | 1 | 4 | 2,8 | 2,21 |



# Content

1. The concept of ecosystem services

2. Mapping and assessment of ES

3. Implementation of ES in BR

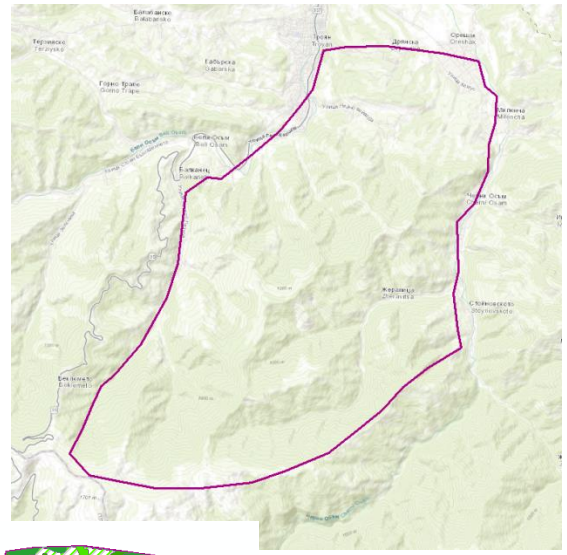
**4. Some practical aspects and exercise**

# Example of express method of assessment and mapping of ES

- Identification and mapping of ecosystems
- Identification of relevant ecosystem services for the area
- Prioritization of ecosystem services
- Preparation of ES matrix
- Expert assessment of ES
- Data processing
- Preparation of maps

# Identification and mapping of ecosystems

- Outline of the case study area
- Identification of appropriate spatial unit (land cover, vegetation map etc.)
- Outline of the spatial units within the case study area
- Identification of the ecosystem types



# Identification of relevant ecosystem services for the area

- Choice of classification
- Choice of appropriate level of the classification
- Selection of ES categories
- Comparison between ecosystems in the area and the selected ES
- Selection of relevant ES

| Section | Division | Group |
|---|---|---|
| **Provisioning** | Nutrition | Biomass |
| | | Water |
| | Materials | Biomass, fibre |
| | | Water |
| | Energy | Biomass-based energy sources |
| | | Mechanical energy |
| **Regulation &** | Mediation of waste, toxics and other nuisances | Mediation by biota |
| | | Mediation by ecosystems |
| | Mediation of flows | Mass flows |
| | | Liquid flows |
| | | Gaseous / air flows |
| | Maintenance of physical, chemical, biological conditions | Lifecycle maintenance, habitat and gene pool protection |
| | | Pest and disease control |
| | | Soil formation and composition |
| | | Water conditions |
| | | Atmospheric composition and climate regulation |
| **Cultural** | Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings] | Physical and experiential interactions |
| | | Intellectual and representative interactions |
| | Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings] | Spiritual and/or emblematic |
| | | Other cultural outputs |

# Prioritization of ecosystem services

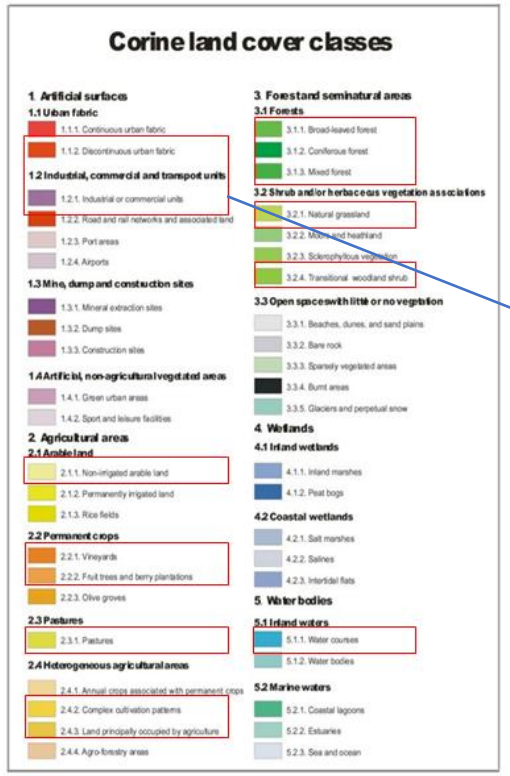
- Prioritization criteria
- Preparation of prioritization matrix
- Scoring the ES
- Selection of most appropriate ES

Appendix A. Prioritization matrix for identification and selection of relevant ecosystem services. Relevance to urban ecosystems: 0 – no relevance; 1 – low relevance; 2 – medium relevance; 3 – high relevance. Indication of relative relevance: 0 – no value; 1 – low value; 2 – medium value; 3 – high value. Data availability: 0 – not available; 1 – available for limited areas; 2 – partially available at national level; 3 – fully available at national level.

| CISES Code | Relevance to urban ecosystems | | | | | | | | | | Indication of relative value | | | | | | | | | | Data availability | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 | J10 | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 | J10 | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 | J10 |
| 1111 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1112 | 0 | 2 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 1113 | 0 | 2 | 3 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 3 | 3 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 0 | 0 | 0 |
| 1114 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1116 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1121 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1122 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1211 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1212 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1213 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1221 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 3 | 1 | 1 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 2 |
| 1222 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1311 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | `1 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1312 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | `2 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

# Preparation of ES matrix

- Selection of spatial units
- Selection of ES




| | Материални услуги Σ | Храна (земеделие) | Храна (животновъдство) | Фураж / храна за животни | Енергия от биомаса | Естествени влакна | Добив на дървесина | Дърва за огрев | Риболов, морски дарове и води за консумация водорасли | Храна от дивораснали растения | Биохимикали и медицина | Прясна вода | Абиотични енергийни източници | Регулационни и поддържащи услуги Σ | Регулиране на климата на глобално ниво | Регулиране на климата на локално ниво | Регулиране качеството на въздуха | Регулиране на водния кръговрат | Качество на водата | Регулиране на ерозията | Регулиране на природните бедствия | Опрашване | Контрол върху вредители и болести | Регулиране на отпадъците | Предоставяне на местообитания | Биоразнообразие | Културни услуги Σ | Рекреация и туризъм | Естетическа и духовна стойност | Образователна и научна стойност | Религия и духовна стойност | Културно наследство и културно разнообразие | Общо |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Населени места със свободно застрояване | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Индустриални или търговски обекти | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ненапоявана обработваема земя | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Лозя | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Овощни и ягодови насаждения | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Пасища | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Комплекси от раздробени земеделски земи | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Земеделски земи със значителни участъци естествена растителност | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Широколистни гори | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Иглолистни гори | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Смесени гори | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Естествени ливади | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Преходна дървесно-храстова растителност | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Водни течения | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Appendix A. Prioritization matrix for identification and selection of relevant ecosystem services. Relevance to urban ecosystems: 0 – no relevance; 1 – low relevance; 2 – medium relevance; 3 – high relevance. Indication of relative relevance: 0 – no value; 1 – low value; 2 – medium value; 3 – high value. Data availability: 0 – not available; 1 – available for limited areas; 2 – partially available at national level; 3 – fully available at national level.

| CISES Code | Relevance to urban ecosystems | | | | | | | | | | Indication of relative value | | | | | | | | | | Data availability | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 | J10 | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 | J10 | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 | J10 |
| 1111 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1112 | 0 | 2 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 1113 | 0 | 2 | 3 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 3 | 3 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 0 | 0 | 0 |
| 1114 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1116 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1121 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1122 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1211 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1212 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1213 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1221 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 3 | 1 | 1 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 2 |
| 1222 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1311 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | '1 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1312 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | '2 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

# Expert assessment of ES

- Scoring of ecosystems

Ecosystem type

Score (0-5)

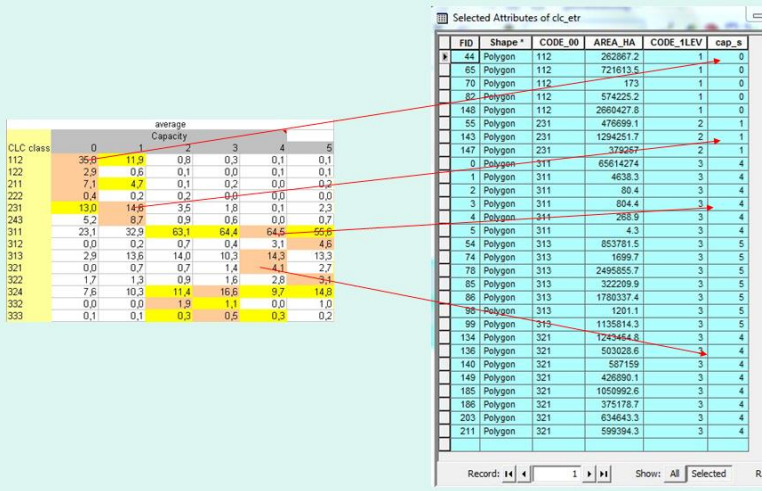
| | Материални услуги Σ | Храна (земеделие) | Храна (животновъдство) | Фураж / храна за животни | Енергия от биомаса | Естествени влакна | Добив на дървесина | Дърва за огрев | Риболов, морски дарове и години за консумация водорасли | Храна от дивораснящи растения | Биохимикали и медицина | Прясна вода | Абиотични енергийни източници | Регулационни и поддържащи услуги Σ | Регулиране на климата на глобално ниво | Регулиране на климата на локално ниво | Регулиране качеството на въздуха | Регулиране на водния кръговрат | Качество на водата | Регулиране на ерозията | Регулиране на природните бедствия | Опрашване | Контрол върху вредители и болести | Регулиране на отпадъците | Предоставяне на местообитания | Биоразнообразие | Културни услуги Σ | Рекреация и туризъм | Естетическа и духовна стойност | Образователна и научна стойност | Религия и духовна стойност | Културно наследство и културно разнообразие | Общо |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Населени места със свободно застрояване | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Индустриални или търговски обекти | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ненапоявана обработваема земя | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Лозя | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Овощни и ягодови насаждения | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Пасища | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Комплекси от раздробени земеделски земи | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Земеделски земи със значителни участъци естествена растителност | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Широколистни гори | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Иглолистни гори | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Смесени гори | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Естествени ливади | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Преходна дървесно-храстова растителност | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Водни течения | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

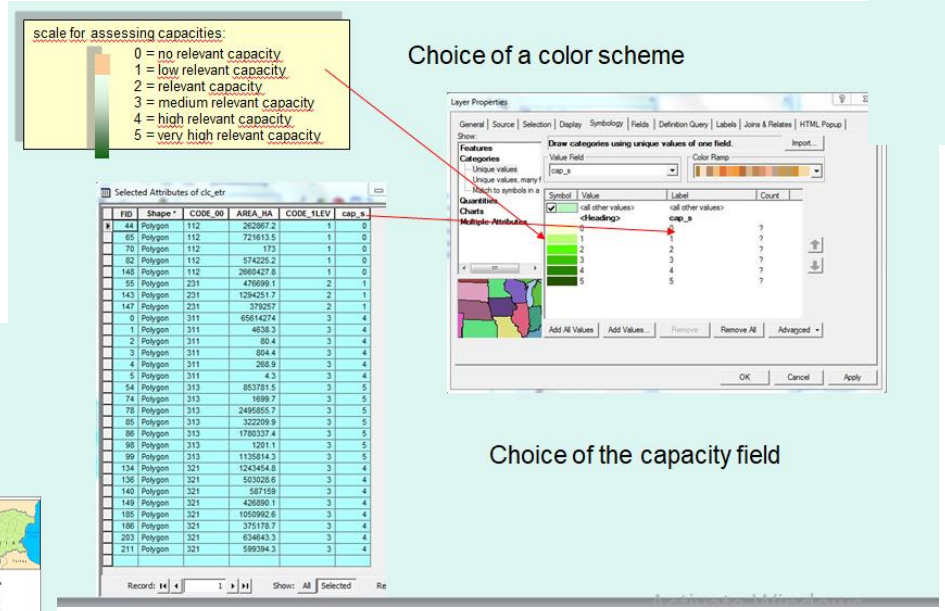
scale for assessing capacities:

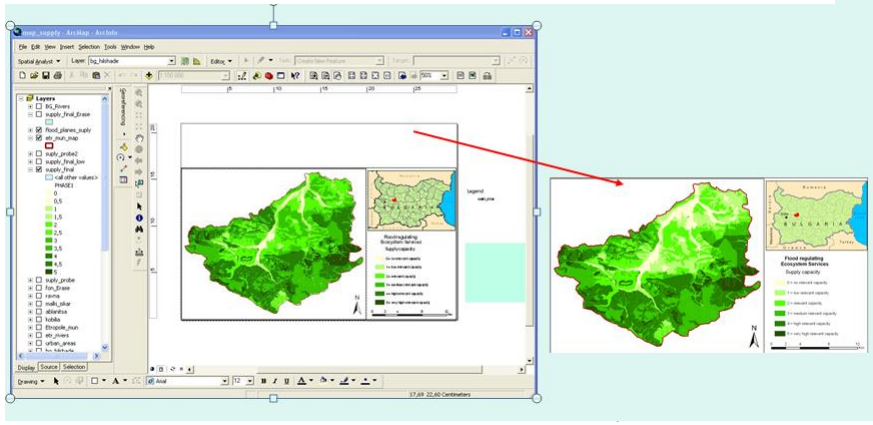
0 = no relevant capacity
1 = low relevant capacity
2 = relevant capacity
3 = medium relevant capacity
4 = high relevant capacity
5 = very high relevant capacity

# Preparation of maps

- Preparation of GIS layers
- Attribute data input
- Selection of color scheme
- Map making



# Thank you for your attention!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