# Mapping And Assessment Of Ecosystems And Their Services -MAES

## Development of ES in Greece and the region

MAES workshop, Thessaloniki, 26th April 2018

Jeroen Arends

ESP -Regional Chapter South East Europe

# Ecosystem Services Assessment and Valuation (ESAV) in SEE

## First scientific ES research in Greece

- First research in Greece appears in the late 1990s (Langford et al. 1998, Gerakis and Kalburtji 1998, Zervas 1998)
- Oglethorpe, D., Miliadou D. (2000): Economic Valuation of the Non-use Attributes of a Wetland: A Case-study for Lake Kerkini
- Mallios, Z. and Latinopoulos, P. (2001) 'Willingness to pay for irrigation water: a case study in Chalkidiki', International Conference on Environmental S&T
- Zalidisa,G.C., Tsiafouli, M.A, Takavakogloua, V., Bilasa, G., Misopolinos, N. (2003): Selecting agri-environmental indicators to facilitate monitoring and assessment of EU agri-environmental measures effectiveness
- Kontogianni, A., Langford, I., Papandreou, A. and Skourtos, M. (2003) 'Social preferences for improving water quality: an economic analysis of benefits from wastewater treatment'
- Damigos, D. and Kaliampakos, D. (2003) 'Assessing the benefits of reclaiming urban quarries: a CVM analysis'
- Fanariotu, I. and Skuras, D. (2004) 'The contribution of scenic beauty indicators in estimating environmental welfare measures: a case study';
- Genius, M., Manioudaki, M., Mokas, E., Pantagakis, E., Tampakakis, D. and Tsagarakis, K.P. (2005) 'Estimation of WTP for wastewater treatment';
- Genius, M. and Tsagarakis, K.P. (2006) 'Water shortages and implied water quality: a contingent valuation study';

First research focuses much on economic assessment of environment, or valuation of environmental benefits, water resources and WTP. Other research related to ES assesses the condition and quality of ecosystems, ecosystem functioning and ES using a range of indicator sets.
Until the year 2006, the number of ESAV studies in Greece and other SEE countries is limited.
However, the year 2006 marks a turning point....

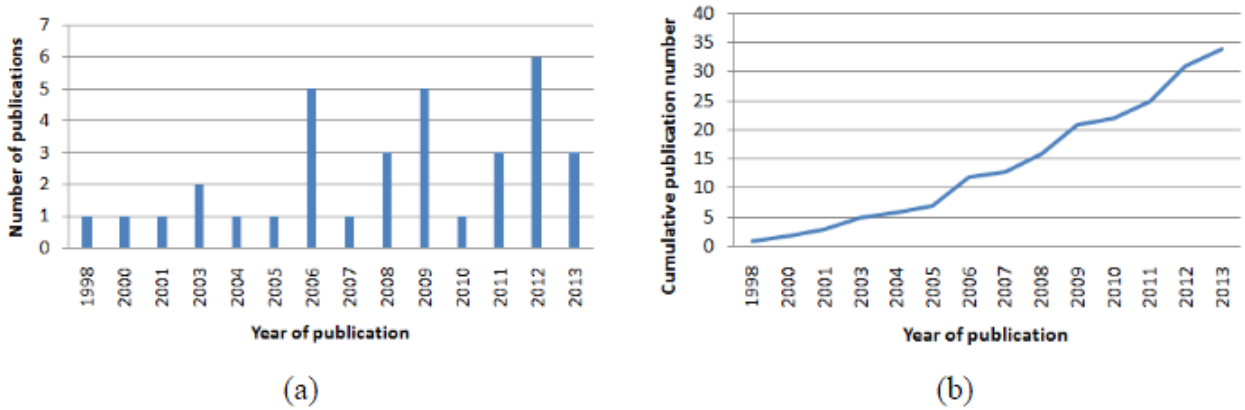
# ESAV in Greece

## 2006: Turning point

- In Greece (2006-2013):

Birol et al. (2006), Genius et al. (2008), Genius and Tsagarakis (2006), Grammatikopoulou and Olsen (2013), Halkos and Jones (2012), Halkos and Matsiori (2012a, 2012b, 2013), Jones et al. (2008, 2011, 2012), Kontogianni et al. (2012, 2013), Koundouri et al. (2009), Markantonis and Bithas (2009), Menegaki et al. (2007), Organtzi et al. (2009), Papaspyropoulos and Pappas (2008), Pavlikakis and Tsihrintzis (2006), Polyzou et al. (2011), Ragkos et al. (2006), Stithou and Scarpa (2012), Tentes and Damigos (2011), Togridou et al. (2006), Tziakis et al. (2009), Xenarios and Bithas (2009) and Zografakis et al. (2010)

**Figure 1** (a) Distribution of studies by year of publication (b) Cumulative number of studies (see online version for colours)




(a) (b)

In Greece, many studies focus on MCES:
•Energy and climate change;
•Environmental Management;
•Resource Management
Most studies use WTP as contingent valuation method (questionnaires, interviews)

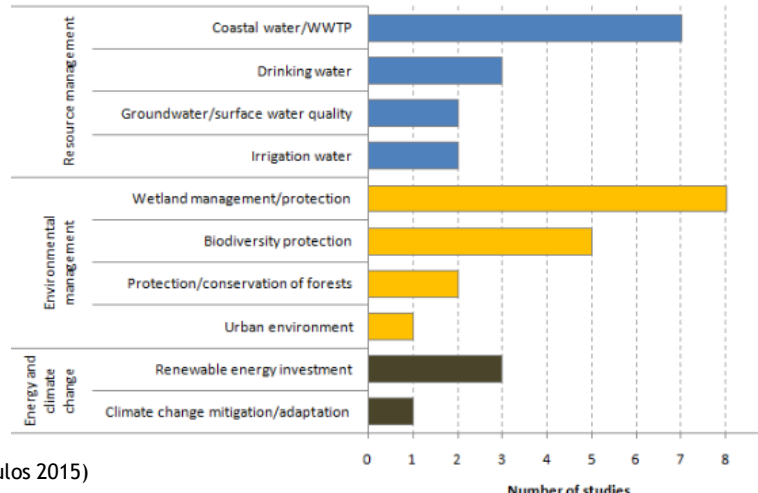
- 2014- 2016:

Katsanevakis, et al (2014): *Impacts of marine invasive alien species on ecosystem services and biodiversity: a pan-European review;*

Kontogianni et al (2014): *The social cost of coastal erosion: eliciting beach users' willingness to pay for protecting European beaches from beachrock processes;*

This is in line with global trend on ESAV

Classification of CVM studies according to the environmental good valued version for colours)




(based on Latinopoulos 2015)

# ESAV in Greece

Table 1.

Brief overview of examples from scientific literature that address several aspects of ecosystem services in Greece. The purpose of this table is illustrative and is not exhaustive.

| Reference | Year | Ecosystem type | ES assessed | ES type | "ES" term referred in text | Method | Location |
|---|---|---|---|---|---|---|---|
| Vlami et al. (2017) | 2017 | All | Cultural | Stock | Yes | Matrix model | Greece, Natura 2000 sites (SACs & SPAs) |
| Garantonakis et al. (2016) | 2016 | Cultivations | Regulation & Maintenance (Pollination) | Stock | Yes | Pollination efficiency for crop production | Western Crete |
| Chatzizacharia et al. (2016) | 2016 | Grasslands | Provisioning (Energy demand) | Benefit | No | Scenario assessment | Greece |
| Santamouris et al. (2015) | 2015 | Urban | Regulation & Maintenance | Benefit | No | Climate change models | Athens city |
| Voloudakis et al. (2015) | 2015 | Cultivations | Provisioning (Cotton yield productivity) | Stock | No | Climate change scenarios | Greece |
| Stara et al. (2014) | 2014 | Forest | Cultural | Benefit | Yes | Non-monetary valuation; surveys | NW Greece |
| Kontogianni et al. (2014) | 2014 | Coastal | Regulation & Maintenance | Benefit | Yes | Vulnerability assessment | Greece |
| Grammatikopoulou and Olsen (2013) | 2013 | Wetland | All | Benefit | Yes | Contingent Valuation | Gialova & Sfaktiria Island |
| Koutroulis et al. (2013) | 2013 | Water resources | Provisioning (Water) | Stock | No | Scenario assessment (GCMs) | Crete |

Dimopoulos et al. 2017

# ESAV in SEE countries

Other countries are catching up....

Turkey:

2009 Identification and Valuation of Ecosystem Goods and Services in the Yildiz Mountains area European Commission, Agrer, Agrin, Agriconsulting

2009 Kaçkar Mountains Sustainable Forest Use and Conservation Project - Assessment of Ecosystem Values Former Min. of Environment and Forestry European Commission, TEMA, METU Esra Başak

2010 Developing a Business Plan for Küre Mountains National Park and its Buffer Zone Min. of Environment and Forestry GEF, Min. of Environment and Forestry, UNDP

2011 The economic analysis of Foça Special Environmental Protection Area. Min. of Environment and Forestry - GDNAP GEF, UNDP Camille Bann & Esra Başak

2012 Pilot Study on Valuation of Sultansazlığı National Park and Social Impact Analysis Min. of Forestry & Water Works - General Directorate of Nature Conservation and National Parks Adem Bilgin

2013 Economic Assessment of Kaş-Kekova Special Environmental Protection Area's Effects on the Sustainability of Local Development. Economic study of the impacts of marine and coastal protected areas in the Mediterranean. Esra Başak

2015 Valuing Forest Products and Services in Turkey: A Pilot Study of Bolu Forest Area. Min. of Forestry & Water Works World Bank Bahar Çelikkol Erbaş

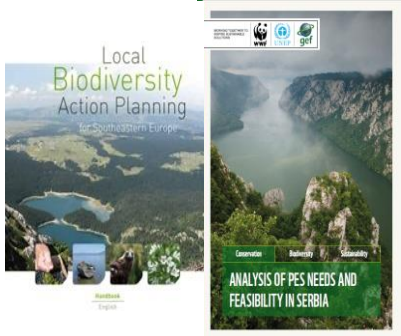
Many of these studies conducted by Ministries or Development agencies, not so much by Academia

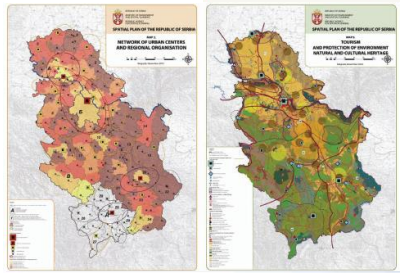
# ESAV in SEE countries

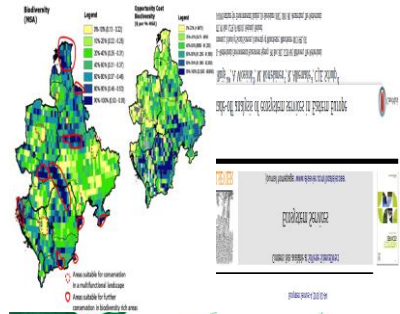
## Serbia:

- 2007 Study on forest valuation and financing in Serbia: Forest sector valuation sub study" (Helsinki University- Department for Forest Economics: Rekola M., Stamatović S., Petrović N.;
- 2009 Natural and manmade capital of Special Nature Reserve Zasavica. Faculty of Ecology, Singidunum University;
- 2009 Danube PES (WWF/GEF/UNDP/EC) project explored the needs and feasibility of PES in Serbia;
- 2012 'Eco services and the role of functional regions in Serbia', Stojkov  Dobričić
- 2013 Assessment of wood resources and NTFP in Kapoanik NP;
- 2013. 'GreenNest Cities for Biodiversity, Ecosystem Services and Well-being in Europe'
- 2013 WWF BioREGIO Carpathian project conducted a socio-economic assessment of the Serbian Carpathian. Assessed tourism, agriculture, forest management, game management, NTFP, fisheries and energy;
- 2014 WWF BioREGION Carpathian project ES assessment of Djerdap NP conducted by the Institute for Nature Conservation;
- 2012 'Mapping ecosystem functions and services in Eastern Europe using global-scale data sets'. Carried out by Dutch Environmental Assessment Agency;
- 2009-2013. 'Local Biodiversity Action Planning for Southeastern Europe' and the implementation of the Project 'Biodiversity and ecosystem services for local sustainable development in the Western Balkans'
- 2012-2014. Within the 'Dinaric Arc Parks' project;
- 2015 Economic valuation of ecosystem services of Special Nature Reserve 'Kovilksko-Petrovaradinski Rit', Institute  for Nature Conservation of Vojvodina Province;

Few Academic studies, most studies conducted by development agencies or public enterprises



# ESAV in SEE countries

## Bulgaria:


- Assenov, A., 2011. Willingness of the Population of Satovcha Municipality to pay for Ecosystems Services. In: Sixth International Conference „ Global Changes and Regional Development". 16-17 April 2010. Sofia, „St. Kliment Ohridski" University Press, Sofia. (c. 84 – 88)
- Assenov, A. 2010. Evaluation of ecosystem services in Satovcha municipality. In: Proceedings from conference Geography and Regional planning, Sozopol, 108-131. (in Bulgarian - Асенов, А., 2010. Оценка на екосистемните услиги в община Сатовча чрез метода на условното остойностяване. В: Сборник от научна конференция „География и регионално развитие" в Созопол, 2009-2010 г. Фондация „ЛОПС". (с. 108 – 131)
- Assenov, A., Borisova, B. 2014. Value of ecosystem/landscape services in the area of Apriltsi, Kalofer and Smolyan towns. Annual of Sofia University, book 2, vol. 107. (in Bulgarian - Асенов А., Б. Борисова (2014). Стойност на Екосистемни/Ландшафтни услуги в районите на градовете Априлци, Калофер И Смолян. Год. на СУ, кн.2 / география, том 107, 24 стр
- Assenov, A., Vassilev, K., Padeshenko, H., Koulov, B., Ivanova, E., Borisova, B. 2016. Research of the Biotope Diversity for the Purposes of Economic Valuation of Ecosystem Services in Chepelare Municipality (The Rhodopes Region of Bulgaria). European Journal of Sustainable Development (2016), 5, 4, 409-420.
- Assenov, A. Borissova, B., Grigorov B. 2016. Application of contingent valuation method in evaluating cultural ecosystem services along the eco-trails "Tsigansko gradishte-Sadilishteto" and "The Devil's Bridge" in the Rhodope Mountains. Proceedings of scientific conference "Geographical aspects of land use and planning under climate change". Varshets 23-25.09.2016. 147-155.
- Boyanova, K., Nedkov. S., Burkhard, B. 2014. Quantification and Mapping of Flood Regulating Ecosystem Services in Different Watersheds – Case Studies in Bulgaria and Arizona, USA. In: Bandrova, T., Konechy, M., Zlatanova, S. (eds.), Thematic Cartography for the Society, Lecture Notes in Geoinformation and Cartography, Springer, 237-255.
- Boyanova, K. 2015. Spatial analysis and assessment of ecosystem services in mountain watersheds using geospatial technologies. PhD thesis, 175 pp. (in Bulgarian - Боянова, К. 2015. Пространствен анализ и оценка на екосистемните и ландшафтни услуги в планински водосбори чрез приложение на геоинформационни технологии. Дисертация. 175с.)
- Boyanova, K., Nedkov, S., Burkhard, B. 2016. Applications of GIS-Based Hydrological Models in Mountain Areas in Bulgaria for Ecosystem Services Assessment: Issues and Advantages. In: Koulov, B., Zhelezov, G. (Eds.) Sustainable Mountain Regions: Challenges and Perspectives in Southeastern Europe, Springer, 35-51.
- Ivanova E., Koulov B, Borisova B. , Assenov A., Vassilev K. 2016. GIS-based Valuation of Ecosystem Services in Mountain Regions: A Case Study of the Chepelare Municipality in Bulgaria. European Journal of Sustainable Development 5, 4, 335-346.
- Markov, B., Nedkov, S. 2016. Mapping of erosion regulation ecosystem services. In: Bandrova, T., Konechni, M. (Eds) Proceedings, 6th International Conference on Cartography and GIS, 13-17 June 2016, Albena, Bulgaria. 97-109
- Nedkov, S. 2010. Analyzing spatial dimensions of ecosystem services and their valuation using GIS: A case study in Smolyan municipality. Problems of Geography, 4, 53-65.
- Nedkov, S. 2011. Landscape Structure and Ecosystem Services of Etropole Municipality. In: Zhelezov, G. (Ed.) Sustainable development in mountain region: South Eastern Europe, Springer, 85-94.
- Nedkov, S. and B. Burkhard 2012. Flood regulating ecosystem services - Mapping supply and demand, in the Etropole municipality, Bulgaria. Ecological Indicators 21: 67-79.
- Nedkov, S., Gikov, A., Nikolova, M., Dimitrov, P., Gachev, E. 2014. Mapping of ecosystem services in mountain areas: a case study of Seven Rila Lakes, Bulgaria. In: Bandrova, T., Konechny, M. (Eds.), 5th International conference on Cartography and GIS, June 15-20 Riviera, Bulgaria, 488-497.
- Nedkov, S., Boyanova, K., Burkhard, B., 2015. Quantifying, modelling and mapping ecosystem services in watersheds. In: Chicharo, L., Muller, F., Fohrer, N., (Eds.) Ecosystem Services and River Basin Ecohydrology. Springer. 133-149.
- Nedkov, S., Zhiyanski, M., Nikolova, M., Gikov, A., Nikolov, P., Todorov, L. 2016. Mapping of carbon storage in urban ecosystems: a Case study of Pleven District, Bulgaria. Proceedings of scientific conference "Geographical aspects of land use and planning under climate change". Varshets 23-25.09.2016. 223-233.
- Zevurdakis, M., Rashev, B., and Germer, C., 2007. Review of the ecosystem services and the values they provide. Rhodope project, UNDP.
- Zhiyanski, M., Gikov, A., Nedkov, S., Dimitrov, P., Naydenova, L. 2016. Mapping Carbon Storage Using Land Cover/Land Use Data in the Area of Beklemeto, Central Balkan. In: Koulov, B., Zhelezov, G. (Eds.) Sustainable Mountain Regions: Challenges and Perspectives in Southeastern Europe, Springer, 53-65.
- Yaneva, R., Zhelezov, G., 2014. Spatial Modeling and Zoning of Regulating Ecosystem Services in Relation to Flood Hazard in Northwestern Bulgaria. In: Bandrova, T., Konechny, M. (Eds.), 5th International conference on Cartography and GIS, June 15-20 Riviera, Bulgaria.

# ESAV in SEE countries

## However, some are still lagging behind....

Albania

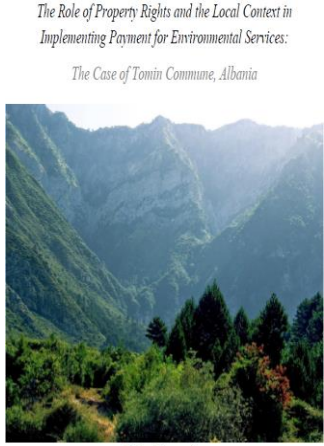
- 2007 Some assessments conducted connected to a carbon sequestration project between World Bank and Albanian government. Status unknown.
- 2014 The Role of Property Rights and the Local Context in Implementing Payment for Environmental Services: The Case of Tomin Commune, Albania
- 2016 “First contingent valuation method evaluation of the biodiversity of Lake Ohrid”, Zdraveski et al.

FYRoM

- 2008 The study “Valuation of natural values of Shar Planina and estimation of their market value”, (Melovski & Hristovski 2008
- 2013 The economic case for long-term protection of the Ezerani Nature Park, financed by a GEF/UNDP/MEPP.
- 2016 “First contingent valuation method evaluation of the biodiversity of Lake Ohrid”, Zdraveski et al.

Montenegro

- 2005 A study carried out by WWF on the value of the Tara River
- 2007 A review undertaken by Arcadis Ecolas and IEEP on the benefits of compliance with the EU environmental acquis
- 2011 Work conducted by UNDP/ISSP on the value of protected areas (Emerton et al 2011).
- 2011 A case study “Putting a price tag on the Multi-Functional Use of Eco-System Services: The case of Morača River and Skadar Lake in Montenegro”





# Recent ES publications emerging from HESP members

Aquatic Invasions (2014) Volume 9, Issue 4: 391–423
doi: http://dx.doi.org/10.3391/ai.2014.9.4.01


Open Access

Review

## Impacts of invasive alien marine species on ecosystem services and biodiversity: a pan-European review

Stelios Katsanevakis[1]*, Inger Wallentinus[2], Argyro Zenetos[3], Erkki Leppäkoski[4], Melih Ertan Çinar[5], Bayram Oztürk[6], Michal Grabowski[7], Daniel Golani[8] and Ana Cristina Cardoso[1]

[1]*European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), Ispra, Italy*
[2]*Department of Biological and Environmental Sciences, University of Gothenburg, Sweden*
[3]*Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, Ag. Kosmas, Greece*
[4]*Department of Biosciences, Environmental and Marine Biology, Åbo Akademi University, Turku, Finland*
[5]*Ege University, Faculty of Fisheries, Department of Hydrobiology, Bornova, Izmir, Turkey*
[6]*Faculty of Fisheries, Marine Biology Laboratory, University of Istanbul, Istanbul, Turkey*
[7]*Department of Invertebrate Zoology & Hydrobiology, University of Lodz, Poland*
[8]*Department of Ecology, Evolution and Behavior and the National Natural History Collections, The Hebrew University of Jerusalem, Israel*

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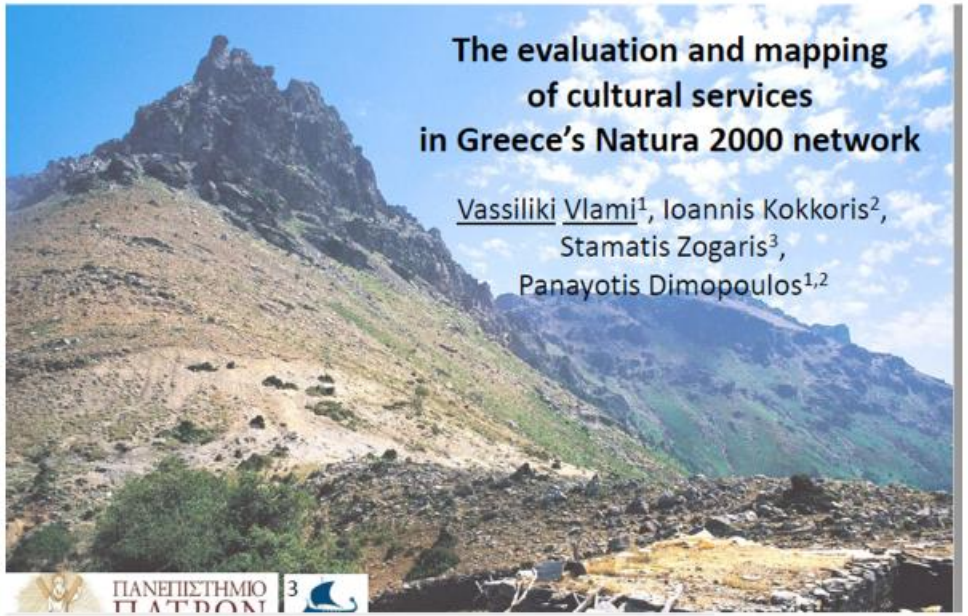
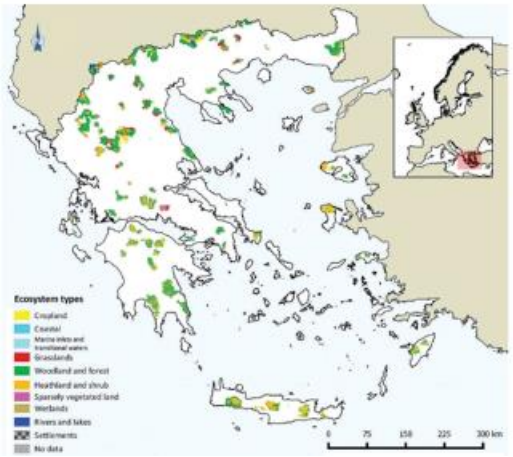
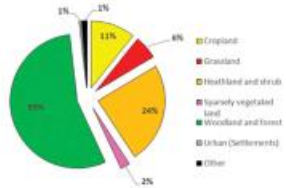
# Recent ES publications emerging from HESP members



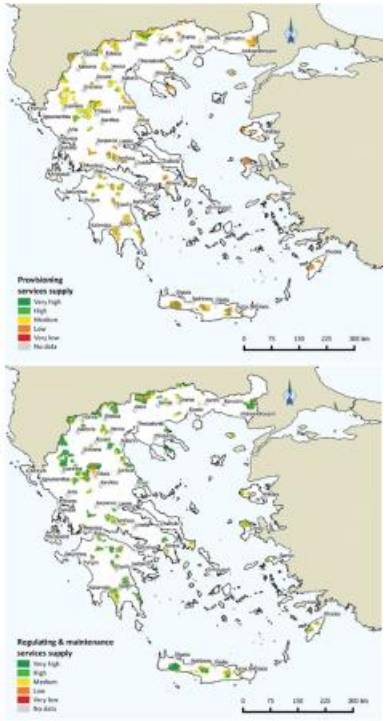

Ecosystem services supply in protected mountains of Greece: setting the baseline for conservation management

Ioannis P. Kokkoris, Evangelia G. Drakou, Joachim Maes & Panayotis Dimopoulos





I. P. KOKKORIS ET AL.



# Recent ES publications emerging from HESP members

## Soil food web properties explain ecosystem services across European land use systems

Franciska T. de Vries[a,b,1], Elisa Thébault[c,d], Mira Liiri[e], Klaus Birkhofer[f], Maria A. Tsiafouli[g], Lisa Bjørnlund[h], Helene Bracht Jørgensen[f], Mark Vincent Brady[i], Søren Christensen[h], Peter C. de Ruiter[c], Tina d'Hertefeldt[f], Jan Frouz[j], Katarina Hedlund[f], Lia Hemerik[c], W. H. Gera Hol[k], Stefan Hotes[l,m], Simon R. Mortimer[n], Heikki Setälä[e], Stefanos P. Sgardelis[g], Karoline Uteseny[o], Wim H. van der Putten[k,p], Volkmar Wolters[l], and Richard D. Bardgett[a,b]

## Ecosystem Service capacity is higher in areas of multiple designation types

Charitini Nikolaidou‡, Nefta-Eleftheria P. Votsi§, Stefanos P. Sgardelis§, John Maxwell Halley‡, John Pantis§, Maria A. Tsiafouli§

‡ Department of Biological Applications & Technology, University of Ioannina, Ioannina, Greece
§ Department of Ecology, School of Biology, Aristotle University of Thessaloniki, Thessaloniki, Greece

## Editorial: Optimizing the Delivery of Multiple Ecosystem Goods and Services in Agricultural Systems





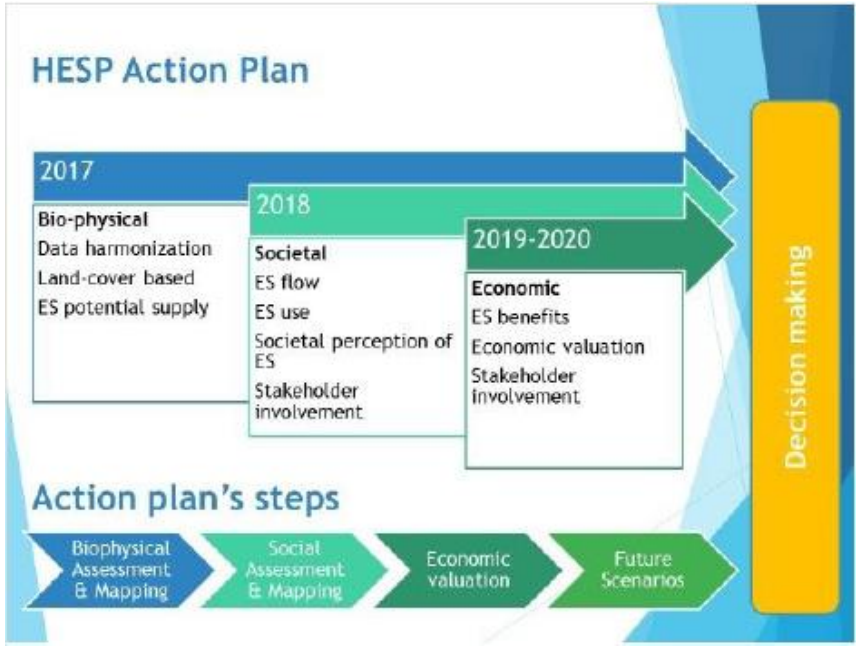
Maria A. Tsiafouli[1*], Evangelia G. Drakou[2], Alberto Orgiazzi[3], Katarina Hedlund[4] and Karl Ritz[5]

[1]Department of Ecology, School of Biology, Aristotle University of Thessaloniki, Thessaloniki, Greece
[2]Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, Netherlands
[3]Land Resources Unit, Joint Research Centre, Directorate for Sustainable Resources, European Commission, Ispra, Italy
[4]Department of Biology, Faculty of Science, Lund University, Lund, Sweden
[5]Division of Agricultural and Environmental Sciences, University of Nottingham, Loughborough, United Kingdom

# Recent ES publications emerging from HESP members

## The need for the implementation of an Ecosystem Services assessment in Greece: drafting the national agenda

Panayotis Dimopoulos[‡], Evangelia G Drakou[§], Ioannis P Kokkoris[‡], Stelios Katsanevakis[|], Athanasios Kallimanis[¶], Maria Tsiafouli[¶], Dimitrios Bormpoudakis[#], Konstantinos Kormas[¤], Jeroen Arends[«]



# Other recent ES publications -SWOS (EKBY)

SWOS Satellite-based Wetland Observation Service

## SWOS Indicators for mapping and assessing the HABITAT MAINTENANCE Ecosystem Service supply

**EO mapping products**
(Land Use Land Cover adopted to wetland ecosystems, Wetland Inventory & Delineation, Surface Water Dynamics)

**1 Landscape Map**
(favorable & hostile areas)

**2a Anthropogenic Impact Indicator**
(0,6 * Landscape degradation + 0.4 * Population density)

Guidos Toolbox + Census data downscaled to urban

**Biodiversity attributes monitored under the EU nature Directives (Art. 17, Art. 12, N2K SDFs, PECBMS)**

**2b Biodiversity State Indicator**

SUB-INDICATORS SCORES: 1-3

Downscaled to favorable areas

**3 Composite Ecosystem Condition Indicator / Natural Potential**
(Ecosystem Condition = 0,5 *Anthropogenic Impact + 0.5 *Biodiversity State)

**4 "habitat maintenance" ES Supply Indicator**

relationship between the natural potential and the protection level (as additional input).

ES Supply Matrix

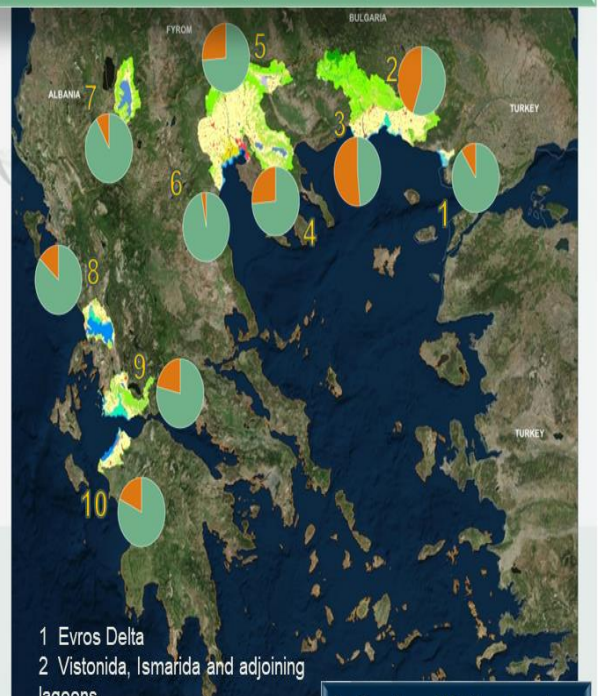
| Protection level | Natural Potential 0 No potential | 1 Very low | 2 Low | 3 Medium | 4 High | 5 Very high |
|---|---|---|---|---|---|---|
| High | 0 | 2 | 3 | 4 | 5 | 5 |
| Medium | 0 | 1 | 2 | 3 | 4 | 5 |
| Weak/No | 0 | 1 | 1 | 2 | 3 | 4 |

**5 Assessment of wetland ecosystems as Service Connecting Units (SCUs)**

Spatial relationships with the Service Benefit Areas - SBAs (N2K sites) and Service Providing Units - SPUs (supply: medium, high, very high)

THE GOULANDRIS NATURAL HISTORY MUSEUM GREEK BIOTOPE/WETLAND CENTRE

## Ecosystem Maps of the Greek RAMSAR SITES and their catchment areas (2016-2017)

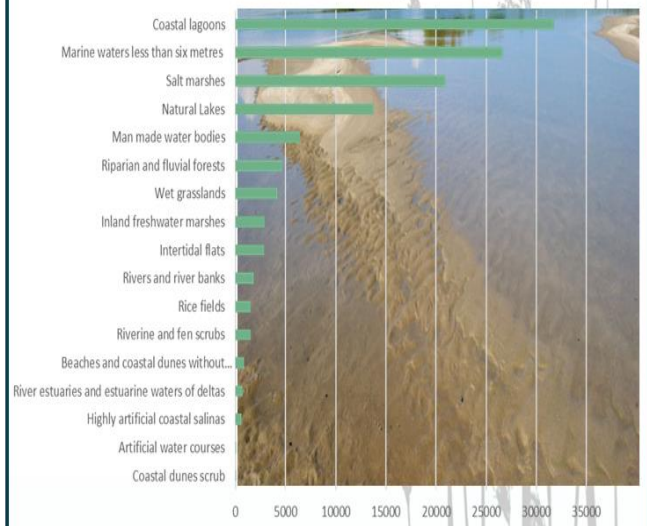



**Indicator: *Wetland extent inside the Ramsar Site***

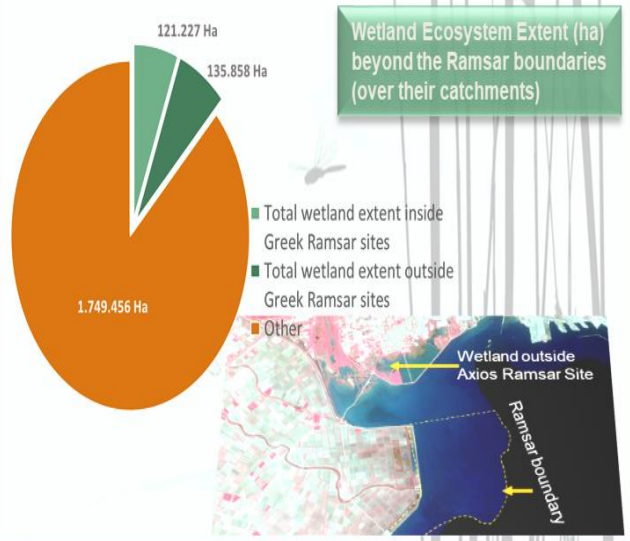

SWOS Satellite-based Wetland Observation Service

SWOS – Satellite-based Wetland Observation Service

**Total wetland ecosystem extent inside the 10 Greek Ramsar sites**

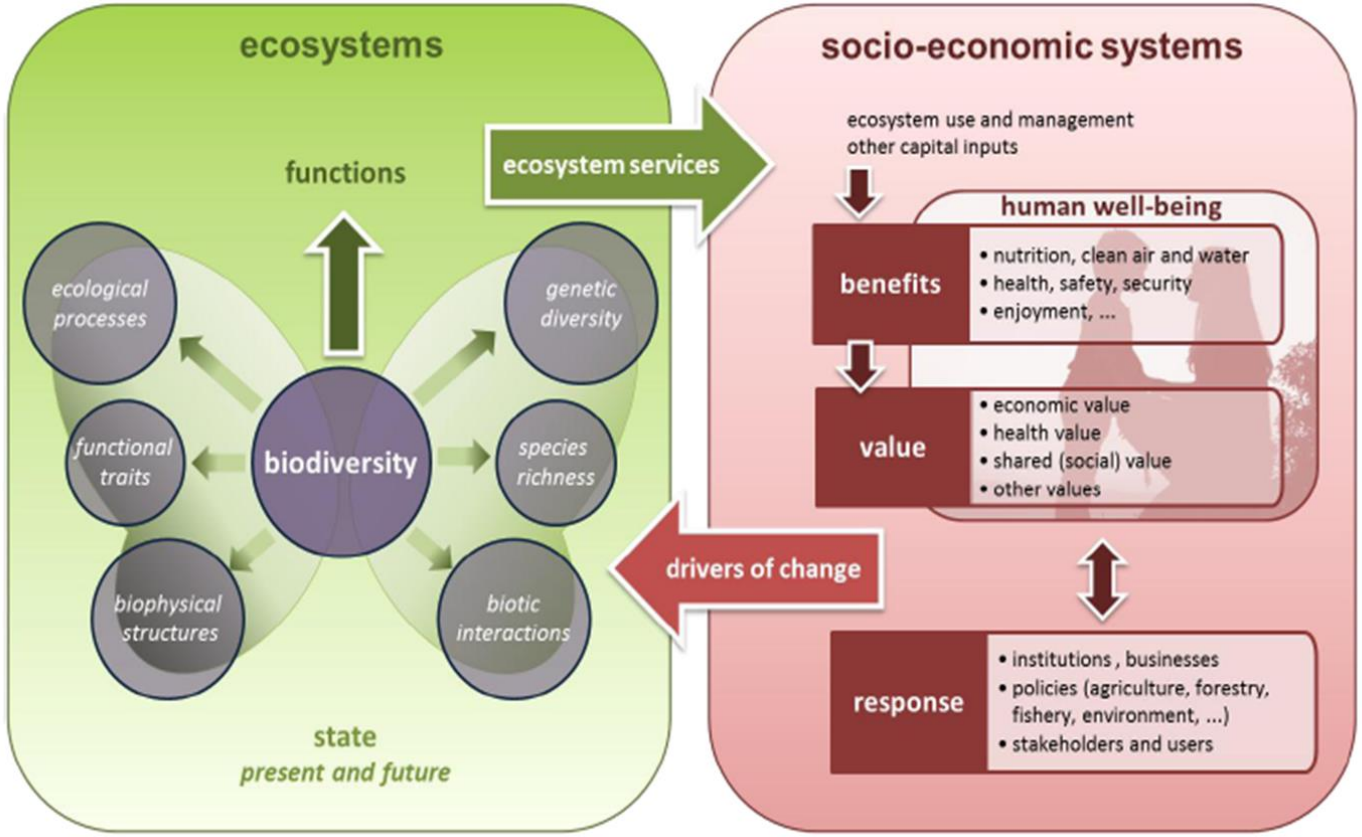



**Wetland Ecosystem Extent (ha) beyond the Ramsar boundaries (over their catchments)**



# Trends in ES research in Greece and region

- Research focuses on wider variety of ecosystems and ES
- Follows CLC/EUNIS/MAES typology and framework




MAES et al. 2013

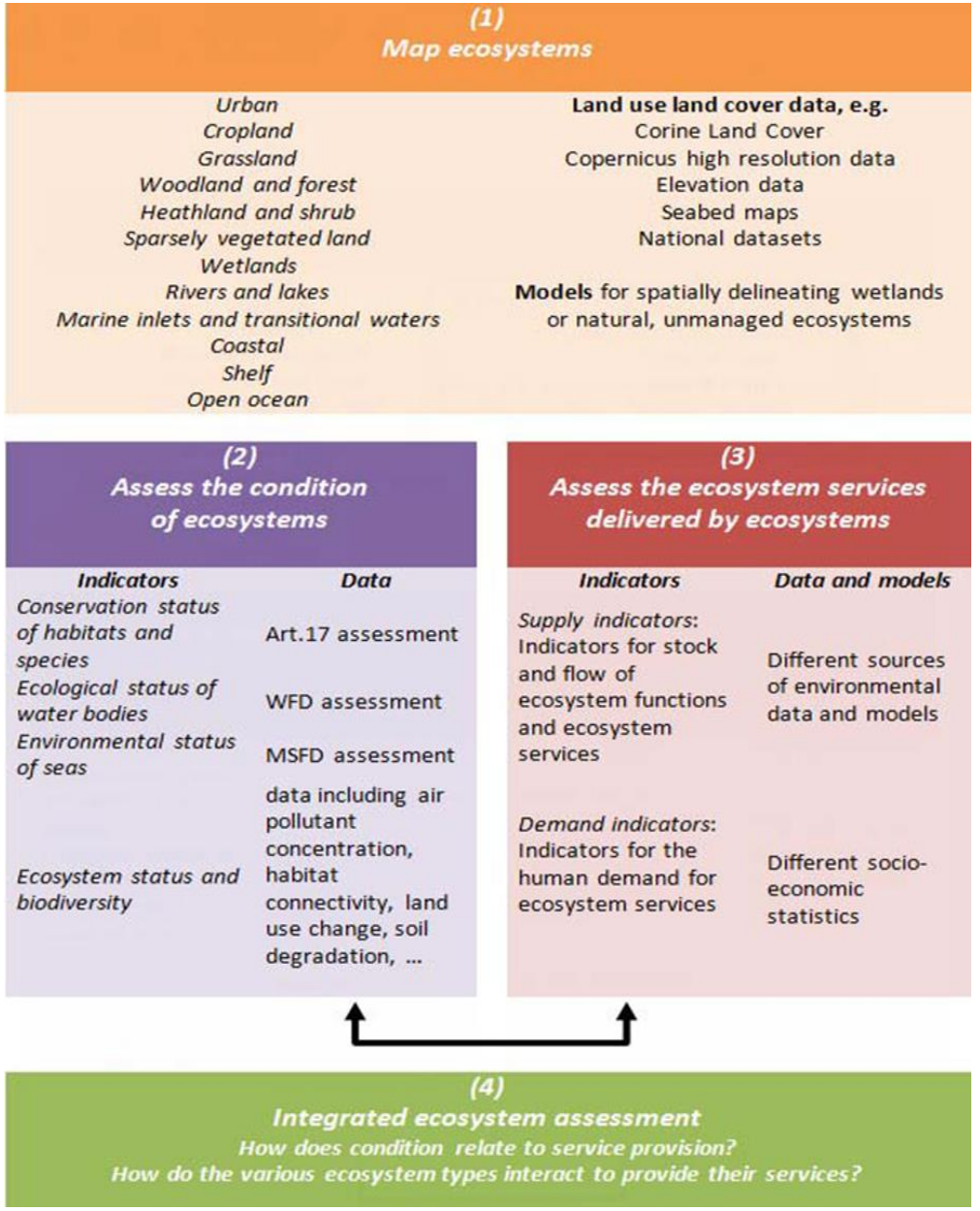
# Common Assessment Framework for ecosystems and their services -CAF

(1) Map ecosystems

(2) Assess the conditions of ecosystems

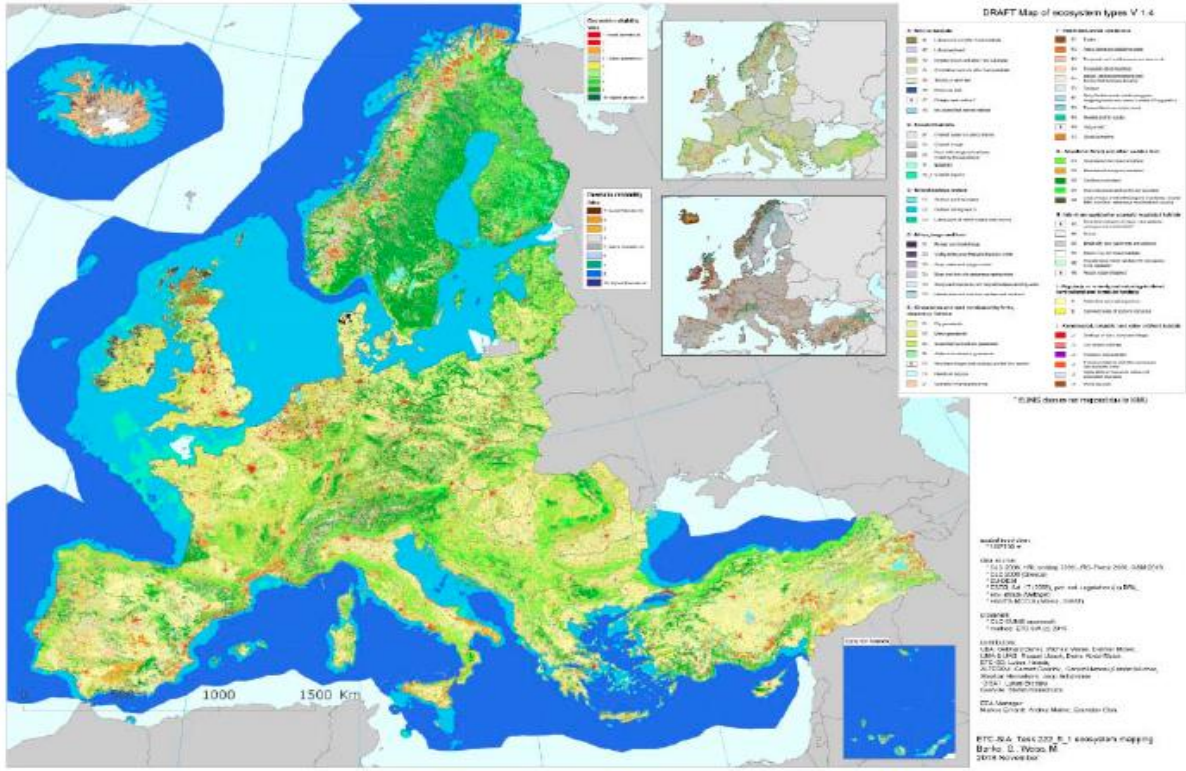
(3) Assess ES delivery

(4) Integrated ecosystems assessment

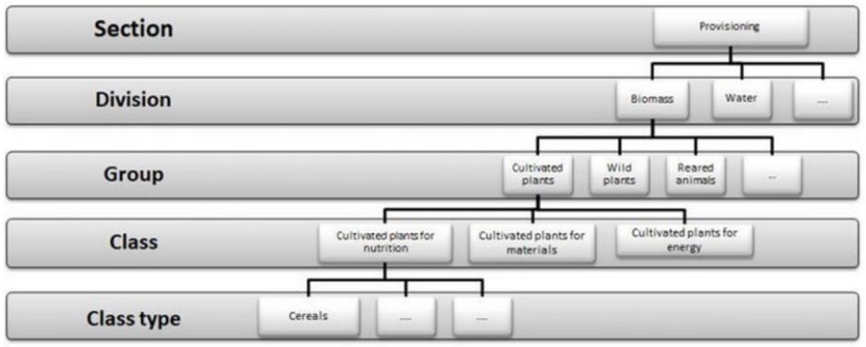



MAES et al. 2013

# Ecosystem types based on CLC classification and EUNIS Habitat Class




# ES based on CICES classification



# MAES process in BG

**Call BG03.02 –** 7 projects mapping 9 ecosystem types outside NATURA, about 67% of Bulgaria

# Programme BG03

## Methodology

1. Introduction
2. Typology of ecosystems in Bulgaria
3. Data availability
4. Mapping of ecosystem types
5. Assessment of ecosystem condition
6. Assessment of ecosystem services
7. List of Annexes

# Methodology
# 1. Mapping of ecosystem types

| Level 1 | Level 2 | Level 3 (EUNIS 2)<br>BG specific |
|---|---|---|
| Terrestrial | Urban | J1 – 10 (10 subtypes) |
| | Cropland | 1 – 5 (5 subtypes) |
| | Grassland | 1-5 (5 subtypes) |
| | Woodland and forest | G1-4 (4 subtypes)<br>(level 4) |
| | Heathland and shrub | F2,3,9 (3 subtypes) |
| | Sparsely vegetated land | 1 – 5 (5 subtypes) |
| | Wetlands | D1,4,5 (3 subtypes) |
| Fresh water | River and lakes | C, J, X (16 subtypes) |
| Marine | Marine inlets and transitional waters<br>Coastal areas<br>Shelf | 1 – 8 (8 subtypes) |

**Ecosystems typology in Bulgaria**

Total 58 subtypes at level 3

# Methodology
## 2. Assessment of ecosystem condition

| | | |
|---|---|---|
| Ecosystem structure | Biotic Heterogeneity | Plant diversity |
| | | Animal diversity |
| | | Habitat diversity |
| | | Invasive species |
| | | Other biotic heterrogeity |
| | Abiotic heterogeneity | Soil heterogeneity |
| | | Hydrological heterogeneity |
| | | Air heterogeneity |
| | | Geomorphological heterogeneity |
| | | Other abiotic heterogeneity |
| Ecosystem processes | Energy budget | Energy balance (capture, storage) |
| | | Entropy production |
| | | Metabolic efficiency |
| | | Other energy budget indicators |
| | Matter budget | Matter balance (input, output) |
| | | Element concentrations |
| | | Efficiency measures |
| | Water budget | Water balance (input, output) |
| | | Water storage |
| | | Other state indicators |
| | | Efficiency measures |

**Indicators for ecosystem condition based on the concepts of ecosystem integrity**

# 2. Methodology
## Assessment of ecosystem services

# Identification of ecosystem services

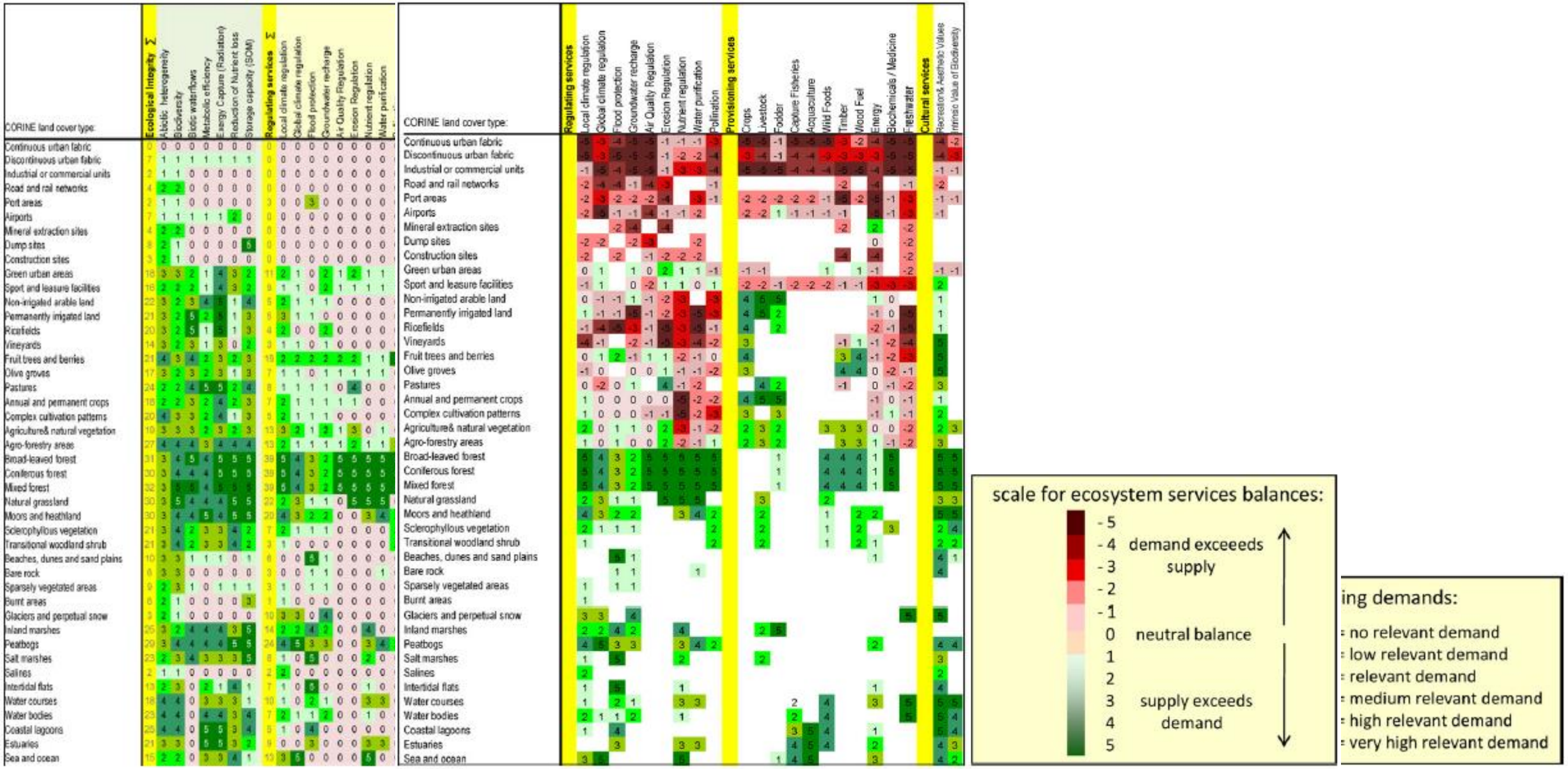
METHODOLOGY FOR ASSESSMENT AND MAPPING OF URBAN ECOSYSTEMS THEIR STATE AND THE SERVICES THAT THEY PROVIDE IN BULGARIA

| Section | Division | Group | Class | Code | Indicator | Parameter (Dimentions/Units) | Data sources | Urban ES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 | J10 |
| 1. Provisioning | 1. Nutrition | 1. Biomass | 1. Cultivated crops | 1111 | 1. Net primary production; 2. Ecosystem state | % | Statistics | | X | X | | | | | | | |
| | | | 2. Reared animals and their outputs | 1112 | 1. Number of animals; 2. Ecosystem state | number/ha | Statistics | | | | | | X | | | | |
| | | | 3. Wild plants, algae and their outputs | 1113 | 1. Usage of plant biomass/amount of plan biomass; 2. Ecosystem state | 1. kg/ha/year; 2. state unit | Statistics | | X | | X | X | | | | | |
| | | | 4. Wild animals and their outputs | 1114 | 1. Usage of animal biomass/amount of animal biomass | 1. kg/ha; | Statistics | | X | | X | X | | | | | |
| | | | 5. Plants and algae from in-situ aquaculture | 1115 | 1. Usage of plant biomass/amount of plan biomass; 2. Ecosystem state | 1. kg/ha/year; 2. state unit | Statistics | | X | | X | X | | | | | |
| | | | 6. Animals from in-situ aquaculture | 1116 | | | N | | | | | | | | | | |
| | | 2. Water | 1. Surface water for drinking | 1121 | | | N | | | | | | | | | | |
| | | | 2. Ground water for drinking | 1122 | 1. Public water supply; 2.Groundwater recharge rate | 1. Mil.$m^3$/year; $m^3$/capita; 2. $m^3$/ha; | Statistics | X | X | X | X | | | | | | |
| | | | 1. Fibres and other materials from plants, algae and animals for direct use or processing | 1211 | 1. Raw material input per capita; 2.Raw materials | 1. t/capita; 2. t/capita; 3. | Statistics | X | X | X | X | | | | | | |

# Tier 1. Simple relations e.g. Land cover and land use coupled to ES

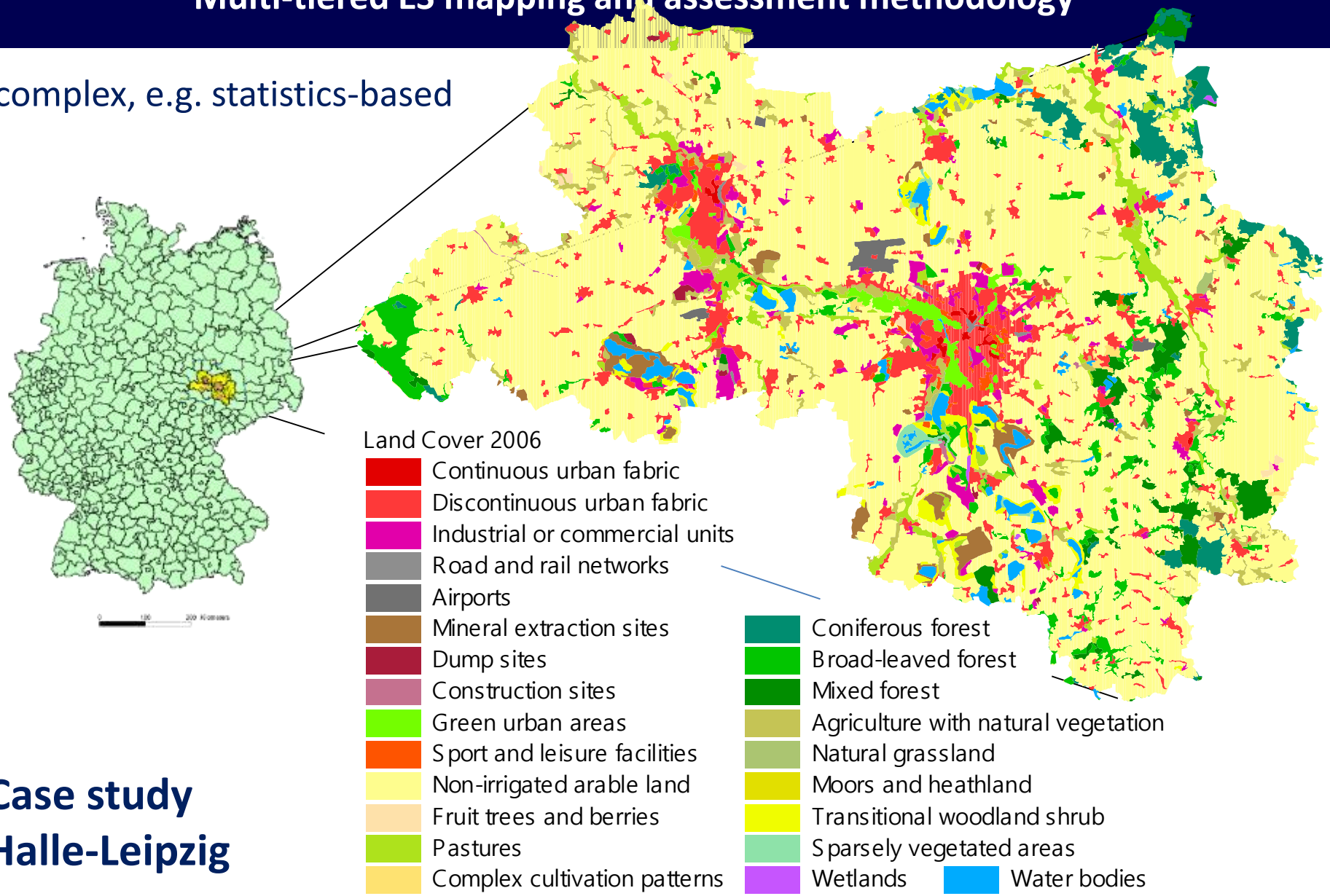
## ES Matrix: Useful when there is not enough data, time or resources.

## Good for qualitative, participatory approaches. In situ validation wishful



# Multi-tiered ES mapping and assessment methodology

★ **Tier 2:** more complex, e.g. statistics-based



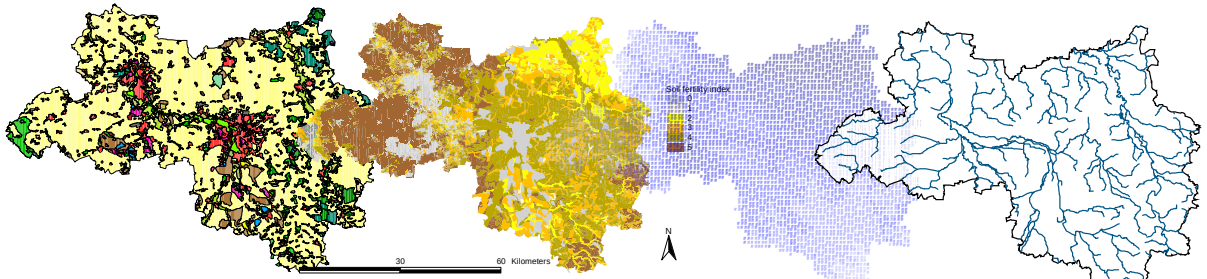

## Case study Halle-Leipzig

Burkhard, Kroll, Nedkov & Müller in *Ecological Indicators* (2012)

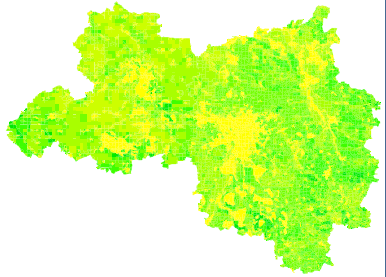
# Multi-tiered ES mapping and assessment methodology

★ **Tier 2:** more complex, e.g. statistics-based

**Land cover data + soil data + climate data + hydrological data + statistics = Ecosystem service maps**




| Population | Community |
|---|---|
| 123789 | 4567844 |
| 3457656 | 5798365 |
| 3456465 | 4564576 |
| 3456567 | 4657467 |



Case study
Halle-Leipzig

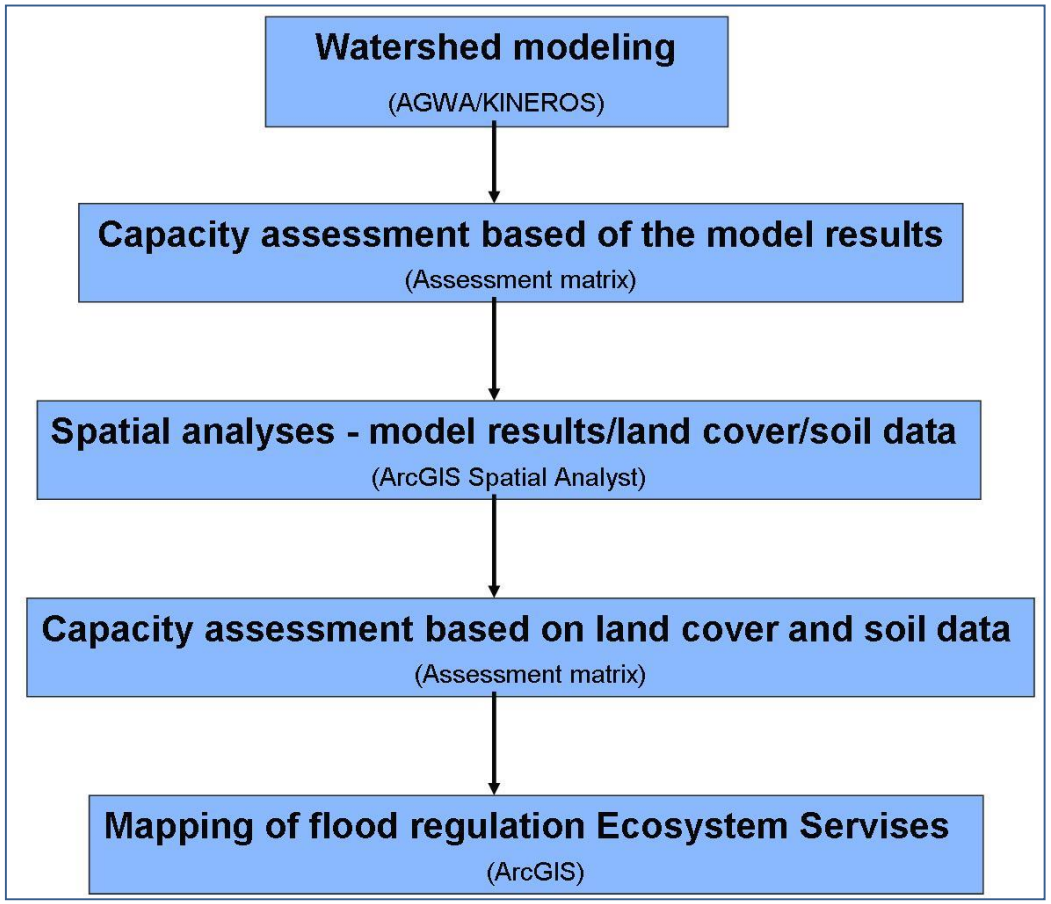
Burkhard, Kroll, Nedkov & Müller in *Ecological Indicators* (2012)

Dump sites
Construction sites
Green urban areas
Sport and leisure facilities
Non-irrigated arable land
Fruit trees and berries
Pastures
Complex cultivation patterns
Broad-leaved forest
Mixed forest
Agriculture with natural vegetation
Natural grassland
Moors and heathland
Transitional woodland shrub
Sparsely vegetated areas
Wetlands
Water bodies

★ **Tier 2:** more complex, e.g. statistics-based

# Multi-tiered ES mapping and assessment methodology

- **Tier 3:** complex, e.g. model-based

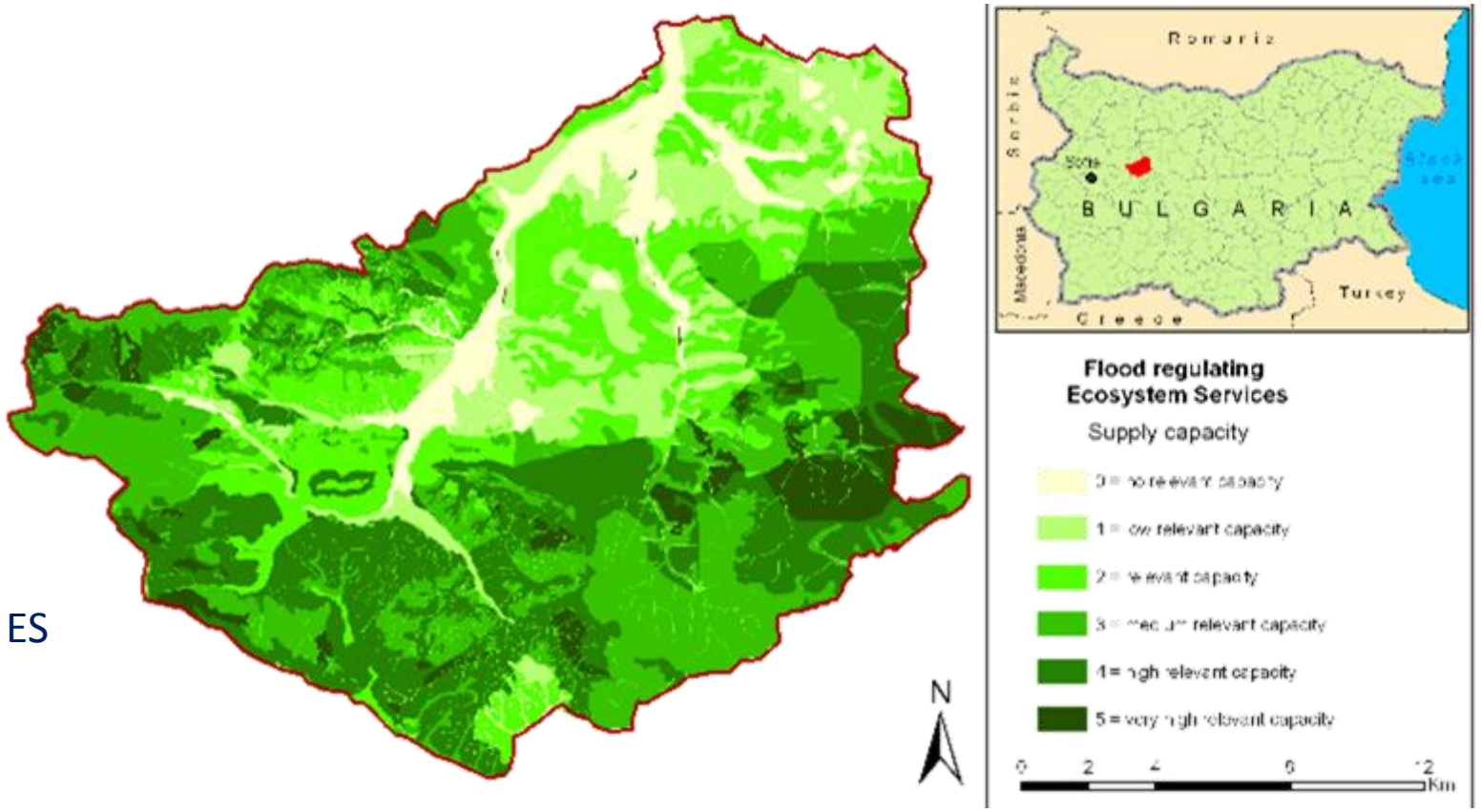




## Case study: Malki-Iskar, Bulgaria

# Multi-tiered ES mapping and assessment methodology

- **Tier 3:** complex, e.g. model-based




Flood regulating ES
Supply

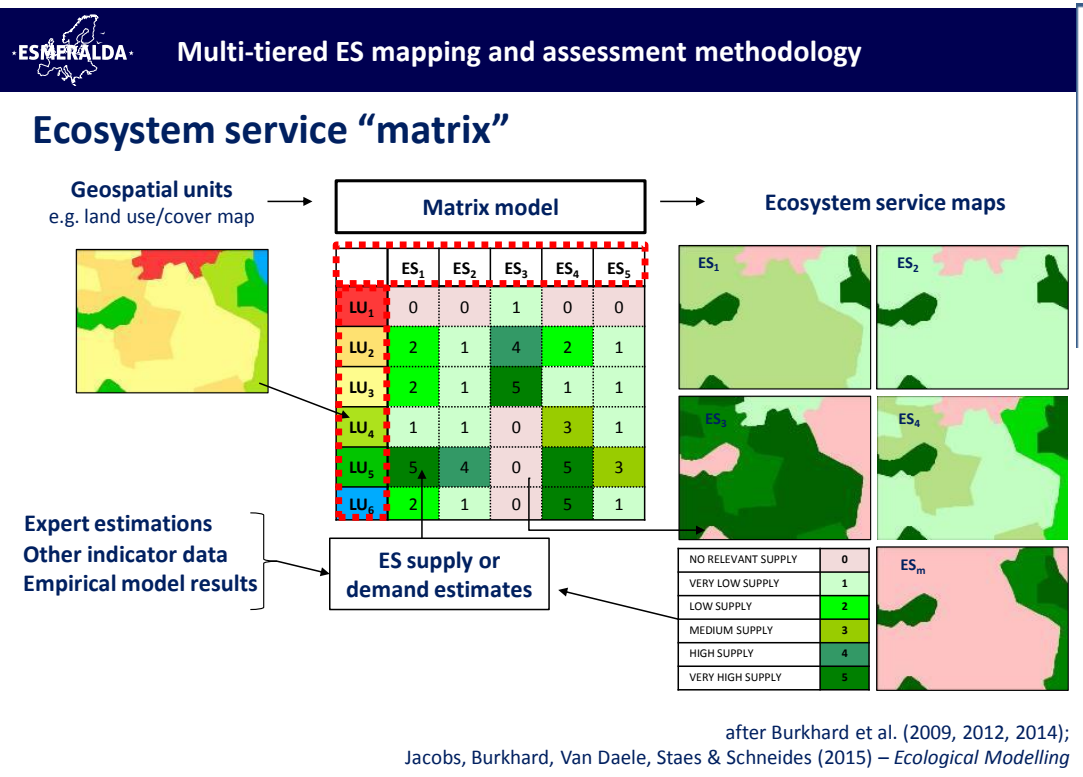
## Case study
## Malki-Iskar, Bulgaria

Modeling based on AGWA (KINEROS) tool

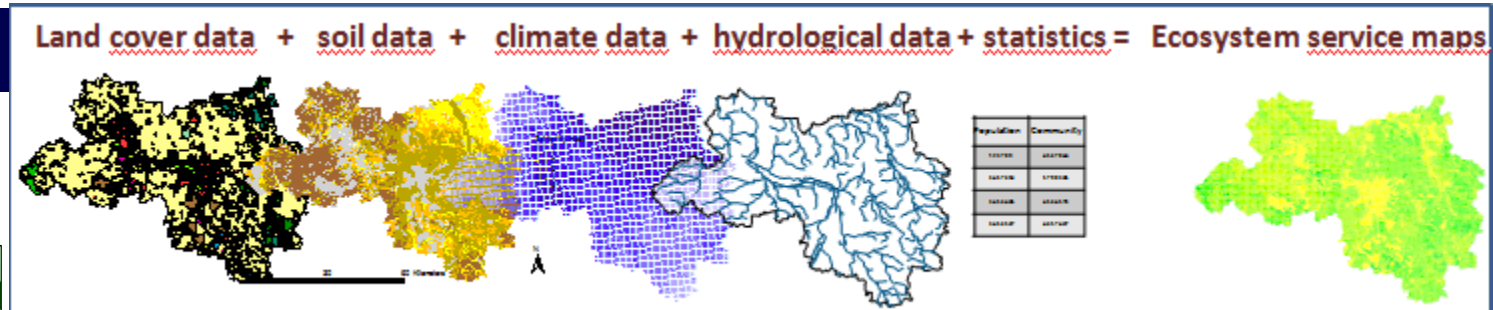
Nedkov & Burkhard in *Ecological Indicators* (2012)

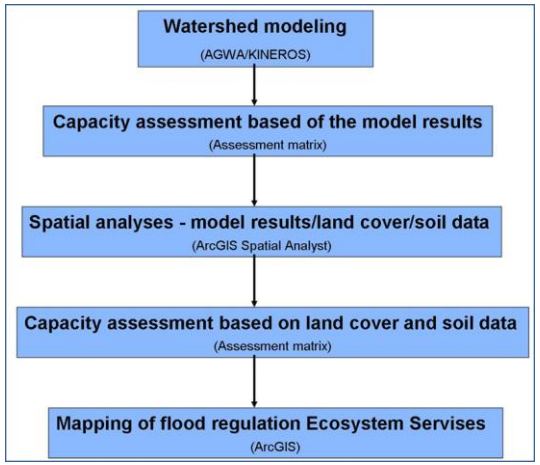
# ES assessment and valuation: Way forward

- Research becomes more elaborate: Tiered approaches, inclusion of primary data, complex models, complex methodologies, data sets, maps, remote sensing, etc.
- Important: Quality and certainty of data, sensitivity analysis, in situ validation of results and calibration of models

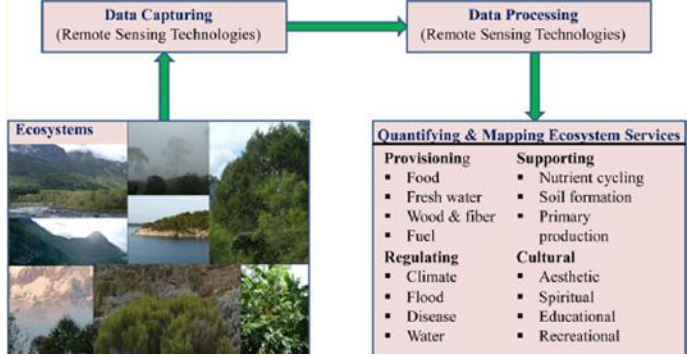



after Burkhard et al. (2009, 2012, 2014);
Jacobs, Burkhard, Van Daele, Staes & Schneides (2015) – *Ecological Modelling*



# ES remote sensing

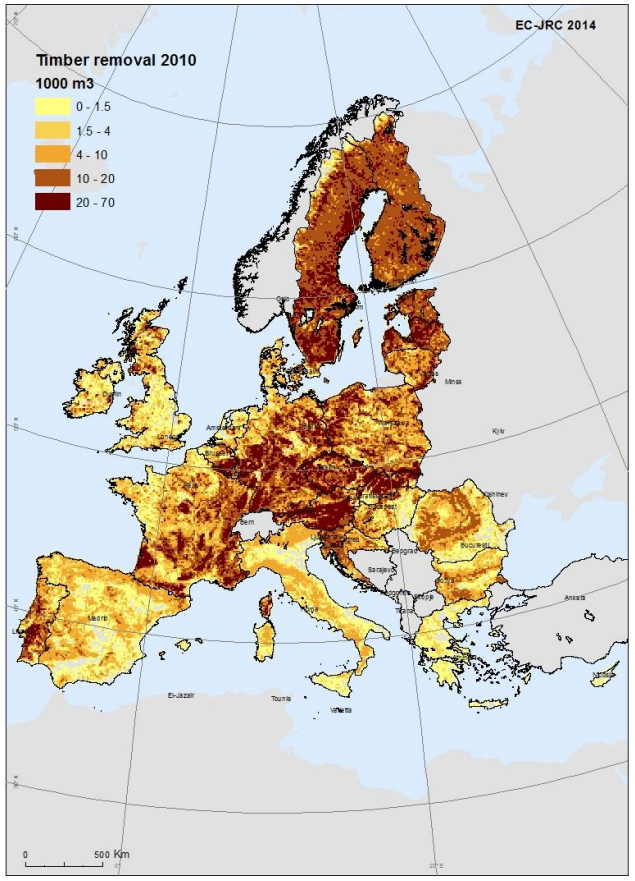


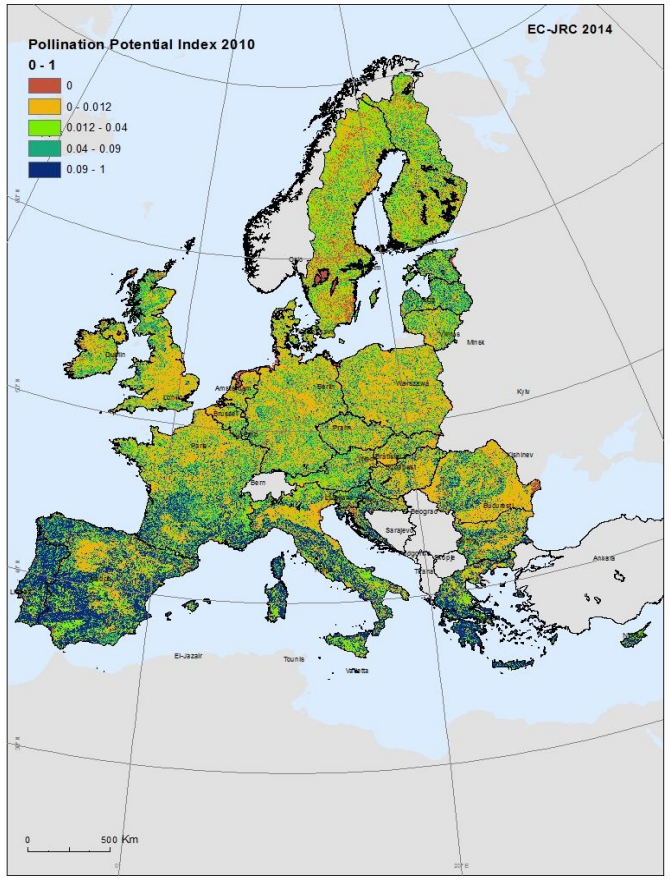

Satellite & airborne imagery (radar, optical, IR, lidar) to

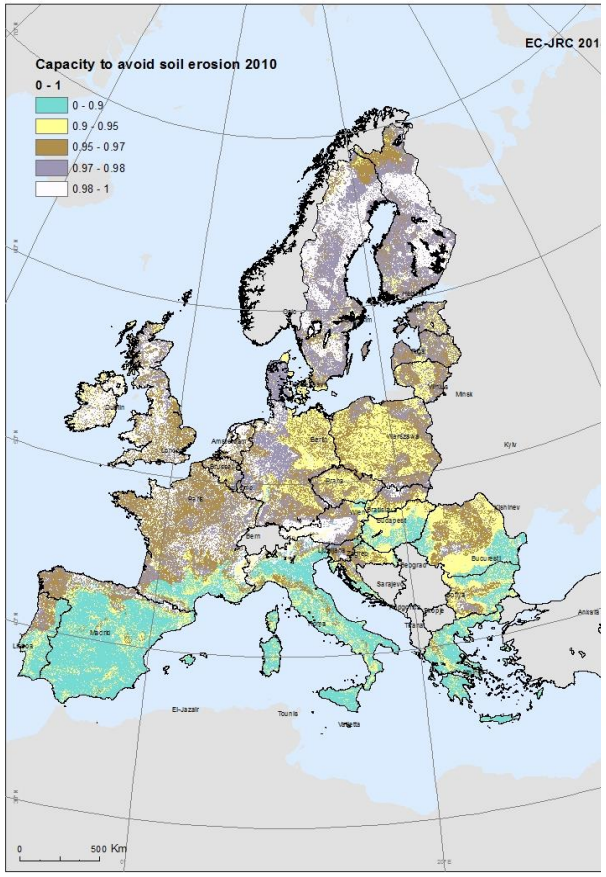
- Identify landcover, habitats, ecosystems, biodiversity hotspot areas, etc.
- Use the imagery data as a proxy for ecosystem functioning and ecosystem services
- For example:
  - IR reflection imagery as a proxy for forest cover (LAI) as a surrogate to assess the capacity of a forest to remove nutrients from the sky
  - IR, radar and laser data to establish standing forest cover as a means to assess carbon sequestration
  - Elevation and slope data to establish run off and hydrological models, erosion control
- Useful to analyse trends, establish threats, to identify spatial and temporal scales
- Much data is freely available
- Expertise is needed as well as validation

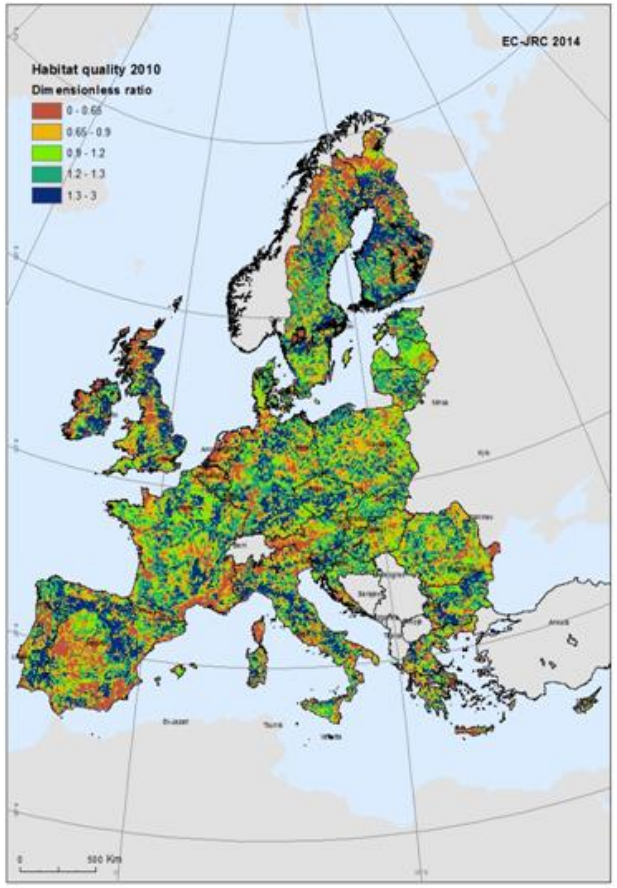
# Trends in ESAV: Mapping

- Mapping makes ES assessment and valuation spatially explicit
- Maps provide a graphical overview how ES and values vary across space
- Useful for scenario development, trade off analysis and designing land use policies



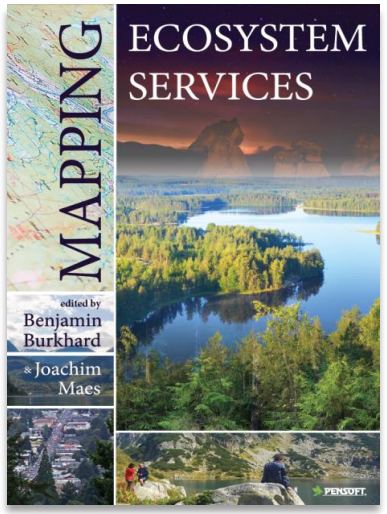



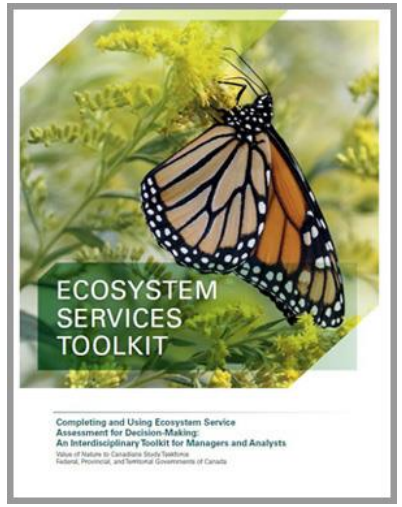



# Want to know more?

- Ecosystem Services Partnership –ESP
- ESP Regional Chapter SEE Researchgate project
- BISE – Biodiversity Information System for Europe
- MAES – Mapping and Assessment of Ecosystems and their Services
- TESSA - Toolkit for Ecosystem Service Site-Based Assessment
- Crossman et al. 2013: A Blueprint for mapping and modelling ecosystem services
- ESTIMAP – Ecosystem Services mapping at European scale
- GIZ: IES, About Values project, WWF: PA Benefits Assessment Tool
- The Ecosystem Services Partnership Visualization tool
- Natural Capital Project
- ESMERALDA
- IPBES
- Teebweb
- Millennium Ecosystem Assessment



# Thank you for your attention

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www.es-partnership.org