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*Editorial*

# Assessment of Ecosystem Services at Different Scales

**Eszter Tormáné Kovács * and Csaba Centeri**

Department of Nature Conservation and Landscape Management, Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Páter Károly u. 1., H-2100 Gödöllő, Hungary; centeri.csaba@uni-mate.hu
* Correspondence: kovacs.eszter@uni-mate.hu

## 1. Introduction

Natural and semi-natural ecosystems are under large anthropogenic pressure and degrading at an alarming speed [1]. It seems to be difficult to balance conservation and meet the need of human society at the same time. There have been continuous attempts to assess the state of nature and to prove the importance of its conservation by showing how vital it is to human society. One of the most recent approaches is based on the assessment of ecosystem services (ESs). ESs are goods and services that ecosystems (natural, semi-natural or man-made) provide to human society, contributing to the well-being of people [2]. ESs can be classified in many ways, but the widely used common international classification system (CICES) distinguishes provisioning, regulation and maintenance, and cultural ESs [3]. The concept of ecosystem services is a significant and still-growing research topic, especially related to biodiversity conservation and sustainable use of natural resources [4,5]. In the past two decades, the concept of ESs has gained momentum in biodiversity policy as well [1,2,6–8].

The assessment of ecosystem services seems to be at the center of the research agenda also for its foreseen applicability in biodiversity and other land use policies [9,10]. For example, the Biodiversity Strategy 2010–2020 of the European Union required the member states to assess their ecosystems and related services in their territory [7]. The assessments can be conducted at different spatial scales, from the local to global scales [11,12]. The methodologies vary, including biophysical, economic and sociocultural valuation, often combined with mapping [13,14]. The assessments can be based on primary or secondary data, models, experts' judgements or on the views of the different stakeholder groups [15,16]. There are quite a few challenges in ES assessments, including conceptual issues, data gaps and many methodological challenges [16–19]. In this Special Issue, we aimed at attracting the papers that show examples of the assessment of different ESs using variable methodologies at different scales from many parts of the world.

## 2. Introduction to the Papers Published in This Issue

Nine articles were published in this Special Issue. Two papers [20,21] focused solely on the assessment of ESs at a national scale, five [22–26] covered only regional scale assessments, and one paper [27] showed the results of a valuation at two scales (regional and national). There was an article [28] that analyzed the possibility of using the ES concept in environmental impact assessments. The ecosystem services assessed as well as methods applied in the studies also vary. The Hungarian research results dominate this Special Issue (six papers), but we received papers from Russia, Malaysia and Thailand as well.

Three papers were related to the Hungarian Mapping and Assessment of Ecosystem Services (MAES-HU) project, which was implemented to meet the requirements of the EU Biodiversity Strategy for 2020. Vári and colleagues [20] gave an extensive introduction to the MAES-HU by showing the conceptual framework applied, the process, the indicators used and raising some challenges of the assessment. The mapping and assessment of 12 ESs



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were conducted by thematic interdisciplinary working groups using a four-level cascade model (ecosystem condition, capacity, actual use and benefit) as the main conceptual framework. Indicators were assigned to the first three cascade levels, ranging from solely expert judgement through rule-based matrix models to more complex (biophysical, hydrological or meteorological) models. The fourth cascade level was qualitatively assessed for all the ESs, and economic valuation was carried out for three ESs. The ES assessment was supplemented with a scenario-building exercise and a synthesis as well. The participation of stakeholder groups and experts characterized the whole process. The authors raised some challenges related to the application of the cascade model (e.g., the delineation of the different cascade levels and choosing indicators) and data availability.

The results of the MAES-HU synthesis work are shown in the paper of Tanács and colleagues [21], who carried out integrated spatial analyses focusing on ES multifunctionality, the relationship between ecosystem condition (EC) and ESs and bundles of ESs. The natural ecosystems and especially native forests were characterized by high-level multifunctionality, underlining that a better ecosystem condition assists the provision of more ecosystem services. Six ES bundles were identified and mapped based on cluster analysis, which were related to the main ecosystem types and their provisioning services. The results of the three analyses were mutually reinforcing. The authors highlighted the limits of their analysis as well in terms of data availability, especially for the grasslands and wetlands.

Also, within the MAES-HU, Széchy and Szerényi [27] provided a value estimate for recreation (more specifically hiking) as a cultural ecosystem service in a specific forest ecosystem and for all Hungarian forests. First, they conducted an economic valuation based on the travel cost method for the Pilis Biosphere Reserve using the results of a previous questionnaire survey. The calculation was based on the number of visits and the average cost per visit. For the latter part, the direct travel expenditure as well as the opportunity cost of time spent on the visit was considered. They also assigned a monetary value of recreation (hiking) to all the Hungarian forests using the value estimates of foreign studies (adjusted to inflation and differences in income levels) via benefit transfer. The results of the study show that the value of forest recreation in the form of hiking is around EUR 10 million/year for the Pilis Biosphere Reserve and ten times more for the whole country in 2020 EUR. The authors acknowledged the limitation of the study given the data gaps.

Nel and colleagues [22] used the InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) model to map the carbon stock of soil (as a proxy for global climate regulation ecosystem service) in two Hungarian agricultural landscapes using soil organic carbon data from the national soil inventory and also from soil sampling. The farmland, forested areas and grassland were distinguished as ecosystems for mapping. The results of mapping vary greatly based on the input data used for the modeling. This proves the usefulness of soil sampling even at the landscape level to refine the results based on data from national soil inventories.

Palásti and colleagues [23] carried out the participatory mapping of 13 ecosystem services provided by White Lake, which is an extensive fishpond system, situated in the southeastern part of Hungary. The list of ecosystem services was compiled based on preliminary interviews with the representatives of local stakeholder groups. It was followed by the mapping with the involvement of local experts in two rounds of interviews and focus groups. Potential ES provisioning was based on a simple matrix model of ESs (assigning a 0–5 score to habitat types for each ecosystem service). For the assessment of actual use, experts were asked to locate habitat patches which are the primary (hotspots) and secondary (warm spots) sources of an ecosystem service. Thirteen ESs were identified by local stakeholder groups. The ESs were assigned to nine main habitat types. The results of the ES assessment show that standing water, reedbeds and canals received the highest scores for potential ES provision. Regarding the actual use, the most hotspot areas identified were related to fish production, microclimate regulation and birdwatching. The authors concluded that participatory mapping can be a useful tool for decision making and communication, but it is time-consuming and can be further developed by using indicators and the results of field studies.

Kozma and colleagues [22] used the MIKE She hydrological model to simulate different water governance scenarios related to water retention in a lowland catchment area near the Tisza River in the northeastern part of Hungary. Based on the results of hydrological modeling, the impact of the different hydrological conditions was also estimated based on crop (maize) yields as a provisioning service using the Biome-BGCMuSo, a process-based biogeochemical model. The results show an increase in groundwater levels in alternative water governance regimes, which have the potential to moderately increase the crop yield in the area. The authors emphasized that water retention in the area could also assist adaptive land use management under climate change. They also mentioned possibilities to refine their models using more detailed input data.

Matthew and colleagues [25] conducted an economic valuation of recreation as a cultural service of Ayer Keroh Recreational Forest (AKRF) situated close to the town of Malacca, in the southwestern part of Peninsular Malaysia. The authors used the travel cost method (TCM) based on the results of a face-to-face questionnaire survey and regression analysis. The cost items that were considered included costs that occurred during the trip (e.g., fuel, toll, food and other expenditures) and costs during park visitation (e.g., food, souvenir, lodging and other expenditures). Other variables, such as age, educational level of the respondents, satisfaction with the park's facilities and the quality of the place, were also taken into account. The results show a USD 20,346/ha/year value for the recreation service of the AKRF. The authors highlighted that their results can assist authorities and give a reason to preserve forest ecosystems in Malaysia.

Belyaev and colleagues [26] estimated the economic value of five ESs that the Volga–Akhtuba Floodplain situated in southern Russia would provide after its restoration. The market prices were used for the calculation of the value of the two provisioning services (water for households and fish) and a cultural service (recreation), while the value of the two regulation and maintenance services (water and air purification) was calculated using the replacement cost method. They predict that, in 2035, when the restored wetland will reach its full operation, the value of ESs that will be provided will reach USD 270 /ha/year. The authors stated that their results can assist decision makers in showing that wetland restoration projects can have large well-being benefits for the local population as well. They also stressed that the methodology applied in their study can also be used in future calculations.

Swangjang [28] developed criteria for the evaluation of integrating ESs in environmental impact statements (EIS) compiled for different phases of environmental impact assessments (EIA) (1. baseline study; 2. impact assessment; 3. mitigation and monitoring). Based on the set of criteria, she conducted the qualitative content analysis of six EIS covering projects related to housing and the chemical industry. Her results show that the quality of the included ESs varied according to the project type; the quality was the best in the baseline study phase, but it still had some weaknesses. Integrating the ESs into the impact assessment and the mitigation and monitoring phases was insufficient in the studied statements. Based on the findings, the author gave recommendations to integrate ESs into EIA studies.

## 3. Conclusions

The papers in this Special Issue show that ES assessment is a complex exercise at regional and national scales, as well for all three types of ES. The methodologies for the assessment are still under development, therefore, the published papers are probably very useful for other scholars in this field. The authors of the studies in this Special Issue all had the aim to assist decision makers at the regional or national level in advancing sustainable land use and the conservation of valuable habitats. We also saw that the primary field data can make the assessments more precise. But even if the primary data are not available, there are still possibilities to use secondary data sources or expert judgements, which can be considered a good alternative to inform policy makers. We hope that the results of such assessments will be used in discussions with stakeholders and also in designing policies or projects.

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