THE CARPATHIAN ECOSYSTEM SERVICES TOOLKIT (CEST)

An Interdisciplinary Toolkit for Managers and Analysts
for Ecosystem Services Assessment

Interreg
CENTRAL EUROPE
European Union
European Regional Development Fund
Centralparks

Carpathian Ecosystem Services Toolkit (CEST)

Interdisciplinary Toolkit for managers and analysts for ecosystem services assessment (2021)

This document has been elaborated thanks to the project Building management capacities of Carpathian protected areas for the integration and harmonisation of biodiversity protection and local socio-economic development (Centralparks), supported by Interreg CENTRAL EUROPE Programme.

Editors:

Radoslav Považan & Ján Kadlečík

Authors:

Andrzej Affek (Institute of Geography and Spatial Organization, Polish Academy of Sciences)

Ildikó Arany (Hungarian Academy of Sciences, Centre for Ecological Research)

Ján Černecký (Institute of Landscape Ecology, Slovak Academy of Sciences; State Nature Conservancy of the Slovak Republic)

Viktória Ďuricová (Matej Bel University in Banská Bystrica, Faculty of Natural Sciences; State Nature Conservancy of the Slovak Republic)

Filippo Favilli (Eurac Research, Italy)

Ján Kadlečík (State Nature Conservancy of the Slovak Republic)

Jiří Lehejček (Vzdělávací a informační středisko Bílé Karpaty, Czech Republic)

Peter Mederly (Faculty of Natural Sciences, Constantine the Philosopher University in Nitra; OZ PRONATUR, Slovakia)

Radoslav Považan (OZ PRONATUR; Slovak Environment Agency)

Juraj Švajda (Faculty of Natural Sciences, Matej Bel University; OZ PRONATUR, Slovakia)

Contributors:

Silvia Bisconti, Isidoro de Bortoli, Barbora Duží, Borbála Major, Zbigniew Niewiadomski, Zuzana Okániková, Marie Petrů, Lukas Weyh, European Wilderness Society

Reviewers:

RNDr. Róbert Kanka, PhD & Ing. Jana Špulerová, PhD.

Citation:

Považan, R., Kadlečík, J. (eds.), Affek, A., Aranyi, I., Černecký, J., Ďuricová, V., Favilli, F., Lehejček, J., Mederly, P. & Švajda, J. (2021). The Carpathian Ecosystem Services Toolkit. Interreg CENTRAL EUROPE project Centralparks "Building management capacities of Carpathian protected areas for the integration and harmonisation of biodiversity protection and local socio-economic development", Deliverable D.T3.1.3. State Nature Conservancy of the Slovak Republic, Banská Bystrica, 115 pp.

ISBN: 978-3-903424-04-3

TABLE OF CONTENT

EXECUTIVE SUMMARY

Background

Nature provides a wealth of **services (ecosystem services - ES)** to our economy and society, from the supply of food, clean air and water, to the regulation of the climate and protection against natural disasters. Without those services, life as we know it would not be possible. However, nature also has value in its own right, independent of human uses. This "intrinsic value" means that nature has value even if it does not directly or indirectly benefit humans.

The concept of ES (IPBES 2019) was developed **to embrace a fuller and more symmetric consideration of diverse stakeholders and world views**, and a richer evidence base for action, i.e., the knowledge base offered by the natural and social sciences, the humanities, and the knowledge of practitioners and indigenous and local communities. Nature underpins quality of life by providing basic life support for humanity (regulating), as well as material goods (material) and spiritual inspiration (non-material). Most of ES are co-produced by biophysical processes and ecological interactions with anthropogenic assets such as knowledge, infrastructure, financial capital, technology and the institutions that mediate them.

Humanity's environmental challenges have grown in number and severity ever since the Stockholm Conference in 1972 and now represent a planetary emergency (UNEP 2021). Environmental changes are undermining hard-won development gains by causing economic costs and millions of premature deaths annually. Society needs to reduce carbon dioxide emissions by 45 per cent by 2030 compared to 2010 levels and reach net-zero emissions by 2050 to limit warming to 1.5 °C as aspired to in the Paris Agreement, while at the same time conserving and restoring biodiversity and minimizing pollution and waste. We also need to include natural capital in decision-making, eliminate environmentally harmful subsidies and invest in the transition to a sustainable future.

Europe's ecosystems, on which we depend, suffer from unrelenting pressures caused by intensive land or sea use, climate change, pollution, overexploitation and invasive alien species. Ensuring that ecosystems achieve or maintain a healthy state or a good condition is thus a key requirement to secure the sustainability of human activities and human well-being (Maes et al. 2020). Knowledge about ecosystem condition, the factors that improve or decline that condition, and the impacts on ES, with the benefits they deliver to people, is key to effective management, decision-making and policy design. Such an understanding helps target actions for conservation or restoration and more broadly sustainable use. Despite the wide coverage of environmental legislation in the European Union (EU), there are still large gaps in the legal protection of ecosystems. On land, 76% of the area of terrestrial ecosystems, mainly forests, agroecosystems and urban ecosystems, are excluded from a legal designation under the Birds and Habitats Directives. The condition of ecosystems that are under legal designation is largely unfavourable.

The EU Biodiversity Strategy for 2030 presents an ambitious agenda on bending the trend in biodiversity loss with increasing emphasis on ecosystem restoration. **Ecosystems are seen as solutions, not only to protect biodiversity but also to enhance carbon uptake and contribute to climate change mitigation as well**

as to deliver essential benefits to people, agriculture, and the economy. A key objective of the 2030 Biodiversity Strategy is to set up an EU Nature Restoration Plan. This plan proposes to carry out an impact assessment for legally binding EU nature restoration targets. The impact assessment will also look at the possibility of an EU-wide methodology to map, assess and achieve good condition of ecosystems so they can deliver benefits such as climate regulation, water regulation, soil health, pollination and disaster prevention and protection (Maes et al. 2020).

Policy-makers around the world are increasingly considering ES assessment and its associated analyses to inform their policies, decisions, and management practices (Preston & Raundsepp-Hearne 2017). ES assessment requires consideration of ecosystem functions, how those functions generate the services to produce benefits, and how those benefits are distributed to society. It is therefore a broadly interdisciplinary, technical activity, requiring an interdisciplinary expert team to complete. This approach identifies the consequences of environmental change and how environmental management decisions can enhance, diminish or maintain the flow of ES benefits. The intent of ES assessment is to **provide comprehensive information regarding the costs and benefits to assist in environmental management decisions.**

Policy relevance of ES assessment

ES assessment can support and inform analyses and decisions related to many issues. In the EU, there were nine policy domains identified (Geneletti et al. 2020): Nature Conservation; Climate, Water and Energy; Marine and Maritime Policy; Natural Risk; Urban and Spatial Planning; Green Infrastructure; Agriculture and Forestry; Business, Industry and Tourism; Health. Regarding Carpathian conditions and our focus on nature and biodiversity, the guidance is provided in this publication (in Chapter 3) for using ES assessment for the following areas for policy- and decision-makers:

- nature conservation (chapter 3.2);
- urban and spatial planning (chapter 3.3);
- green infrastructure, agriculture and forestry (partially included in chapter 3.5);
- involvement of stakeholders in this process (chapter 3.4);
- "mainstreaming" of ES in policy and decision-making (chapter 3.5).

For any particular policy issue that is being addressed, it is important to identify the relevance of ES, as well as the entry points in the policy process for considering ES and what some of those considerations might include (Preston & Raundsepp-Hearne 2017).

ES assessment is a technical, interdisciplinary activity

According to Preston & Raundsepp-Hearne (2017), **ES assessment provides a practical set of procedures for understanding what might be gained or lost from a given management choice** and the human dimensions of such effects. It can help managers to better comprehend and address potential issues and reduce conflict. Briefly, ES assessment involves:

- identifying high-priority ES;
- assessing their environmental, socio-cultural, and economic dynamics and their significance;
- identifying the consequences of change on these ES.

ES assessment typically requires **biophysical measures** and descriptions of the ecosystems and the dynamics involved in the production of ES. It also requires **description of ES benefits to people and the dynamics of how benefits are distributed** among different groups of people. People are often not aware of some benefits that they rely on from ecosystems. ES assessment clarifies these benefits as well as benefits that people commonly know of. ES assessment may include identifying the significance of ES benefits to people through valuation. Valuation can be particularly useful when decisions involve trade-offs, when decision-makers need to justify costs associated with the management of ES or when there is a need to inform diverse stakeholders of the broad value, or importance of ES. Integrated analysis of the various relevant ecological, socio-cultural, and economic factors can be completed using a decision-support approach (such as cost-benefit analysis, multi-criteria analysis or structured decision-making) that can identify trade-offs and implications of different environmental management and development options. The primary objective of ES assessment is to **support evidence-based decision-making in improving human well-being and ensuring environmental sustainability**. Since the ES form the basis for most of the relationships between ecosystems and human well-being, ES assessment necessarily considers both ecosystem dynamics and human dependence on those dynamics. Therefore, ES assessments do not replace other ecosystem-focused analyses, but can be used in conjunction with them.

Basic ES assessment framework

Before embarking on an ES assessment, it is necessary to ask the **basic questions**, what is the main reason for the evaluation and what issues need to be addressed in a given specific situation. For example, Preston & Raudsepp-Hearne (2017) provide a sequence of the following questions:

- Which ES are priorities in a given situation?
- What to measure or assess and which analysis tools to use?
- How are various ES produced and how do they interact with each other ecologically?
- How do ES benefit different groups of people (whether they are aware of it or not)?
- What are the values of these ES benefits to those groups of people?
- Are ES benefits increasing or decreasing over time?
- What are the likely effects of a project or policy on ES and associated ES benefits?
- How can the specific policy objectives be achieved without undue negative impacts on important ES?

It is also necessary to clarify the **basic conceptual framework** of ES assessment - the extent to which the evaluation should focus on the individual main "boxes" of the so-called ES cascade model (Potchin & Haynes-Young 2011). Within the ecological assessment of a given territory, it is crucial to recognise the ecosystem categories, state of ecosystems, their structure, natural processes, function; and how they are affected by anthropogenic pressures and drivers. On the other hand, in a planning document such as a local development strategy, it is essential to know what benefits for people could be achieved by wise management of natural resources. The example of such framework gives e.g. Preston & Raundsepp-Hearne (2017) – see **Figure A.** It shows that ES evaluation needs combining of the biophysical, socio-cultural, and economic information. The main goal is to reveal the processes of ES production and benefit distribution, the role of management and governance in affecting these processes, as well as the broader social and natural drivers of change that influence how ES are produced and managed.

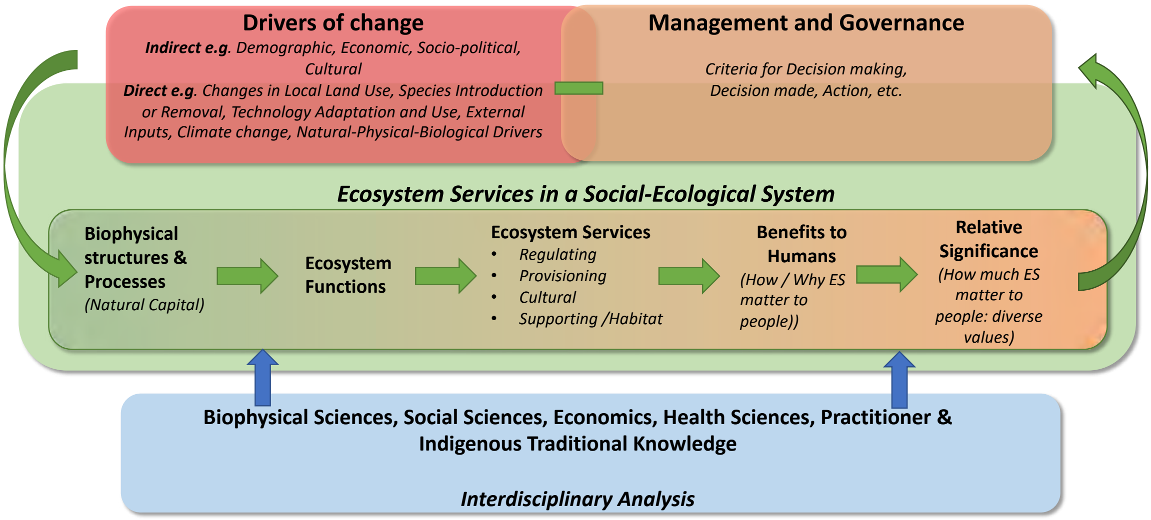

Figure A – Conceptual and analytical framework for the Canadian toolkit (Source: Preston & Raudsepp-Hearne 2017)

A simplified conceptual framework of ES assessment expressing the links between society and nature through causal relationships in accordance with the often used DPSIR (Drivers – Pressures – State – Impact – Response) framework is presented at **Figure B** (the relationships between ES and this framework is given e.g. by Rounsevell et al. 2010). It would be ideal if the ES assessment was comprehensive and included all components of the cascade (or the D-P-S-I-R sequence shown).

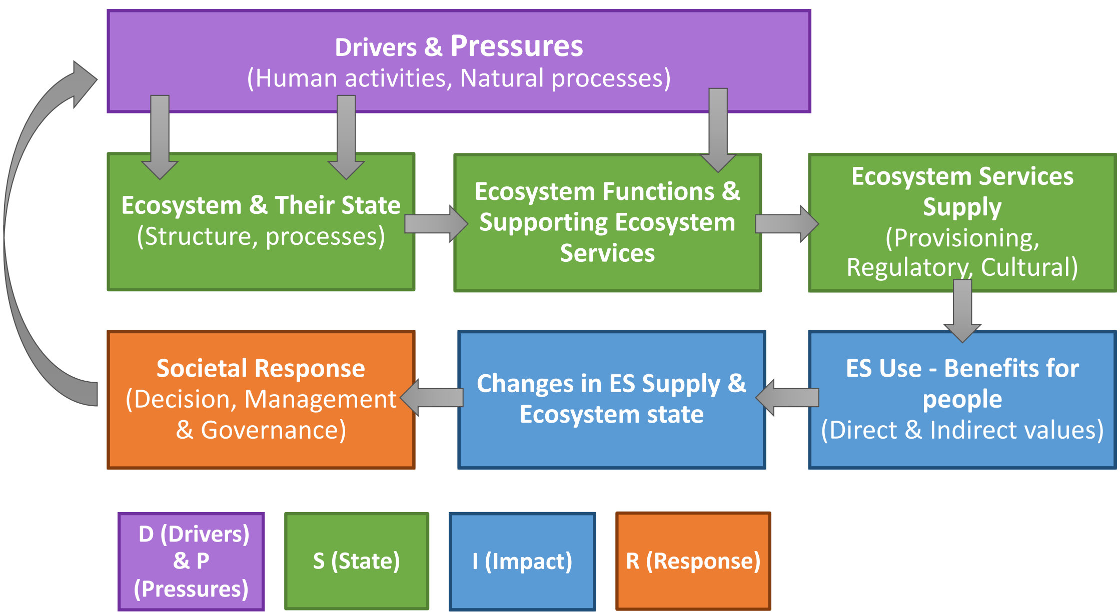

Figure B – Simplified DPSIR framework for ES assessment

Proposed main phases and evaluation steps

ES assessment process itself contains the **main phases and individual evaluation steps (Table A).** In the beginning, after clarifying the main purpose of the assessment, it is appropriate to implement the **"Scoping"** - a conceptual phase in which the individual steps and methods of evaluation are clarified. The main **"Appraisal"** phase follows, which is usually divided into several steps. The assessment process is completed by the **"Implementation"** phase, or at least by its initial step. Each phase consists of two steps, so there are six steps in total.

Table A – ES assessment phases, steps and outcomes

Phase	Step	Milestone/Outcome
A - SCOPING (Conceptual phase)	**1 - Introduction to the assessment process**	Introductory report (Terms of reference)
	2 - Designing the assessment process	Procedure and methodology of the ES assessment (Scoping document)
B - APPRAISAL (Research phase)	**3 - Ecosystem services assessment**	Ecosystem services assessment report
	4 - Integrated assessment	Integrated and/or context specific ES assessment report
C - IMPLEMENTATION (Realization phase)	**5 - Results communication, dissemination and implementation**	Implementation plan
	6 - Process verification and Updating	Monitoring & re-assessment report

There are several possibilities for how to design the process of ES evaluation in detail (see Chapter 2) – e.g. Canadian Ecosystem Services Toolkit (Preston & Raundsepp-Hearne 2017), Latvian approach to the ES assessment (NCAL 2020) or Local Integrated Planning Toolkit for Biodiversity and Ecosystem Services report (Pierce 2014).

Comprehensive "step-by-step" guide

This Carpathian ES Toolkit offers a practical, step-by-step guide and numerous resources for further understanding and direction. It is focused on the Carpathian countries, which are part of the EU, with similar mapping and assessment of ES, i. e. the Czech Republic, Hungary, Poland, Romania and Slovakia. Due to the lack of information and contacts in non-EU countries we do not pay a special attention on Serbia and Ukraine. The Toolkit approach is fully interdisciplinary. We encourage all users of the Toolkit to read the entire document carefully before starting off with the actual ES assessment. Doing it in this order will help the users to get familiar with the overall range of the activities and tools available in this paper. We offer several options and approaches and therefore the user can choose the most suitable way adapted to the specific context. The Toolkit contains key tools for planning and conducting ES assessments, complemented by a number of cases and case studies at various levels.

The **structure** of the Carpathian ES Toolkit includes the following main parts:

- **Chapter 1** sets the foundations. It brings the framework for concept of the ES, definitions, implementation and its global and European context. It pays a special attention to the value of the ES in the environmental policy and decision-making. The classification of the ES is discussed within the international systems that recognize the main categories such as provisioning services; regulation and maintenance services; and cultural services. One subchapter is dedicated to the approaches to evaluation of ES. It is possible to summarize them into three basic groups according to the main principle of assessment and provision of results - biophysical methods, socio-cultural (non-monetary) methods and economic/monetary methods (including natural capital). Besides, there are integrated methods that use multiple approaches and often combine multiple methods, and rapid assessment of ES, which is a useful tool for policy-makers and practitioners (such as site managers) to recognize the important functions and the multiple values of ecosystems and reflect them in their decisions, policies and actions. Since we focus on the Carpathian countries, which are part of Europe or the EU, we also describe the process of mapping and assessment of ES in the EU with an overview of the status in the Carpathian countries such as the Czech Republic, Hungary, Poland, Romania, and Slovakia.
- **Chapter 2** focuses on outlining the appropriate procedure for the ES assessment. It is intended for use in various contexts and scales – contains the basic inputs, steps and outputs of the evaluation. The available approaches and methodical toolkits are used as inspiration; other recommended sources are also provided.
- **Chapter 3** offers advice on how to address ES considerations in a variety of different policy contexts such as nature conservation (chapter 3.2), urban and spatial planning (chapter 3.3), green infrastructure, agriculture and forestry (partially included in chapter 3.5), involvement of stakeholders in this process (chapter 3.4) and "mainstreaming" of ES in policy and decision-making in Carpathian countries (chapter 3.5). For each context, the chapter advises on the relevance of ES, entry points for incorporating ES analysis or considerations in typical processes, additional considerations, and sources mostly in the European context.
- **Chapter 4** brings insights into current experiences with the application of ES mapping and assessment for policy and decision-making and related recommendations and defines challenges in the ES assessment as well. Besides the European context, it also presents more detailed description of the challenges of applying the concept of ecosystem services in 5 Carpathian countries (Czech Republic, Hungary, Poland, Romania and Slovakia).
- **Chapter 5** provides a knowledge marketplace with recent examples on natural capital and ecosystem services case studies (including Carpathian countries). Its purpose is to bring knowledge and inspiration for better management of nature and protected areas. The case studies are selected for people with diverse needs and interests - from science, policy and practice; public, private and voluntary sectors; organisations large and small, as well as individuals.
- **Conclusions** briefly summarize the most important findings in the Toolkit.
- **Glossary** provides definitions that are oriented to the use of terms in the context of ES work. Together, it contains 135 terms relevant for the mapping and assessment of ES in the Carpathian countries.
- **References** contain a complete bibliographic list of sources cited (provided at the end of the Toolkit).
- **Annexes** provide examples of the national ecosystem services assessment in Carpathian countries **(Annex 1)** and examples of mainstreaming of ES in Carpathian countries **(Annex 2)**.

Who is this Toolkit for?

In the Carpathian region we are witnessing quite intensive development, increasing urbanization and related declines in biodiversity. However decisions of relevant authorities are often not based on proper analysis and ecosystem services are not considered in policy processes. This interdisciplinary Carpathian Ecosystem Services Toolkit is intended to serve as a **guide and resource for evidence-based decision-making and management practices** not only in the Carpathian region but also in other European countries. In this regard, this Toolkit is related to many issues, especially area-based planning, regulatory decision analysis, environmental damages assessment and environmental management.

INTRODUCTION

World economic prosperity and quality of life of the population are conditioned by the existence of natural capital such as biodiversity and ecosystems which provide important goods and services to humanity - from fertile soils and multifunctional forests to drinking water and clean air, to pollination, climate mitigation or prevention of natural disasters. Mapping and assessment of ecosystem services are essential to understand how ecosystems contribute to the quality of human life and to support the argumentation of multisectoral policies that have a major impact on natural resources and their use (Burkhard & Maes 2017). Potschin & Haines-Young (2011) explained the fundamental idea of the ES approach which is the usefulness and benefits of nature for society and human well-being.

On the other hand, people make pressure on geo-ecosystems by using ecosystem services, by mediating effects on ecosystem functions and by other ways of influencing the landscape. These pressures can cause adverse changes in the structure and functions of ecosystems themselves and thus in the further potential for their use (Mederly & Černecký 2020). Ecosystems need to be in good condition to provide a set of essential services that benefit humans (Maes et al. 2018). Drivers of change can have positive (e.g. conservation) or negative (pressures) impact on ecosystem conditions. Pressure refers to a human-induced process that alters the condition of the ecosystem.

Central Europe, including the Carpathian region, is the place where the suggested challenges are not only present but are rather getting worse. Traditional approaches to resource management and nature conservation in this area are no longer sufficient to guarantee the long-lasting economic benefits and the provision of ecosystem services. Since such issues require transboundary cooperation, the institutions from six Central European countries joined in their efforts to develop the "Building management capacities of Carpathian protected areas for the integration and harmonization of biodiversity protection and local socio-economic development" (Centralparks) project, co-funded by the Interreg CENTRAL EUROPE Programme. The project supports the efforts for nature protection and local sustainable development in order to improve the integrated environmental management capacities and policies as well as to enhance the transnational cooperation in general. Moreover, it also aims to mitigate the existing threats to biodiversity in the suggested region. Policy support documents and tools, tailored for decision-makers and protected area managers, should as a result enhance the biodiversity and landscape conservation, local sustainable tourism development, integrated nature conservation planning, habitat evaluation, and communication with local communities. Additionally, they will also include the innovative environmental management tools, such as the toolkit for assessment of ecosystem services.

The above noted, numerous experts from the Carpathian countries have thus worked on the following Carpathian Ecosystem Services Toolkit (CEST) which is intended to serve as both a guide and a valuable resource for the evidence-based decision-making as well as for the similar management practices not only in the Carpathian region but also in other European countries. In the project consortium were involved institutions from five Carpathian countries (out of seven Parties to the Carpathian Convention). Due to lack of information and contacts in non-EU countries (Serbia and Ukraine) the CEST is based on information from EU Member States, but can be completed in future also from experience and knowledge in other parts of the region.

Chapter 1: FOUNDATIONS

1.1 Foundation of ecosystem services

1.1.1 Definition of ecosystem services

Ecosystem services (ES) can be easily defined as the contribution of ecosystems (living systems) to human well-being. These services are final and present outputs of ecosystems (whether natural, semi-natural or largely altered by human activity) that directly affect human well-being. Their basic attribute is that they retain a link to the related ecosystem functions, processes, and the ecosystem structure itself that, in turn, co-creates them. Another related definition of the ES is provided by the Millennium Ecosystem Assessment (MEA 2005), which describes the ES simply as benefits provided to people by the ecosystems. In contrast, The Economics of Ecosystems and Biodiversity (TEEB) views the ES as the direct and indirect contributions of ecosystems to human well-being (de Groot et al. 2010). An interesting definition of ES provide Boyd and Banzhaf (2007): "ES are components of nature, directly enjoyed, consumed, or used to yield human well-being." In this definition, it is important to distinguish between end-products and intermediate products in relation to welfare accounting. The ES are considered as end-product of nature. Furthermore, Czúcz & Condé (2017 compiled an operative MAES glossary that consists of the most used terms and their relevant scientific and policy-oriented definitions, which, on their end, are related to the ecosystem services.

As argued by Potschin et al. (2016), "despite many differences between definitions of what exactly ES are, there is some kind of pathway (cascade) to delivering the ES that goes from ecological structures and processes at one end through to the well-being of people at other". At the basis of such cascade model there are the ecosystems or more precisely geo-ecosystems (Potschin & Haines-Young 2011), which are represented by the biophysical structures and ecological processes (e.g. nutrient and energy cycles). At the following cascade 'stage' there are the ecosystem functions, especially those ecological processes that generate benefits, directly used by people afterwards (e.g. slowing down the watercourse after long-term rainfall). At the centre of the cascade there are the ES themselves, which can be defined as the final outputs of the ecosystem. Outputs of the ecosystems are linked to the ecosystem structures and processes, while directly contribute to the creation of various benefits for humans. Their existence, in turn, is conditioned by the general human consumption. Finally, the last stage of the cascade consists of goods and benefits, which have a particular value for people - monetary or non-monetary and that present a specific contribution of the ES to human well-being. According to Izakovičová et al. (2018), the ES concept represents an integrated approach to country assessment with an emphasis on participatory methods and has a great potential to streamline spatial planning in Slovakia.

1.1.2 The overview of function/implementation of ecosystem services approach

The gradual application of the concept of ecosystem services in the scientific sphere began in the 1980s with the publication of Ehrlich & Ehrlich (1981), where the term ES was comprehensively explained. The first scientific study, which estimated the average annual value of 17 ES for 16 biomes, was published by Costanza et al. (1997)

and in 2014 this value was updated and refined to $125 trillion in 2011 (Costanza et al. 2014). In 2001, The Millennium Ecosystem Assessment (MEA) was called for by the United Nations Secretary. The main objectives of the MEA were to assess the consequences of the ecosystem change for human well-being and enhance the conservation and sustainable use of ecosystems and their contribution to human well-being. The findings of more than 1,360 experts worldwide consist of five technical volumes and six synthesis reports that suggest on the state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide (such as clean water, food, forest products, flood control, and natural resources) as well as on the options to restore, conserve or enhance the sustainable use of ecosystems (MEA 2005). The comprehensive overview of the economic vision of the concept of ES was brought in 2010 by The Ecological and Economic Foundations (TEEB 2010) which created methodological framework to enable the decision-makers at different levels to undertake an analysis of economic values of ecosystem services and biodiversity, as well.

The milestone, which has extensively captured the need for the ES assessment, was the adoption of a global commitment to biodiversity conservation - the Convention on Biological Diversity (CBD), including the Aichi Biodiversity Targets adopted in Nagoya in 2010. The Strategic Goal D defines the need to increase biodiversity and ecosystem services benefits for all and the Objective 14 thus specifies that by 2020, ecosystems which provide the essential services, including water-related services and services that contribute to health, livelihood, and well-being, should be restored and maintained. Additionally, the EU Biodiversity Strategy to 2020 (Strategy 2020) likewise obliges the Member States to promote the ES. It notes that Member States develop an assessment of ecosystems and their services at the national level, integrate them into the reporting system by 2020 and then implement those within their national policies (Mederly et al. 2020). In 2012, the implementation of such ES concept into the policy agenda was supported by the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES).

To promote the fulfilment of the Strategy 2020 commitments, the European Commission set up an Expert Group on Mapping and Assessment of Ecosystems and their Services (MAES) in 2013. The meeting of the MAES group in March 2019 showed that the level of implementation of commitments in the ES sphere by Member States of the EU is assessed at 70% (Mederly et al. 2020).

1.1.3 The value of ES in environmental policy and decision making

ES assessment is a valuable tool to analyse socio-cultural, economic, and environmental implications and trade-offs (Preston & Raudsepp-Hearne 2017). ES assessment was implemented in the EU law through Action 5 of the EU Biodiversity Strategy to 2020 which anticipated that the Member States, with the assistance of the Commission, map and assess the state of ecosystems and their services in their national territory by 2014. This is an important point as it helps to understand the conditions of the EU ecosystems and the benefits provided by them as well as to fulfil the target of restoring 15% of our degraded Ecosystems (European Commission 2011 – COM/2011/0244). The new EU Biodiversity Strategy for 2030 will pay particular attention to the sustainable water resource management, the restoration of degraded land, and the protection and restoration of biodiverse areas with high ecosystem services and climate mitigation potential. Therefore, the Commission will develop in 2021 methods, criteria and standards to describe the essential features of biodiversity, its services, values, and sustainable use (European Commission 2020 - COM/2020/380).

ES assessment is particularly relevant for measuring the progress towards the Sustainable Development Goals by 2030 - SDGs (UN General Assembly 2015). The Carpathians and their ecosystems can contribute to the SDG (1) No Poverty, SDG (2) Zero Hunger, SDG (3) Good Health and Well-being, SDG (6) Clean Water and Sanitation, SDG (8) Decent Work and Economic Growth, SDG (11) Sustainable Cities and Communities, SDG (12) Responsible Consumption and Production, SDG (13) Climate Action, SDG (15) Life on Land and SDG (17) Partnerships for the Goals.

With the help of an ES assessment decision-makers can make informed and science-based decisions in line with the SDGs and IPBES targets. According to Preston & Raudsepp-Hearne (2017) the ES assessment can support the decision-makers in:

- regulatory processes such as environmental assessment;
- wildlife management and habitat stewardship;
- land use and infrastructure planning at the municipal, watershed, regional, and provincial scales;
- establishing protected areas, undertaking ecosystem restoration and rehabilitation, and other conservation initiatives to maintain or improve ecological integrity;
- damage assessment, risk assessment, cumulative effects management, and hazard mitigation;
- design of incentive measures to support conservation and sustainable use of ecosystems;
- economic development;
- resource allocation, use, and management;
- reporting and monitoring;
- natural capital accounting and national ecosystem accounts;
- public health and well-being;
- full-cost accounting;
- raising awareness of the importance of healthy ecosystems to human well-being;
- identification of stakeholders and possible cooperation.

Nature, through its ecological and evolutionary processes, sustains the quality of the air, fresh water and soils on which humanity depends, distributes freshwater, regulates the climate, provides pollination and pest control, and reduces the impact of natural hazards (IPBES 2019). It also acts as an essential component, contributing to human overall existence as well as to the general quality of life. Given such importance, the humans should therefore act so as to preserve and not destruct the nature not only for the sake of nature itself, but also for the sake of our own existence.

1.2 Classification of ecosystem services

For scientific, as well as policy purposes worldwide, there are three basic and frequently used international classifications **(Table 1)** which are more or less similar and originated from the work of Costanza et al. (1997, 2017). The first one is a classification of ecosystem goods and services processed in the large-scale project Millennium Ecosystem Assessment (MEA 2005). The Economics of Ecosystems and Biodiversity classification proposal

(TEEB 2010) following the division of MEA contains 22 ES divided into 4 main categories. TEEB defined the concept of the direct and indirect contribution of ecosystems to human well-being. The third one, CICES classification - Common International Classification of Ecosystem Services (Haines-Young & Potschin 2018) is the ecosystem-based classification system which assumes that services are provided either by living organisms (biota) or a combination of living organisms and abiotic processes.

All of the above classification systems include the following main ES categories:

Provisioning Services consist of material products and goods receiving from ecosystems that are essential for human life e.g. nutrition, material and energy, more precisely biomass for nutrition, utility biomass, genetic resources, materials for energy, abiotic material including drinking water and water for non-drinking purposes, etc. (Mederly et al. 2020).

Regulation and Maintenance Services represent the benefits from regulating natural processes in ecosystems and the provision of other services such as regulation/mediation of flows (mass, liquid and gaseous), regulation of climate and air, regulation/moderation of natural disasters, regulation of pests and diseases, soil formation, regulation of life cycles, water cycles, etc. (Mederly et al. 2020).

Supporting Services involve ecosystem functions and processes relevant to the healthy state of ecosystems e.g. nutrient cycle or biodiversity. Later classifications such as TEEB or CICES do not recognize "Supporting ES", but include them into "Maintenance ES".

Cultural Services describe all the non-material, and normally non-consumptive, outputs of ecosystems that affect physical and mental states of people. This includes cultural identity and heritage, spirituality and religion, knowledge systems and education, aesthetic experience, recreation and ecotourism and sense of place (Preston & Raudsepp-Hearne 2017).

Basic ecosystem processes such as nutrient cycling or primary production are classified as supporting services by the MEA, however CICES considers these as dimensions of ecosystem condition instead of final (i.e. readily available to humans) services. This logic is more consistent with the cascade concept (Haines-Young & Potschin 2018, La Notte et al. 2017).

There are clear benefits of using ecosystem services classification systems for practitioners - Finisdore et al. (2020) identified 18 main benefits including functional and genetic benefits, e. g. improved identification of elements, metrics and analytical techniques; improved knowledge transfer; quickly identify complementary elements of an final ES; quicker identification of research needs; lower number of mislabelled final ES, loose-fitting metrics; reduced cost associated with employee loss; etc.

Table 1 - Comparison of four main worldwide used classifications of ecosystem services (Source: Costanza et al. 2017, modified)

	Costanza et al. (1997)	**Millennium Ecosystem Assessment (MEA 2005)**	**The Economics of Ecosystems and Biodiversity (TEEB 2010)**	**Common International Classification of Ecosystem Services - CICES (Haines-Young & Potschin 2018)**
Provisioning services	Food production	Food	Food	Biomass - Nutrition, Freshwater and sea plants and animals for nutrition
	Water supply	Fresh water	Water	Ground and surface water for drinking, Ground and surface water for non-drinking purposes
	Raw materials	Fibre, timber	Raw materials	Utility biomass - timber and other fibres
	Genetic resources	Genetic resources, Biochemicals and natural medicines	Genetic resources, Medicinal resources	Genetic sources of biotic origin, Genetic material for biochemical and pharmaceutical processes
	X	Ornamental resources	Ornamental resources	Materials of biotic origin (ornamental resources)
	X	X	X	Biomass - sources of energy of plant and animal origin
	X	X	X	Abiotic sources of energy
Regulating and maintenance	Gas regulation	Air quality regulation	Air purification	Regulation of gaseous and air flows
	Waste treatment	Water purification and waste treatment	Waste treatment (esp. water purification)	Regulation of waste, toxic substances and other pollutants
	Disturbance regulation (storm protection & flood control)	Natural hazard regulation	Disturbance prevention or mediation	Regulation of air and liquid flows
	Water regulation (e.g. natural irrigation & drought prevention)	Water regulation	Regulation of water flows	Regulation of liquid flows
	Erosion control & sediment retention	Erosion regulation	Erosion prevention	Regulation (mediation) of mass flows
	Climate regulation	Climate regulation	Climate regulation	Atmospheric composition and global climate regulation
	Soil formation	Soil formation (supporting service)	Soil fertility maintenance	Support of soil formation and composition
	Pollination	Pollination	Pollination	Lifecycle maintenance (including pollination)
	Biological control	Regulation of pests & diseases	Biological control	Support of pest and disease control
Supporting & Habitat	Nutrient cycling	Nutrient cycling & photosynthesis, primary production	X	X
	Refuges (nursery, migration habitats)	Biodiversity	Lifecycle maintenance, Gene pool protection	Life cycle and habitats maintenance, gene pool protection

Cultural services	Recreation (incl. eco-tourism & outdoor activities)	Recreation & eco-tourism	Recreation & eco-tourism	Physical and experiential interactions (recreation & eco-tourism)
	Cultural (incl. aesthetic, artistic, spiritual, education, & science)	Aesthetic values	Aesthetic information	Experiential interactions
	Cultural (incl. aesthetic, artistic, spiritual, education, & science)	Cultural diversity	Inspiration for culture, art & design	Representative interactions (promotion, art)
	Cultural (incl. aesthetic, artistic, spiritual, education, & science)	Spiritual & religious values	Spiritual experience	Spiritual and/or emblematic interactions (cultural heritage)
	Cultural (incl. aesthetic, artistic, spiritual, education, & science)	Knowledge systems and educational values	Information for cognitive development	Intellectual interactions (Willingness to protect nature, moral aspects)

The Table 1 compares four of the main ecosystem services classification systems used worldwide and their differences and similarities. One can see that, while there are differences in the details, these classification systems are broadly very similar and do not deviate significantly from each other (Costanza et al. 2017). Later classifications such as TEEB or CICES do not recognize "Supporting ES", but include them into "Maintenance ES".

1.3 The approaches to ecosystem services evaluation

Several methods are appropriate for ES assessment. It is possible to summarize them into three basic groups according to the main principle of assessment and provision of results - biophysical methods, socio-cultural (non-monetary) methods and economic (monetary) methods. Moreover, there are also integrated methods that use multiple approaches and often combine multiple other methods inside (Mederly et al. 2020). Below we provide an overview and a brief description of the most frequently used and recommended methods of the ES assessment.

1.3.1 Biophysical approaches

The first step in the ES assessment is usually the biophysical evaluation. It focuses in particular on the assessment of the condition and functioning of ecosystems and their characteristics, from which - through the supply of ecosystem services - the social and economic values are consequently derived. The ecosystem condition includes the ecosystem health which can be expressed or measured by ecological indicators such as an amount of biomass, fragmentation by forest cover loss, threatened species (red list index), farmland Bird Indicator (index), soil organic carbon (SOC) etc. (for the list of best available indicators for assessment of ES across different ecosystems see Maes et al. 2016), or biodiversity monitoring schemes (for more information see Geijzendorffer & Roche 2013, Geijzendorffer et al. 2015). The quantification of the flow of assessed services could be expressed in biophysical measurement units as material and energy stocks or flows (Mederly et al. 2020). In order to express the ES value measurable indicators are most commonly used, and in justified cases substitute indicators (proxy-indicators) can be used. Mathematical and biophysical models (e.g. hydrological, climatic, erosion, production, etc.) are used to express the state, functions and processes in ecosystems as well as the ES potential. Within the Carpathian countries, the ES potential and their indicators are discussed by Affek et al. (2020) from multiple perspectives. Specific mapping methods are also often used - for instance based on geographic information systems and allow for spatial rendering of the value or ES provision and their components (e.g. ES matrix method). The main biophysical methods include Ecological Footprint, Land Cover Flow Analysis, Life Cycle Analysis and Energy / Exergy methods (Gómez-Baggethun & de Groot 2010). The best known (predominantly biophysical) software used for ES assessment include InVEST (www.naturalcapitalproject.org), ESTIMAP (Zulian et al. 2018) and Quick Scan (www.quickscan.pro).

More specific determination of biophysical methods used Vihervaara et al. (2018) in the technical report from Enhancing ecosystem services mapping for policy and decision making (ESMERALDA) project. Direct measurement methods deliver a biophysical value of ES in physical units that correspond to the units of the indicator, and quantify or measure a stock or a flow value. Direct measurements are usually used as an input for a different biophysical mapping method or to validate certain mapping and assessment elements and are considered one of the most accurate ways to quantify ES. Indirect measurement methods use different data sources based on biophysical value and expressed in physical units (results of remote sensing and Earth observation derivatives, e.g. Barbarosa et al. 2015). These types of values need further interpretation or data processing before it can be used. Modelling methods involve modelling approaches from different earth sciences (hydrology, soil, ecology, climatology etc.), as well as conceptual models and integrated modelling frameworks.

1.3.2 Socio-cultural approaches

Socio-cultural (non-monetary) ES assessment is focused on the importance, preferences, needs or requirements which people express in relation to nature. The number of studies using these methods for ES assessment is still growing and so the socio-cultural methods are becoming an accepted part of the ES concept (Gómez-Baggethun et al. 2014). Socio-cultural methods are mostly based on qualitative data – especially on value estimates of the importance of individual ES, they express the social preferences of people and population groups with respect to the ES. These are the so-called deliberative methods that use for example the expression of relative significance instead of monetary or economic values. They are often based on collective and interactive procedures – e. g. workshops, meetings, structured interviews or questionnaire methods. So, it is not so much about determining the exact value (for example, the suitability of the territory for the provision of the given ES), rather than attaining approval, or agreement on a particular assessment or solution (Mederly et al. 2020). On the basis of the study by Santos-Martín et al. (2017), the most commonly used methods are:

- Preference Assessment – collection of data through a ranking or rating of ES based on individual or social preferences to a selected ES by analysing motivation, perception, knowledge, etc.;
- Time Use Methods – methods are based on people´s willingness to devote time to changing ES quality or quantity;
- Photo-Elicitation Survey – uses people´s visual experiences and preferences to evaluate socio-cultural value of ES;

- Narrative Methods – methods using description or specific story to express ecosystem/landscape value from an ES perspective;
- Participatory Mapping – aiming on spatial distribution of ES which is evaluated by approach and knowledge of various stakeholders;
- Scenario Planning – creating possible future alternatives and assessing their relationship with ES utilisation (usually with participatory methods);
- Deliberative Methods – open discussion of stakeholders and non-scientific participants about their preferences for ES; this method is usually combined with other approaches.

1.3.3 Economic and monetary approaches, natural capital

The economic assessment is reflecting the economic value of the ES in the decision-making processes. Environmental economists use mainly the concept of total economic value, which is composed of both use and non-use values. To capture these values, economists use a variety of methods - primary methods or value transfer methods. For primary methods, direct market methods (e.g. market prices) are used - if such information is not available, then parallel or hypothetical "markets" based on preference surveys are used (travel costs, contingent valuation etc.). If no such data is available, or a survey cannot be conducted directly in the research area, then the information obtained in other research is used, i.e. the mentioned transfer of values (Mederly et al. 2020). The attitudes on the ES monetary assessment vary and there is a need for the economic assessment to be broadened into a wider ES assessment context with its main role as a supporting tool for moving towards a sustainable society.

Natural capital is the world's stock of natural resources which includes geology, soils, air, water and all living organisms. Some natural capital assets provide people with free goods and services (ES). Natural capital accounting is the process of calculating the total stocks and flows of natural resources and services in each ecosystem or region. Accounting for such goods may occur in physical or monetary terms. This process can subsequently inform government, corporate and consumer decision-makers as each relates to the use or consumption of natural resources and land, and sustainable behaviour. Within the EU the interaction between Eurostat and national statistical offices of EU Member States was formalized in 2011 (European Environmental Economic Accounts). It requires the Member States to report data and accounts on air emissions, taxes related to the environment, and material flows from 2012. The creation of inclusive wealth indicators is also a recognized priority of the EU. The 7th Environment Action Programme (EAP) of the EC explicitly identifies this issue, by calling for further development and integration of economic and environmental indicators. The Shared Environmental Information System (SEIS) proposes to streamline the collection of data required for designing environmental indicators. The EU also committed to the Aichi Accord at the CBD COP-10, in which Parties agree to integrate biodiversity into their national accounts. The European Environment Agency (EEA) proposed that given the compatibility of the design with the System of National Accounts (SNA), it would be possible to use one particular indicator, Consumption of Ecosystem Capital (CEC) to adjust National Accounts aggregates to create, in particular, CEC Adjusted Net Domestic Product and CEC Adjusted Net National Income.

1.3.4 Integrated assessment of ES

Integrated methods reflect the need to link different ES assessment methods and are used for the overall assessment of the final benefits of the ES for human well-being or quality of life. Integration is crucial to assess synergies and trade-offs between different ES as well as between ES and ecosystem conditions, to avoid the overuse of certain services. It also helps with the decision on priorities for the use of individual ES, which are expressed in different units and different methods. For this purpose, the following are used (Kelemen et al. 2015, Mederly et al. 2020):

- Multi-Criteria Decision Analysis – a participatory tool used to link ecological, socio-cultural and economic contexts through an assessment and discussion framework involving various stakeholder groups (a specific policy framework), using modelling;
- Bayesian Belief Networks – uses graphical models for decision making in different probability conditions;
- State and Transition Models – scientific modelling of probable ecosystem changes that result from their management with interaction to natural biotic and abiotic drivers; they can be linked to spatial GIS models;
- Scenario Development – a definition of possible future impacts of various drivers of change (e. g. climate change or different policy interventions) on certain territory, based on verified assumptions about substantial trends and drivers;
- Deliberative Valuation – framework that combine various tools and techniques involving different researchers and stakeholders and form their preferences for ES through open dialogue, preferably by the consensus of a majority.

Several of these methods, or procedures are not just an "integration" but can also be described as combined - they also use the techniques of biophysical, socio-cultural and partly economic assessment (Mederly et al. 2020). The Integrated Assessment Framework (Nikolova et al. 2018), developed within the ESMERALDA H2020 project, offers a clear overview of the levels of integration. Finally, we need to remind, that it is necessary to define the purpose of the assessment and the policy context, the degree of accuracy required, spatial resolution and geographic scale - and only then select the appropriate methods.

1.3.5 Rapid assessment of ES

In some cases, the rapid assessment of the ES is a useful tool for policy-makers and practitioners (such as site managers) to recognize the important functions and the multiple values of ecosystems and reflect them in their decisions, policies and actions (Russi et al. 2013). However, there are inherent limitations, including resourcing, access, cooperation, time and capacity which have acted as barriers to more extensive attempts to recognize the functions and benefits that ecosystems like wetlands provide. Therefore, the Ramsar Convention on Wetlands developed the Rapid assessment of wetland ecosystem services (RAWES) approach, as an example of approaches that can be developed and it was adopted by Ramsar Contracting Parties at their 13th Meeting of the Conference of Parties by Resolution XIII.17 in 2018[1] . This approach satisfies the definition of "rapid" assessment (Fenessy et al. 2007) insofar that no more than two people should spend more than half day in the field and another half day on preparation and analysis and it is not resource-intensive. It is flexible, allowing assessments at a range of scales and it is in principle also relevant to other habitat types. The outputs from applying the RAWES approach can be used to inform subsequent quantitative assessments of targeted ecosystem services, by effectively providing an initial screening, or in more general local or national policy frameworks

1 https://www.ramsar.org/sites/default/files/documents/library/xiii.17_rapid_assessment_ecosystem_services_e.pdf

and decision-making processes such as environmental impact assessments. Another example of rapid assessment of ES at sites of biodiversity conservation importance brought Peth et al. (2013) in TESSA toolkit. It helps to local non-specialist in identification of ES (by relatively accessible methods) that may be important at a site, evaluate current benefits for people and compare them with those expected under alternative land-uses. It is recognized that rapid assessment does not replace a comprehensive field assessment.

1.4 Development of ecosystem services assessment in the European Union

The European Green Deal (EC 2019) recognises that ecosystems provide essential services such as food, fresh water and clean air, and shelter. They mitigate natural disasters, pests and diseases and help regulate the climate.

The EU Biodiversity Strategy to 2020 (EC 2011) called Member States to map and assess the state of ecosystems and their services in their national territory with the assistance of the European Commission. They were also obliged to assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at the EU and national level by 2020 (Target 2, Action 5):

Target 2: By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems.
Action 5 foresees that EU Member States will map and assess the state of ecosystems and their services in their national territory by 2014.

This specific action aimed to provide a knowledge base on ecosystems and their services in Europe. It underpinned the achievement of all 6 targets of the strategy and was also relevant to several other EU sectoral policies such as agriculture, maritime affairs and fisheries, and cohesion.

A coherent analytical framework as well as common typologies of ecosystems for mapping and a typology of ecosystem services for accounting, have been developed (first technical report from Mapping and Assessment of Ecosystems and their Services "MAES" - Maes et al. 2013) to be applied by the EU and its Member States in order to ensure consistent approaches. It contributed to the sub-global assessments of ecosystems and ecosystem services under the IPBES. A second technical report (Maes et al. 2014) proposed an initial set of indicators that could be used at the European and Member State's level to map and assess biodiversity, ecosystem condition and ecosystem services. The third technical report (Erhard et al. 2016) is taking stock of the available information to map and assess the condition of Europe's ecosystems. The fourth technical report is on mapping and assessment of urban ecosystems and their services (Maes et al. 2016). The fifth technical report provides an integrated analytical framework and set of indicators for mapping and assessing the condition of ecosystems in the EU (Maes et al. 2018).

All Member States are actively involved in mapping and assessing the state of ecosystems and their services in their national territory (Mederly & Černecký 2020). In order to deliver Action 5, the MAES Working Group was established in 2012 under the Common Implementation Framework (CIF). Members of the group provide updates on progress in their countries twice a year and a barometer is updated accordingly (Figure 1).

According to this assessment, nine countries have already achieved full implementation (not only the ecosystem and ES assessment but also their integration in national policies) – the countries include the UK, the Netherlands, Ireland, Hungary, France, Finland, Estonia, Bulgaria and Greece. Other countries are significantly approaching this objective (Germany, Italy, Romania, Lithuania). For the period since 2015, Greece, Estonia, Norway, Cyprus and Lithuania have made the largest progress.

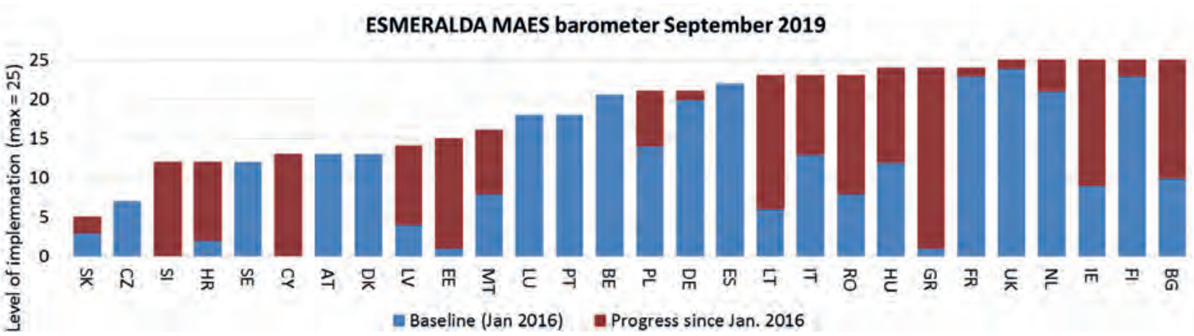

Figure 1 - ESMERALDA MAES barometer: Development in evaluation and application of ecosystem services approach of EU Member States' in the period 01/2016 - 03/2021 (Source: https://biodiversity.europa.eu/ecosystems)

Table 2 - Analysis of EU Member States' evaluations of ecosystems services and quantity of evaluated ecosystem services in some states (Source: Mederly & Černecký 2019)

Member State	Overall ecosystem services	Provisioning ecosystem services	Regulating and maintenance ecosystem services	Cultural ecosystem services
Czech Republic	18	7	5 / 4	2
Denmark	11	3	1 / 2	5
Finland	28	10	8 / 4	6
Netherlands	19	5	5 / 5	4
Ireland	28	9	5 / 6	8
Lithuania	31	14	6 / 5	6
Luxembourg	13	4	4 / 4	1
Germany	18	5	5 / 5	3
Romania	12	4	3 / 2	3
Spain (SP)	22	7	4 / 4	7
United Kingdom	26	12	4 / 5	5
Portugal	6	3	0 / 3	4
Italy	5	0	2 / 2	1

Mederly et al. (2020) analysed EU Member States' evaluations of ecosystems services (Table 2) and found some generalizations which can also be used for the process of preparing the ES national assessments in Carpathian countries:

The number of ES for assessment in individual countries (related only to countries analysed in the paper cited above) varies significantly but is on average 15 – 20 ES. The lowest number (3 - 6 ES) is reported by IT and PT; by contrast, the largest number (26 - 28 ES) is reported by UK, FI and IE.

The ratio of ES representation by main groups varies - some countries have over-represented provisioning ES (FI, LT, UK), others – cultural ES (DK, IE, SP). Regulating and supporting ES are significantly represented in almost all countries.

Ecosystem maps were used as an important basis for the ES assessment for most countries. Some countries (LT) used simpler land use maps, or Corine Land Cover maps, some National Land cover classification for ES (GR).

All countries use indicators for the assessment of the ES - the natural environment properties database is standard, and it is further used for the selection of other indicators, the creation of maps in the GIS and for the possible use of models. The most sophisticated indicator system is used by FI, LU, IE, UK, NL.

ES assessment methods vary significantly across countries. Complex ES mapping and assessment involving many indicators and statistical data evaluation were for example presented in studies of BE, NL, UK, RO, SP.

Biophysical models have been used in different countries - DK, FI, GE, IE, IT, LU.

Economic valuation in the form of a benefit transfer method was used by CZ, IT, UK, FI, SP.

Most of the studies focus on the current status and trends related to ES value but some also offer future development scenarios (UK, PT, SP).

Most of the studies address not only the ES capacities, but also the demand and current ES flows (actual use) and compare them in different ways. The most common methods include statistical evaluation of relationships between these categories for administrative units - regions (e.g. DK, GE) (Mederly & Černecký 2020).

The new EU Biodiversity Strategy for 2030 recognises that **natural capital investment**, including restoration of carbon-rich habitats and climate-friendly agriculture, are among the five most important fiscal recovery policies, which offer high economic multipliers and positive climate impact. Over the last 30 years, the EU has put in place a solid legislative framework to protect and restore its natural capital. However, recent evaluations show that although legislation is fit for purpose, implementation on the ground is lagging. This is having dramatic consequences on biodiversity and comes with a substantial economic cost. The full implementation and enforcement of EU environmental legislation is therefore at the heart of this strategy, for which political support and financial and human resources will need to be prioritised. In this context, the EU will support the establishment of an **international natural capital accounting initiative**.

1.5 Ecosystem services assessment in (selected) Carpathian countries

Carpathian countries also carry out mapping and assessment of ecosystem services in their territories. In this section, we present a brief description of their state of the art and main gaps of the planning processes and tools related to the ES in the involved 5 countries **(Czech Republic, Hungary, Poland, Romania and Slovakia)**. More details with some examples are listed in **Annex 1**.

In the **Czech Republic**, the significant progress in evaluation of ES brought study focused on methodology for integrated assessment of ecosystem services in the Czech Republic (Vačkár et al. 2014). An important basis for evaluation of ES on national and regional level is a detailed map of ecosystems called "Consolidated Layer of Ecosystems of the Czech Republic". CLES was based on a combination of a Habitat Mapping Layer (VMB) with other area data sources in the Czech Republic, especially ZABAGED (Basic Geographic Data Base), DIBAVOD (Digital Database water management data), UrbanAtlas and CORINE Land Cover (Vačkář et al. 2014). CLES comprises 41 main categories of ecosystems in four hierarchical levels and six wider types of ecosystems, that can be used on national or regional level (on basic scale 1 : 29 000). The ECOSERV database, that contains 197 values of ecosystem services, was prepared by systematic literature review with aim to collect input data on biophysical and economical values. Several selected values from database were used for a benefit transfer to calculate total ecosystem values in the Czech Republic (Frélichová et al. 2014).

In **Hungary,** mapping and assessment of ES (MAES) started with the project "Strategic investigations on the long-term preservation and development of the natural heritage of Community Importance and on the implementation of the EU Biodiversity Strategy 2020 objective" in 2016 led by the Ministry of Agriculture. The MAES-HU aimed to build up spatial databases of ecosystems and ES in Hungary, and assess them by biophysical, economic, and social indicators. Selected 12 ES were mapped and assessed. The methodology of the assessment was built on the guidelines of the EU MAES working group and technical reports of former national assessments of several EU member states. The evaluation of the prioritized ES was conducted in a four steps process along with the four levels of the cascade model: 1) condition of ecosystems, 2) capacity (potential supply) of the ecosystems for the selected ES, 3) actual use of the selected ES, 4) contributions of ES to human wellbeing. The MAES-HU was performed by six expert working groups, involving around 40 experts from different fields. The results of the MAES-HU project should assist to the sustainable management of environmental resources, the development of the green-infrastructures network, improved communication between different sectors, to incorporate the results into biodiversity and sectoral policies, and to reach the UN Sustainable Development Goals (Kovács-Hostyánszki et al. 2018).

In **Poland**, a nationwide preliminary mapping of ecosystems and ES assessment was ordered by the Ministry of Environment and conducted by UNEP-GRID Warszawa in 2015. The project had more objectives (e.g. determination of ecosystem types, analysis of the spatial distribution of ecosystem potentials to provide ES, development of indicators characterizing the level of ES provision/flow or analysis of the spatial distribution of ES). The map of ecosystem types has been developed (scale 1 : 2 500 000 showing spatial differentiation of ecosystem types in Poland). The assessment matrix contained a list of 63 ecosystem types and 34 ES and maps of ES assessment (scale 1 : 2 500 000) are presenting spatial differentiation of potential to deliver ecosystem services.

In **Romania**, the MAES process started in 2015 as part of the project "Demonstrating and promoting natural values to support decision-making in Romania" implemented by the National Environmental Protection Agency (NEPA) in collaboration with World Wildlife Fund - Romania (WWF), Romanian Space Agency (ROSA) and Norwegian Institute for Nature Research (NINA). Major results were achieved regarding mapping ecosystems at the national level and the selection of methods for ES assessment. All 9 major ecosystem categories existing on the national level were evaluated and 79 EUNIS level 3 classes were identified. Just 2 ES have been assessed in detail, but there is additional evaluation of other ES (more or less graphical). It also includes a monetary evaluation of selected ES based on foreign scientific papers.

In **Slovakia**, an expert working group MAES-SK was established under the Ministry of the Environment in 2014. In the period from 2017 to 2018 Slovakia was represented by the Ministry of the Environment of the Slovak Republic in the international project ESMERALDA. The project established a flexible methodology for mapping and assessing ecosystems and services provided by these ecosystems on a Pan-European, national and regional level. Then, an initial ecosystem map of Slovakia was prepared using data from various sectors e.g. nature protection, agriculture and forestry (see Černecký et al. 2020b). The map (at scales between 1 : 10 000 and 1 : 5 000) can be used for ES assessment, spatial planning, nature protection analysis, and other related purposes. In 2020, the Catalogue of Ecosystem Services in Slovakia was published (Mederly & Černecký 2020). It provides a summary of available theoretical and methodological knowledge and presents the findings of the first phase of a comprehensive ES assessment with the pilot evaluation of 18 ES. These partial works resulted in the publication The Value of Ecosystems and Their Services in Slovakia in 2020 (Černecký et al. 2020a). In the context of the entire territory of the Slovak Republic, this is the first assessment of individual ecosystems, both from a qualitative (biophysical) and quantitative (monetary) point of view. It uses an ecosystem approach, which is based on the state of ecosystems and the degree of their degradation. It assesses the capacity of ecosystems to provide selected 23 ES as well as their production. It brings a monetary evaluation of selected ES for individual ecosystems of Slovakia (EUR / ha / year) and an overall economic evaluation of ES provided at the national level. The overview and results of the MAES-SK process are described in the article of Mederly et al. (2020).

Chapter 2: THE ECOSYSTEM SERVICES ASSESSMENT PROCEDURE

This chapter focuses on outlining the appropriate procedure for the ES assessment. It is intended for use in various contexts and scales - contains the basic inputs, steps and outputs of the evaluation. The available approaches and methodical toolkits are used as inspiration; other recommended sources are also provided.

2.1 Basic ES assessment framework

In general, before embarking on an ES assessment, it is necessary to ask the **basic questions**, what is the main reason for the evaluation and what issues need to be addressed in a given specific situation (NESP 2016, Maes, Liekens & Brown 2018, Ruskule, Vinogradovs & Pecina 2018). For example, Preston & Raudsepp-Hearne (2017) provide a sequence of such questions as follows:

- Which ES are priorities in a given situation?
- What to measure or assess and which analysis tools to use?
- How are various ES produced and how do they interact with each other ecologically?
- How do ES benefit different groups of people (whether they are aware of it or not)?
- What are the values of these ES benefits to those groups of people?
- Are ES benefits increasing or decreasing over time?
- What are the likely effects of a project or policy on ES and associated ES benefits?
- How can specific policy objectives be achieved without undue negative impacts on important ES?

It is also necessary to clarify the **basic conceptual framework** of ES assessment - the extent to which the evaluation should focus on the individual main "boxes" of the so-called ES cascade model (Potchin & Haynes-Young 2011). Within the ecological assessment of a given territory, it is crucial to recognise the ecosystem categories, state of ecosystems, their structure, natural processes, function; and how they are affected by anthropogenic pressures and drivers. On the other hand, in a planning document such as a local development strategy, it is essential to know what benefits for people could be achieved by wise management of natural resources.

An example of such a framework gives e.g. Preston & Raundsepp-Hearne (2017) – see **Figure 2**. It shows that ES evaluation needs combining of the biophysical, socio-cultural, and economic information. The main goal is to reveal the processes of ES production and benefit distribution, the role of management and governance in affecting these processes, as well as the broader social and natural drivers of change that influence how ES are produced and managed.

A simplified conceptual framework of ES assessment expressing the links between society and nature through causal relationships in accordance with the often used DPSIR (Drivers – Pressures – State – Impact – Response) framework is presented at **Figure 3** (the relationships between ES and this framework is given e.g. by Rounsevell et al. 2010). It would be ideal if the ES assessment was comprehensive and included all components of the cascade (or the D-P-S-I-R sequence shown). However, this is often not possible or necessary – usually, the "D-R" and/or "R" components of the framework are not considered in the ES assessment. Before the evaluation itself, it is useful to "rethink" your own evaluation conceptual model and then adapt the content of the assessment steps.

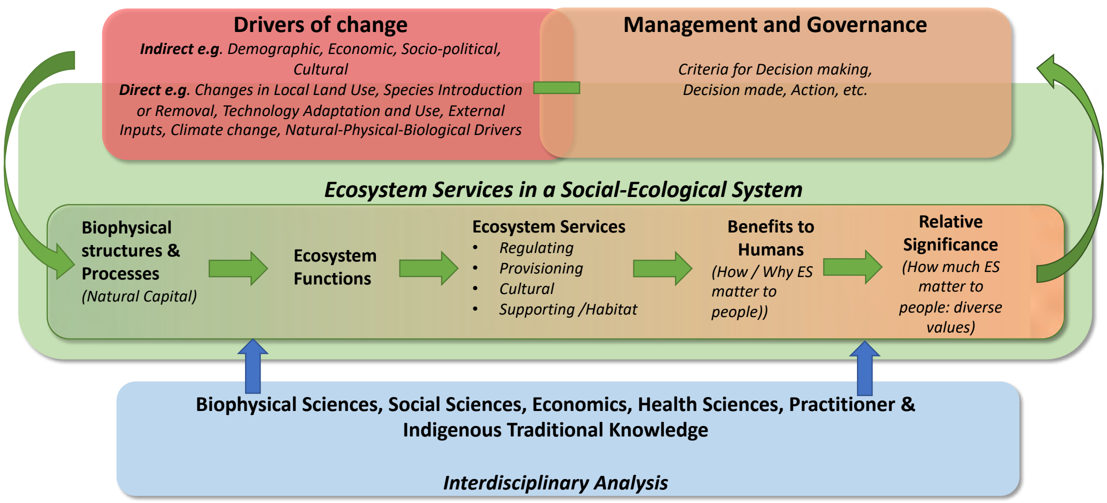

Figure 2 – Conceptual and analytical framework for the Canadian toolkit (Source: Preston & Raudsepp-Hearne 2017)

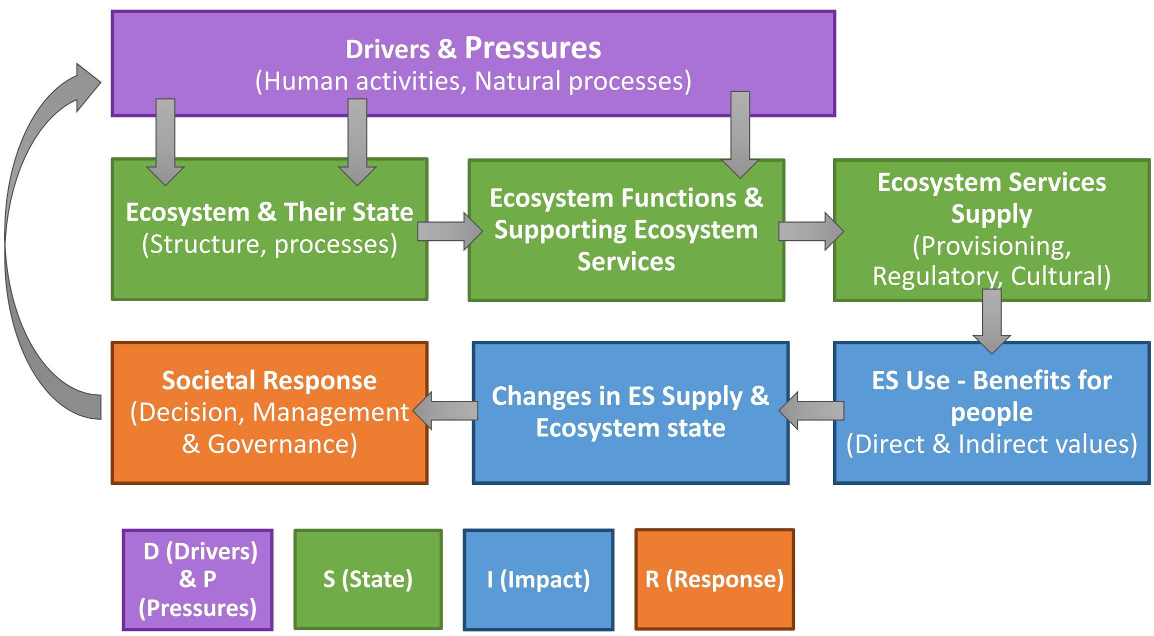

Figure 3 – Simplified DPSIR framework for ES assessment

There are several possibilities for how to design the process of ES evaluation in detail. For example, Canadian Ecosystem Services Toolkit could be considered as "a technical guide to ecosystem services assessment and analysis that offers practical, step-by-step guidance for governments at all levels, as well as for consultants and researchers" (Preston & Raundsepp-Hearne 2017). The proposed process distinguishes six basic steps and accompanies the researchers and practitioners with the task from the beginning of the process to its completion, using worksheets and tables. An overview of the proposed procedure is provided in Table 3. Note that these steps do not include the full final phase of the proposed process (phase C), they pass through phases A (steps 1-3) and B (steps 4-5). Final step 6 is only an introduction to the implementation phase of the process.

Table 3 - Six-step ES assessment framework (Source: Preston & Raundsepp-Hearne 2017)

Step 1. Defining the issue and context
• Setting up a lead team • Defining the issue(s) that are driving the assessment • Reviewing the key terms and considerations
Step 2. Identifying priority ES and beneficiaries for assessment
• Identifying priority ES and beneficiaries
Step 3. Identifying what needs to be evaluated to answer assessment questions
• Organizing assessment team and process • Identifying what will be evaluated to answer assessment questions
Step 4. Going into detail: Identifying and using indicators, data sources, and analysis methods
• Identifying which indicators are most relevant for assessing each ES • Identifying and gathering existing data sources or developing new data • Selecting and using analysis methods and tools to answer the assessment questions • Choosing analysis approach
Step 5. Synthesizing results to answer assessment questions
• Integrating and synthetizing results
Step 6. Communicating assessment outcomes
• Understanding what results mean and do not mean • Communicating results to different audiences • Distilling complex, integrated results into key messages

Within the LIFE EcosystemServices project in Latvia (NCAL 2020), an eight-step conceptual framework for integration of ecosystem services approach into planning processes was proposed (see Table 4). As seen, more emphasis is put on the ES economic valuation and the post-research steps (decision-making and implementation). This could be a proper approach in case of the need for practical assessment outcomes; it is in full accordance with our approach and the closest to the Carpathian Toolkit purpose and goals.

Table 4 – Eight steps of the Latvian approach to the ES assessment (Source: NCAL 2020)

Integration of ecosystem services approach into planning processes	
1.	Assessment of ecosystems (mapping of ecosystems and assessment of ecosystem condition)
2.	Assessment of ecosystem services (assessment and mapping of ecosystem services)
3.	Economic valuation of the ecosystem services (benefits of ecosystem services, determination of monetary, non-monetary value and trade-offs)
4.	Assessment of existing management and alternatives
5.	Involvement of stakeholders
6.	Support mechanisms
7.	Decision-making (support mechanisms, aggregating and integrating of information)
8.	Implementation and monitoring (Implementation of the concrete land use and management solutions; assessment of implementation)

Another relevant source of methodological guidance could be found e.g. in the *Local Integrated Planning Toolkit for Biodiversity and Ecosystem Services* report (Pierce 2014). In the case of integrated assessment and planning process, it emphasises the role of combining the knowledge from research and practice – see Table 5. The proposed stages are very similar to our approach – the difference is that Stage 1 is beyond the introductory phase of our framework. Such simplifying understanding is worth using in the "pure" practical and participative focusing of the assessment process.

Table 5 - Common stages for integrated planning

Corresponding planning stages		Complementary stages for multi-stakeholder, integrated planning		Barriers
Recognition of the problem		**Step 1**	Recognition of the problem systematically	Need to understand biodiversity loss as a significant problem that affects nearly all sectors
				Confusion about the root drivers of biodiversity loss
				Reflexive small-scale and isolated thinking
Desire for action		**Step 2**	Commonly held desire for action	Lack of awareness about potential benefits of diverse stakeholder involvement
				Culture of competition between interests
				Disempowerment of long-term and environmental interests
Ability to implement solution		**Step 3**	Coordinated implementation	Misallocated resources
				Mistrust of shared ownership outcomes
				Discomfort with cooperation-building organizational methods
				Lack of interactive feedback mechanisms

Within several European research projects oriented on the ES assessment and their practical implementation, at least two have great implementation potential: **OpenNESS** and **ESMERALDA** (for more information and outputs, see section 2.3). One of the outputs of the latter project is available as an online guidance tool ESMERALDA MAES Explorer[2] and provides directions on the process of mapping and assessment of ecosystem services. It has seven topics (Questions and Themes - see Figure 4), from which three are oriented on the "scoping" phase, two on the "appraisal" phase and two on the "implementation" phase. Each topic is briefly described and provides useful information and guidance through the process of ES assessment.

2 http://www.maes-explorer.eu/

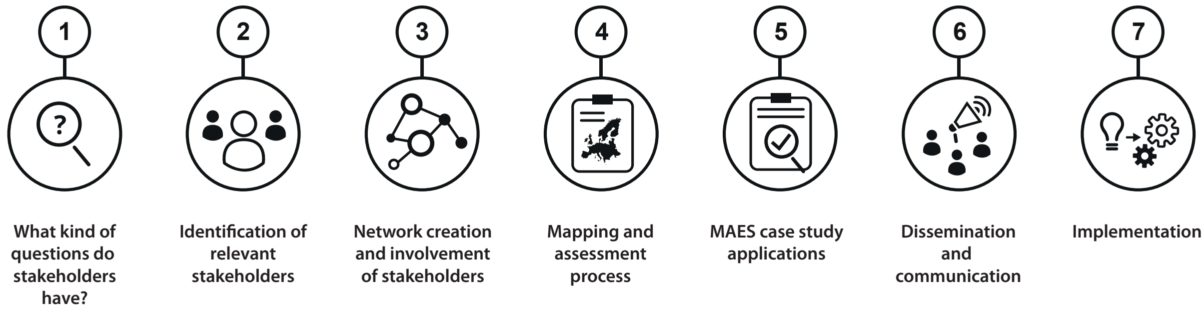

Figure 4 - Main Questions and Themes of ESMERALDA MAES Explorer (Source: http://www.maes-explorer.eu/)

2.2 Ecosystem services assessment phases and steps

2.2.1 Ecosystem services assessment

The ES assessment process itself contains the **main phases and individual evaluation steps (Figure 5)**. In the beginning, after clarifying the main purpose of the assessment, it is appropriate to implement the **"Scoping"** - a conceptual phase in which the individual steps and methods of evaluation are clarified. The main **"Appraisal"** phase follows, which is usually divided into several steps. The assessment process is completed by the **"Implementation"** phase, or at least by its initial step.

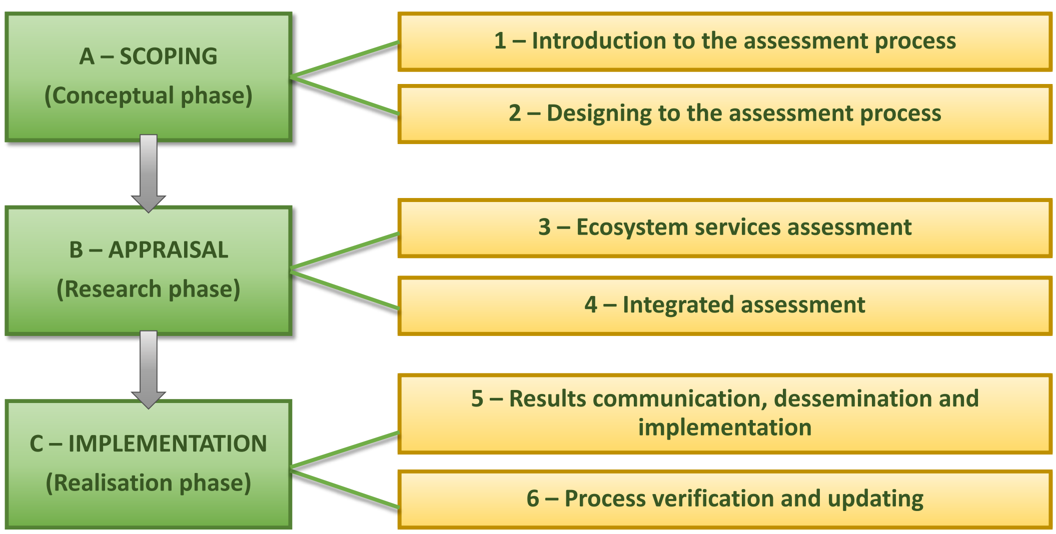

Figure 5 – ES assessment phases and steps

This procedure suggests that the "pure" scientific ES assessment is only part of the whole evaluation process (phase B). However, due to the applied nature of the ES concept, we emphasise that especially in the initial and final assessment phase (A, C) the participation of stakeholders operating in the concerned area is necessary. Without their involvement, ES assessment does not make practical sense. Such understanding is in accordance with e.g. the approach proposed by the US National Ecosystem Services Partnership (NESP 2016) or ICLEI ES toolkit (Pierce 2014). According to NESP, integrating ES consideration into the decision-making process requires changes through the decision process, particularly in the scoping and assessment phases - the full process requires stakeholder engagement. ICLEI, in turn, calls for multi-stakeholder integrated planning. Nevertheless, many examples of ES evaluation remain mainly based on expertise (phase B).

Figure 5 shows the main phases and steps of the proposed assessment process, which are more described in the following sub-chapter.

2.2.2 Brief description of the main phases and steps of ES assessment

In general, we recommend splitting the whole ES assessment process into three main phases. Each phase could consist of two main steps (topics), resulting in the outcome (written report or document) – see Table 6. The whole proposed process of ES assessment is briefly described in the following text.

Table 6 – ES assessment phases, steps and outcomes

Phase	Step	Milestone/Outcome
A - SCOPING (Conceptual phase)	1 - Introduction to the assessment Process	Introductory report (Terms of reference)
	2 - Designing the assessment Process	Procedure and methodology of the ES assessment (Scoping document)
B - APPRAISAL (Research phase)	3 - Ecosystem services assessment	Ecosystem services assessment Report
	4 - Integrated assessment	Integrated and/or context specific ES assessment report
C - IMPLEMENTATION (Realization phase)	5 - Results communication, dissemination and implementation	Implementation plan
	6 - Process verification and Updating	Monitoring & re-assessment report

Stage A – SCOPING (Conceptual phase)

The main aim of this stage is to set up the whole process of ES assessment and tailor it for the given context and purpose. Usually, the core team of researchers and key stakeholders are involved in this assessment phase. First, it is appropriate to carry out an initial review, which will set the basic framework for the evaluation. This step should end with a "terms of reference" document. The next step is scoping and planning the whole process, in which it is necessary to specify as precisely as possible: inputs and outputs of the process, selection of ES for evaluation, identification of target groups, research methodology, research team, specification of other practicalities. A comprehensive "scoping" document should complete the whole initial phase.

Step 1 – Introduction to the assessment process

- Identifying the purpose and needs of the ES assessment: context (policy support, planning, resource management, impact assessment, funding and investments, human well-being, knowledge base…), requested outcomes (Implementation measures? Planning outcomes? Measurable indicators?); schedule (long-term and mid-term results, short-term tasks); financial resources (for both assessment and implementation) … and other essential issues (depending on the project specifics)
- Creating the overall conceptual model for ES assessment
- Setting up the core research team (key researchers – e.g. team leader, natural science coordinator, social science coordinator, GIS and modelling expert, planning expert…) and stakeholder board (primary users, affected subjects, contracting authority, concerned agencies…)
- Preparing the terms of reference – main aim and partial goals of the assessment, schedule, planned outcomes, milestones, human resources, control mechanisms…

Milestone & Outcome 1 – Introductory report (Terms of reference)

Step 2 – Designing the assessment process

- Choosing the ecosystems and ecosystem services for assessment: their definition, context and importance
- Defining the target groups of the assessment: ES providers, ES users - beneficiaries, other affected groups
- Identifying the stakeholders and their roles in the process; involving key stakeholders in the research team
- Elaborating the methodology for ES assessment: assessment framework (capacity, demand, flow, balance); methodology for individual ES appraisal (data, methods, assessment procedures); integrated assessment methods and procedure
- Designing and completing the research team, refining the schedule and resources needed for the assessment
- Sharing the knowledge between the researchers and stakeholders, awareness-raising in the ES issue

Milestone & Outcome 2 – Procedure and methodology of the ES assessment (Scoping document)

Useful information sources for steps 1 and 2 (see also Section 2.3):

- Canadian ES Toolkit: Chapter 1: Foundations; Worksheets: W1 - Defining the issue and context; W2 - ES priority screening tool; W3 – Summarize screening / Confirm priority ES; W4 – Characterize the priority ES; W6 – Develop detailed ES assessment plan; W7 – Select relevant indicators to assess ES; W8 – Determine an approach to analysis methods and tools
- MAES Explorer, Theme 1: What kind of questions do stakeholders have? Theme 2: Identification of relevant stakeholders; Theme 3: Network creation and involvement of stakeholders; Theme 4: Mapping and assessment process
- ICLEI toolkit (Pierce 2014)
- NESP Guidebook and NESP toolkit
- ARIES methodology (Villa et al. 2014)

Stage B – APPRAISAL (Research phase)

The most time- and knowledge-consuming phase of the assessment. It is appropriate to carry out several research cycles carried out by researchers and their verification realised at joint meetings of researchers and stakeholders. The first step is focused on the evaluation of individual ES and their main groups (the level of detail and research methods should be specified in the scoping document), followed by the presentation of results to stakeholders, and their refinement according to comments with the creation of a detailed assessment report. The second step is a synthesis ES appraisal (integrated assessment), which should already be tailored to the requirements and needs of the end-users. The main outputs should be presented in the form of key-indicators of ES delivery. The main context-specific goals should be identified - for ES indicator values, pathways and measures to achieve them within the specified time horizon. The integrated assessment report will be the input for the final stage of the assessment.

Step 3 – Ecosystem services assessment

- Individual assessment of ecosystems, selected ES and their groups:
  - ecosystem mapping, assessment the state of crucial ecosystems
  - using appropriate methods (biophysical, socio-cultural, economic)
  - targeting different problem areas (ES capacity, ES demand, ES flows…)
  - synthesising main ES groups (provisioning, regulating & maintenance, cultural)
- **Communicating the results -** review of results, getting the stakeholder attitudes and requirements, compiling the information for integrated assessment
- **Refinement of the results -** elaborating the final output from the first assessment phase

Milestone & Outcome 3 –Ecosystem services assessment report

Step 4 – Integrated assessment

- Compiling the **requests and needs** for integrated and/or context-specific assessment – setting the process content and schedule based on assessment targets and needs (involvement of stakeholders)
- Elaborating the **integrated assessment** – e.g. balance between ES and their groups; ES hotspots (core areas) and coldspots (deficit areas), ecosystem disservices and their importance; monetary valuation (balance) of selected ES…
- Evaluating the selected key **socio-economic indicators of ES** – shifting from services to the benefit values (using monetary and non-monetary values)
- Elaborating the **context-specific outcomes** as a basis for the implementation process (policy support, planning, resource management, impact assessment, funding and investments, human well-being, knowledge base…)

Milestone & Outcome 4 – Integrated and/or context-specific ecosystem services assessment report

Useful information sources for steps 3 and 4 (see also Section 2.3):

- Canadian ES Toolkit: Chapter 2: Completing an ES assessment, Worksheets: W8 - Determine an approach to analysis methods and tools Worksheet, W9 - Synthesize analysis results
- MAES Explorer: Theme 4 Mapping and assessment process, Theme 5 MAES case study applications
- MESH ES modelling platform (USA)

- NEAT Toolkit (UK)
- NESP Guidebook; Overview of benefits assessment
- OPPLA marketplace: Methods, Topics
- LEED Toolkit: The Local Environment and Economic Development (Sunderland & Butterworth 2016)
- RESPA: The Rapid Ecosystem Services Participatory Appraisal (Rey-Valette et al. 2017)
- ARIES methodology (Villa et al. 2014)
- TESSA toolkit (Peh et al. 2013)

Stage C – IMPLEMENTATION (Realisation phase)

The final phase of the process is the implementation. In most of the projects, however, it is already "beyond the scope" of the assessment; nevertheless, we consider it essential for the successful conclusion of the entire process.

The content and extent of this phase depend on the assessment objectives and the expectations of users and key stakeholders. First, the results achieved by the ES assessment need to be communicated and disseminated across stakeholders. The implementation of the results means the realisation of the conclusions. It can be achieved in various ways - e.g. planning process, changes in decision-making and political priorities, specific measures and activities. For the process monitoring and feedback, it is appropriate to use particular indicators that help to verify the implementation and possible revision or restart of the assessment process. However, it must be acknowledged that this phase is rare - often the whole process ends with results communication and dissemination.

Step 5 – Results communication, dissemination and implementation

- **Communicating and disseminating** the final results – methods based on specific needs, stakeholder groups and local conditions. Emphasis: collaboration and mutual supporting effects of ES promotion for the whole community
- Setting the context-specific **framework for the implementation process** (main tasks and actions based on stakeholders' preferences, financing, schedule) – main issue for stakeholders, researchers as advisors

Milestone & Outcome 5 – Implementation plan

- **Implementation** of the actions and measures proposed by the final assessment and chosen for the realisation

Step 6 – Process verification and updating

- **Monitoring and verification** of the implementation process (e.g. using indicators) - collaboration between implementation agency and various stakeholder groups
- **Assessment the results**, periodical reporting & decision making

Milestone & Outcome 6 – Monitoring & re-assessment report

- **Feedback** – reassessing the process

Useful information sources for steps 5 and 6 (see also Section 2.3):

- Canadian ES Toolkit, Chapter 3: Addressing ES in different policy and decision contexts
- ICLEI toolkit (Pierce 2014)
- MAES Explorer: Theme 6: Dissemination and communication, Theme 7: Implementation
- OPPLA marketplace: Implementation
- Outcomes of the EU projects (OpenNESS, OPERAs, ESMERALDA)

2.3 Further reading - resources for the ES assessment process, methods and tools

Toolkits (methodical guidance):

- Preston & Raundsepp-Hearne (eds.) (2017). Canadian ES toolkit: https://biodivcanada.chm-cbd.net/documents/ecosystem-services-toolkit
- Olander et al. (2018). NESP toolkit: https://nicholasinstitute.duke.edu/project/ecosystem-services-toolkit-for-natural-resource-management
- NESP (2016). NESP guidebook: https://nespguidebook.com
- Pierce (2014). ICLEI toolkit: https://cbc.iclei.org/wp-content/uploads/2017/09/Mainstreaming-toolkit-1GA.pdf
- NCAL (2020). Latvian ES toolkit: https://ekosistemas.daba.gov.lv/public/eng/toolkit/
- NEAT (2014). National Ecosystem Approach Toolkit: http://neat.ecosystemsknowledge.net/ecosystem-services-tools.html

Websites (methods & data):

- ECOservice models library (US EPA) - Online ES modelling database: https://esml.epa.gov
- Ecosystem Knowledge Network (UK) – Environmental tools assessor: https://ecosystemsknowledge.net/tool
- IPBES Policy Support Gateway: https://ipbes.net/policy-support
- MESH - ES integrative modelling platform (WLE 2016): https://wle.cgiar.org/solutions/mapping-ecosystem-services-human-well-being-mesh
- OPPLA – European Union ES information repository: https://oppla.eu/
- USDA – ES assessment portal: https://www.oem.usda.gov/content/es-portal

OpenNESS project publications (http://www.openness-project.eu/library):

- Barton, Harrison (eds.) (2017); Braat et al. (2014); Gómez Baggethun et al. (2017)

ESMERALDA project publications (http://www.esmeralda-project.eu/documents/1/):

- Geneletti, Adem Esmail (2018); Geneletti, Adem Esmail et al. (2018); Haines-Young et al. (2018); Nikolova et al. (2018); Santos-Martín et al. (2018); Vihervaara et al. (2018)

EU projects case studies:

- ESMERALDA project: http://www.maes-explorer.eu/page/overview_of_esmeralda_case_studies
- OpenNESS project: http://www.openness-project.eu/cases
- OPERAs project: https://operas-project.eu/exemplars

Other publications:

- Burkhard, Maes (eds.) (2017): https://doi.org/10.3897/ab.e12837
- Burkhard, Maes et al. (2018): https://doi.org/10.3897/oneeco.3.e29153
- Burkhard et al. (2018): https://doi.org/10.3897/oneeco.3.e22831
- Maes et al. (2018): https://doi.org/10.3897/oneeco.3.e25309
- Neugarten et al. (2018): https://doi.org/10.2305/IUCN.CH.2018.PAG.28.en.

2.4 Examples of step by step ES assessment for policy and decision making

Chapter 2.2 presents the "ideal" procedure for the ES assessment in 3 stages and 6 steps recommended for the conditions of the Carpathian countries. However, either an incomplete process or a process focused on specific objectives is used in practice. Therefore, it is not easy to find an example that would apply the proposed "Step by step" procedure in practice. ES experts are also aware of ES assessment procedures' inconsistency, calling for the need for evaluation studies to compare empirical examples in terms of linking the ES assessment and decision-making process. Such an approach includes case studies of European projects OpenNESS and ESMERALDA (some general features provide e.g. Dick et al. 2018; Dunford et al. 2018; Geneletti et al. 2020).

The study of Geneletti et al. (2020) entitled "Ecosystem services mapping and assessment for policy- and decision-making: Lessons learned from a comparative analysis of European case studies" presents a comprehensive comparison of 14 ESMERALDA case studies (see Table 7) focused on mapping and evaluating the ES in different decision-making contexts, in different types of ecosystems and several spatial scales. This study specifically describes and critically analyses the main steps of ES mapping and assessment. Based on this, it formulates recommendations for each step of the ES mapping and assessment process. The research uses the ESMERALDA MAES Explorer conceptual framework[3] (see section 2.2) close to the Carpathian Toolkit approach. It considers the key stages of the ES mapping and assessment process - the comparison of case studies is going through the identification of relevant questions from policy, society and business, stakeholder involvement, follows then the procedures of ES mapping and assessment, dissemination and communication of the results and finally, it is dealing with the actual implementation in policy- and decision-making[4].

The following text provides an overview of the procedures and methods used in ESMERALDA case studies, following the proposed "step by step" assessment process. The information is based on the article by Geneletti et al. (2020) and case studies booklets[5].

3 http://www.maes-explorer.eu/

4 The full article is available at the link https://oneecosystem.pensoft.net/article/53111/

5 http://www.maes-explorer.eu/page/overview_of_esmeralda_case_studies

Table 7 - ESMERALDA case studies of ecosystem services mapping and assessment to support policy- and decision-making (Source: Geneletti et al. 2020)

Country	Case Study	Scale*	Area (km^2)
Belgium	Mapping green infrastructures and their ES in Antwerp	L	205
Bulgaria	Mapping and assessment of ES in Central Balkan area at multiple scales	L/SN	2 999
Czechia	Pilot National Assessment of ES	N	78 000
Finland	Green infrastructure and urban planning in the City of Järvenpää	L	40
Germany	Mapping ES dynamics in an agricultural landscape	L/SN	60
Hungary	ES mapping and assessment for developing pro-biodiversity businesses in the Bükk National Park	L	432
Italy	ES mapping and assessment for urban planning in Trento	L	156
Latvia	Mapping marine ES in Latvia	N	28 518
Malta	Assessing and mapping ES in the mosaic landscapes of the Maltese Islands	SN/N	316
Netherlands	ES-based coasted defense	L	810
Poland	ES in the biggest 10 Polish urban areas	L/SN	2 - 6 000
Portugal (Azores)	BALA – Biodiversity of Arthropods from the Laurisilva of Azores (Terceira Island)	SN	400
Spain	Spanish National Ecosystem Assessment	N	505 990
Sweden	ES mapping and assessment in the Videlälven-Juhtatdahka river valley	SN	13 300

** SCALE: L. Local; SN. Sub-national; N. National*

<u>**Step 1 – Introduction to the assessment process**</u>

- **Identifying the purpose and needs of ES assessment: context, requested outcomes**

  All ESMERALDA case studies provide support for the stakeholders in terms of **planning and decision making** (design and assessment of alternative planning actions in the urban, rural and natural areas while ensuring that impacts on ES are included and their equal provision for all citizens is provided) – roughly half of the studies are direct policy-orientated, the rest is more **science-orientated.**

  Within case studies, **9 policy areas are addressed** representing the variety of policy and planning processes, e.g. nature conservation and protected area planning; land use, green infrastructure and spatial planning; water resource protection and management; climate adaptation and energy policy; agriculture and forestry management; natural risk issues; business, industry and health issues.

  For most of the case studies, the context of **multi-functionality** is typical, as they addressed more than one key research question – about half of cases combined nature conservation and green infrastructure planning. Table 8 provides the context of the studies as an overview of addressed policy domains.

Table 8 - An overview of the policy domains (themes) addressed in the selected case studies (Source: Geneletti et al. 2020)

Case Study	EU-relevant Policy Domains								
	Nature Conservation	Climate, Water, Energy	Marine and Maritime Policy	Natural Risks	Urban and Spatial Planning	Green Infrastructure	Agriculture and Forestry	Business, Industry and Tourism	Health
Belgium		x		x	x	x			
Bulgaria	x			x	x	x	x	x	
Czechia	x			x					
Finland	x				x	x			x
Germany		x					x		
Hungary	x						x	x	
Italy		x			x	x			x
Latvia	x	x	x		x			x	
Malta						x	x		
Netherlands	x	x		x		x	x	x	
Poland	x	x		x	x	x	x	x	
Portugal (Azores)	x					x	x		
Spain	x								
Sweden	x				x	x	x	x	

- **Schedule & financial resources of ES assessment**

  Schedule and financing of the projects are case-specific. Regarding ESMERALDA case studies, most of them were realized earlier and financed by other European, national and local funding resources. It is also not real to find out the recommended schedule for the ES assessment process – it is based on the project's expectations and initial assignment. But generally, such a process took at least one year.

- **Creating the overall conceptual model for ES assessment**

  In most cases, no such model is explicitly stated. Generally, the well-known **ES Cascade model** is accepted as a theoretical background for problem framing. There is also an agreement on three **basic groups of research methods** used for the assessment process (biophysical, socio-cultural and economic) and on the **basic classification of ES** (3-4 main groups). The research model itself depends on the objectives and needs of the assessment.

- **Setting up the core research team**

  Most research teams are led by **natural scientists**, supplemented by **social science experts**. Representation of ecologists and biologists is essential; geographers, environmentalists, and spatial planning experts are also team members in most cases. The share of **economists** is low, which results from the limited use of economic evaluation methods. Ideally, the **experts from different science fields** should be represented within the core research team.

- **Preparing the terms of reference**

  No specific information is available on this point from the case studies. Such a step should be part of each project's setup, although it may not be in writing.

Step 2 – Designing the assessment process

- **Choosing the ecosystems and ecosystem services for assessment**

  This step is usually case-specific - based on the research topic, local conditions and main **ecosystem types** covering the areas. Within ESMERALDA cases, in overall 11 broad ecosystem types are distinguished. In some cases, assessing the **ecosystem state/condition** and identifying the ecosystems with critical ES shortages is realised (grasslands, forests and woodland were present in 11 cases). Half of the studies cover most types of ecosystems (see Table 9). On the other hand, the Italian case addresses only urban ecosystems and the Latvian study covers marine and coastal ecosystems.

  The **selection of ES**, setting their **importance** and research context, was mainly scientist-driven (based on experts' opinion) - only in 6 cases, the stakeholders were actively involved. Different ES classification systems are used, mostly CICES v. 4.3 (2013) and Millennium Assessment division (MEA 2005). The context-specific selection of ES usually covers **three main ES groups** – provisioning (9 studies), regulating (10 studies) and cultural (11 studies).

Table 9 - An overview of ecosystems condition assessment and ES selection (Source: Geneletti et al. 2020)

	Ecosystem type*											Ecosystem Conditions	Selection of ES		
Case Study	a	b	c	d	r	f	g	h	i	j	k	Assessed	Scientist-driven	Stakeholders-driven	Classification**
Belgium	x		x	x			x					Yes	x	x	CICES 4.3
Bulgaria	x	x	x	x	x	x		x				Yes	x		CICES 4.3
Czechia	x	x	x	x	x	x	x	x				No	x		MA (2005)
Finland	x	x	x	x		x		x				Yes (indirectly)	x	x	CICES 4.3
Germany		x	x	x				x				Yes	x		"KIEL"
Hungary	x	x	x	x	x		x					Yes	x	x	CICES VS.1
Italy	x											Yes (indirectly)	x	x	
Latvia									x	x	x	Yes	x		CICES 4.3
Malta	x	x	x	x	x	x	x			x		Yes (indirectly)	x		CICES 4.3
Netherlands		x					x	x	x	x		No	x	x	MA (2005)
Poland	x	x	x	x		x	x	x				Yes	x		CICES 4.3
Portugal (Azores)		x	x	x	x	x						Yes	x		CICES 4.3
Spain	x	x	x	x	x	x	x	x	x	x		Yes	x		MA (2005)
Sweden			x	x	x	x	x	x	x	x		Yes	x	x	CICES 4.3

** ECOSYSTEM TYPES: a. Urban; b. Cropland; c. Grassland; d. Woodland & forest; e. Heathland and shrub; f. Sparsely-vegetated land; g. Wetlands; h. Rivers and lakes; i. Marine inlets and transitional waters; j. Coastal; k. Shelf.*
*** ES CLASSIFICATION: CICES 4.3 and 5.1. - Common International Classification of ES (version 4.3 and 5.1); MA. Millennium Ecosystem Assessment; KIEL. Kiel own classification of ES.*

- **Defining the target groups of the assessment**

  Within the ESMERALDA case studies, setting the assessment target groups was influenced mainly by the study's **political domain** (see Figure 8). That means the **principal audience** could be characterized as local and regional administration officers, planning agencies, landscape and land-use managers.

  Both **ES providers and users** were addressed as a target group of the assessment process mainly indirectly. The representatives of agriculture, forestry, water management and nature protection belong mainly to the common providers. Some of the case studies also addressed the ES provision **beneficiaries** - mostly inhabitants living in case study areas (representing the general public) and visitors (involved through questionnaires and online tools).

- **Identifying the stakeholders and their roles in the process**

  Representatives of **four basic categories of stakeholders** are involved within ESMERALDA case studies: (1) **competent authorities** for the specific policy area (e.g. decision-makers at different levels and people working for governmental agencies), (2) **ES experts and specialists** (other than those from research teams), (3) **business sector** (concerned people from different sectors – e.g. agriculture, forestry, industry) and (4) **general public** (represented often by people from environmental NGOs). Stakeholders from authorities and experts are involved mostly in all studies, business and public are represented in five cases. Only three studies have successfully involved all categories of stakeholders (see Table 10).

  The **level of stakeholder involvement** in the case studies elaboration is different. The lowest involvement levels representing the stakeholders' information and mutual consultations were successful in most cases. Direct involvement and collaboration within the project are successful in nine cases. Only one study (Latvian) reports the stakeholders' full involvement, including their real empowerment within the decision-making process.

Table 10 - An overview of the stakeholders and their involvement in the case studies (Source: Geneletti et al. 2020)

	Involved stakeholders				Level of involvement				
Case Study	Competent authorities	Other experts	Business sector	General Public	Inform	Consult	Involve	Collaborate	Empower
Belgium	x	x			x		x	x	
Bulgaria	x	x			x	x	x	x	
Czechia	x				x			x	
Finland	x	x		x	x	x	x	x	
Germany	x			x	x				
Hungary	x	x	x	x	x	x	x	x	
Italy	x	x			x	x	x	x	
Latvia	x	x	x	x	x	x	x	x	x
Malta	x	x			x	x			
Netherlands	x	x	x		x	x	x	x	
Poland	x				x	x			
Portugal (Azores)	x	x	x		x	x		x	
Spain	x	x	x	x	x	x	x		
Sweden	x	x			x	x	x		

- **Elaborating the methodology for ES assessment**

  No specific information is available about the elaboration of an assessment methodology within the ESMERALDA case studies – in all cases is this process depending on the **scientific background and composition of the research team**. Table 11 gives an overview of the used methods in all case studies - as a whole, 29 mapping and assessment methods were used. All cases apply biophysical methods; 5 cases use socio-cultural methods; only Czech and Spanish cases apply economic methods for the assessment of the crucial ES. **Diverse approaches and methods** are used at various spatial levels and contexts. In most cases, the methods are combined for obtaining partial and also final results. For such purposes are used, e.g. normalisation to a common qualitative scale (Bulgaria), multi-criteria analysis (Finland, Italy, Latvia), or interactive web-tool (Belgium).

Table 11 - An overview of selected ES analysed in the case studies and related methods (Source: Geneletti et al. 2020)

Country	ES	CICES class	Applied Method*	Type
Belgium	Filtration/sequestration/storage/accumulation by ecosystems	(2.1.2.1)	Spatial proxy method (expert scoring)	Biophysical
	Physical use of land /seascapes in different environmental settings	(3.1.1.2)	Spatial proxy method (expert scoring)	Biophysical
Bulgaria	Surface water of drinking	(1.1.2.1)	Process-based models (swat)	Biophysical
	Aesthetics	(3.1.1.5)	Photo elicitation surveys	Social
Czechia	Surface water for drinking	(1.1.2.1)	Value (benefit) transfer	Economical
	Global climate regulation by reduction of greenhouse gas concentrations	(2.3.5.1)	Integrated modelling frameworks (invest)	Biophysical
	Entertainment	(3.1.2.4)	Integrated modelling frameworks (estimap)	Biophysical
Finland	Education	(3.1.2.2)	Participatory GIS	Social
	Multiple ES	*Multiple ES*	Integrated modelling framework (spatial multi-criteria decisions analysis)	Biophysical
Germany	Plant-based (energy) resources	(1.3.1.1)	Spatial proxy methods	Biophysical
	Buffering and attenuation of mass flows	(2.2.1.2)	Integrated modeling frameworks (Giscame)	Biophysical
	Educational	(3.1.2.2)	Narrative assessment	Social
Hungary	Animals reared to provide nutrition, fibers and other materials	(1.1.1.2, 3.2.1.2)	Spatial proxy methods (rule-based matrix model)	Biophysical
	Touristic attractiveness of nature	(3.1.1.1, 3.1.1.2)	Spatial proxy methods (rule-based matrix model)	Biophysical
Italy	Micro and regional climate regulation	(2.3.5.2)	Process based methods	Biophysical
	Physical use of land /seascapes in different environmental settings	(3.1.1.2)	Integrated modelling frameworks (ESTIMAP recreation model)	Biophysical
Latvia	Wild plants, algae and their outputs	(1.1.1.3)	Spatial proxy methods	Biophysical
	Maintaining nursery populations and habitats	(2.3.1.2)	Spatial proxy methods (spreadsheet method)	Biophysical
	Experiential interactions – Physical use of landscapes/ seascapes in different environmental settings	(3.1.1.1+ 3.1.1.2)	Integrated modelling frameworks (multi-criteria ES assessment model)	Biophysical
Malta	Reared animals and their outputs	(1.1.1.2)	Preference assessment	Social
	Pollination and seed dispersal	(2.3.1.1)	Spatial proxy methods + field data	Biophysical
Poland	Filtration/sequestration/storage/accumulation by ecosystems	(2.1.2.1)	Spatial proxy methods	Biophysical
	Physical use of land/seascapes in different environmental settings	(3.1.1.2)	Spatial proxy methods	Biophysical
Portugal (Azores)	Pollinations and seed dispersal	(2.3.1.1)	Macro-ecological models	Biophysical
	Maintaining nursery populations and habitats	(2.3.1.2)	Macro-ecological models	Biophysical
Spain	Cultivated crop	(1.1.1.1)	Market price methods	Economical
	Surface water for drinking	(1.1.2.1)	Integrated modelling frameworks (invest)	Biophysical
Sweden	Reared animals and their outputs	(1.1.1.2)	Participatory GIS	Social
	Experiential (physical) use of plants, animals and landscapes	(3.1.1.1 & 3.1.1.2)	Intergrade modelling framework (integrated monitoring data gam-modelling framework)	Biophysical

- **Designing and completing the research team, refining the schedule and resources**

- **Sharing the knowledge between the researchers and stakeholders**
  No related information is available from the case studies assessment. However, these steps are the **natural completion of the first stage** of most projects.

<u>**Step 3 – Ecosystem services assessment**</u>

- **Individual assessment of ecosystems, selected ES and their groups**
  During the ESMERALDA project, all case studies were evaluated and compared regarding the used methods and results. As specified in step 2, a whole range of methods are used for the individual ES assessment and the results' expression (for more information, see the case studies booklets). Nevertheless, it is possible to specify some commonalities.

  All cases highlight the crucial importance of ecosystems, their properties and state for ES provision. For such purpose, most cases use indicators on ecosystem conditions, relevant for different ecosystem types in the study area. The selection of indicators and assessment methods depends mainly on the data availability and expertise of researchers. On the other hand, it was considered as useful involving stakeholders and using local knowledge at this research stage.

  The ES assessment process was based on the above-mentioned research scope and methods used in case studies. Most of the methods are scientifically based, with a specific demand for expertise and time. This is a real playground for the researchers. As seen in Table 11, the most used are **biophysical methods**; the share of **socio-cultural methods** with direct or indirect inputs of stakeholders and/or concerned citizens is relatively low. The representation of economic methods and experts is even rarer, which points to the complexity of incorporating this issue into the ES concept. The market price and benefit transfer method were the only used in the case studies.

  In terms of ES provision, most of the studies use the concept of **ES capacity and/or real flow**. Capacity is expressed mostly in the qualitative scale (e.g. from low to high, from 0 to 5), in the biophysical units (resource stock, polluting substance absorption level etc.) or in the financial value of the service. Real flow is usually connected to the statistical data about the real extraction of the resources or specific service use. The problem of **demand for ES** is omitted in most studies – it needs stakeholders' input (as, e.g. in Italian or Latvian study).

  After assessing individual ES, there is usually a need for the **comprehensive assessment or synthesis** of ES bundles, groups or the whole ES spectrum. This problem turns out to be very complex due to **synergies or trade-offs** between most of ES. It could be relatively easy to present the synthesis within the ES economic valuation (as in the case of the Czech Republic) by summing individual ES values. However, this is only a theoretical value, which does not address trade-offs, as some ES are mutually exclusive. Therefore, most of the case studies remained at the individual ES assessment level, or their bundles evaluated for specific purposes and policies. However, in the background of some cases is a national ES assessment, which is more extensive than the case study presented (e.g. Spain, Malta) and which should also provide a synthesis.

- **Communicating the results**

  Generally, the ES assessment should be understood and accepted not only by researchers but also by involved stakeholders. Therefore, the presentation of the results and their shared understanding is essential.

  As only preliminary results could be presented at this stage of the research, it is usually done during **project meetings and workshops**. The main goal of such events is obtaining the **attitudes of concerned stakeholders** about the results and gathering their requirements for integrated ES assessment.

<u>**Step 4 – Integrated assessment**</u>

- **Compiling the requests and needs for integrated and/or context-specific assessment**
- **Elaborating the integrated assessment**

  The original **"Integrated Ecosystem Service Assessment Framework"** was developed within the ESMERALDA project (Nikolova et al. 2018) and used to compare the case studies. The studies have confirmed the importance of integrating methods and results for the real use of the ES approach when integrating different perspectives (nature, society, economy). With such integration, also the value and credibility of the results are rising. The reason for the integration (besides the policy relevance) is the need to analyse trade-offs, synergies, and interactions amongst the different ES.

  More than half of ESMERALDA case studies (8 from 14) use **integrated modelling framework methods** – mainly with the biophysical background and the inputs of social and economic methods. The most used are spreadsheet method (relatively simple spatial matrix), Multi-Criteria Analysis and spatial modelling approaches.

- **Evaluating the selected key socio-economic indicators of ES**
- **Elaborating the context-specific outcomes as a basis for the implementation process**

  This step is in most cases **beyond the ES evaluation process** - the potential of such measures is not yet fully recognised and used.

  Key indicators are mainly used in the case of **direct application of results** for specific purposes of planning and practice. It was the case of the Finnish, Italian and Lithuanian studies, which directly entered into the planning documents - urban spatial plans, respectively Maritime spatial plan. Mostly, the non-monetary values are used for expressing the key indicators for the ES implementation.

Step 5 – Results communication, dissemination and implementation

- **Communicating and disseminating the final results**

  ESMERALDA case studies overall use three main types of dissemination and communication of the results. For the research results, the basic way is the publication of **scientific articles/reports** or communication at conferences or similar events. Such methods were used for most studies (11 from 14). Addressing the relevant **competent authorities** (decision-makers, people working in agencies) is the second way (e.g. through policy briefs, reports and meetings) – it was realized in all cases (excluding Germany). Thirdly, in about half of the studies, the **general public** was addressed (through newspaper articles, social media and documentaries).

  Table 12 provides an overview of the dissemination and communication of the case studies results.

Table 12 - An overview of the dissemination and communication activities in ESMERALDA case studies (Source: Geneletti et al. 2020)

Case Studies	Dissemination and communication activities		
	Scientific publications	D&C to competent authorities	D&C to general public
Belgium		x	x
Bulgaria	x	x	
Czechia	x	x	
Finland	x	x	x
Germany	x		
Hungary		x	x
Italy	x	x	
Latvia	x	x	
Malta	x	x	x
Netherlands	x	x	
Poland	x	x	(Partially yes)
Portugal (Azores)	x	x	
Spain	x	x	x
Sweden		x	(Partially yes)

- **Setting the context-specific framework for the implementation process**
- **Implementation of the actions and measures**

  An appropriate **five-degree framework for expressing the degree of implementing the results** presents Ruckelshaus et al. (2015) - this framework is also used for ESMERALDA case studies comparison. The scale expresses the raising impact and implementation level (see Table 13).

  Some of the ESMERALDA case studies represent **good ES implementation examples** in different policy- and decision-making contexts. The highest level is reached by urban planning cases – only Belgian study of green infrastructure planning in the city of Antwerp reported a complete 5-stage implementation level.

A high implementation level is also reached within the Italian case (ES mapping and assessment for urban planning in Trento), and the Finnish case (ES as a part of urban and green infrastructure planning in the city of Järvenpää). Close to the practice implementation is also the Latvian case study involving ES mapping and assessment as a part of the official national maritime planning process. In the Hungarian case, ES approach is used for participatory local action planning at the local level.

On the other hand, some studies also reported **barriers for implementation** – e.g. lack of data and research-based evidence, land ownership as a critical barrier, or poor understanding of the administrative procedures by the researchers.

Table 13 - An overview of the impact on policies and decisions of the ES mapping and assessment process in the case studies (Source: Geneletti et al. 2020)

Case Studies	Increasing Level of Impact				
	(i) People aware of, understand and discuss ES	(ii) Stakeholders focus on ES and articulate different positions	(iii) Alternative choices based on ES mapping and assessment	(iv) Plans & policies consider ES mapping and assessment	(v) New policy and finance mechanism established
Belgium	x	x	x	x	x
Bulgaria		x	x		x
Czechia				x	
Finland	x	x	x	x	
Germany					
Hungary	x	x	x		
Italy	x	x	x	x	
Latvia			x	x	
Malta	x	x			
Netherlands					
Poland				x	
Portugal (Azores)		x		x	
Spain			x	x	
Sweden			x	x	

Step 6 – Process verification and updating

- **Monitoring and verification of the implementation process**
- **Assessment the results, periodical reporting & decision making**

As stated in section 2.3, **this step is rare** within the ES assessment procedure. Also, ESMERALDA case studies did not have such a topic elaborated. Most of them reached the communication and dissemination of the results, in some cases also the implementation process began (mostly as a part of planning documents).

Nevertheless, we consider monitoring, verification the implementation process and (in case of necessity) also updating the results and proposed measures as **essential for the successful and complete implementation** of the ES approach in practice.

Chapter 3: ADDRESSING ECOSYSTEM SERVICES IN DIFFERENT POLICY AND DECISION CONTEXTS

3.1 Introduction

Governments around the world are increasingly considering the ES assessment and its associated analyses to inform their policies, decisions, and management practices. The ES approach requires the understanding of the ecosystem functions, how those functions generate ES, and how the benefits from ES are distributed within the society. With the use of such approach, it will therefore be possible to identify the consequences of the environmental change as well as to study how the environmental management decisions can enhance, diminish or maintain the flow of the ES benefits (Preston & Raudsepp-Hearne 2017). In the EU, the concept of the ES is seen as a key action for the advancement of biodiversity objectives as well as for the development and implementation of the related policies on water, climate, agriculture, forest, marine and regional planning (Maes et al. 2016). Although we already have a number of examples of studies on ecosystem services, their inclusion in policy documents remains a challenge. Practical experiences of mapping and assessment of the ES in different EU contexts (14 case studies) and policies are discussed by Geneletti et al. (2020). They represent the different policy- and decision-making processes, across a wide range of themes, biomes and scales.

This chapter thus aims to enhance the understanding around the application of the ES mapping and assessment for policy- and decision-makers. For this purpose, we have identified the nine policy domains within the EU (Geneletti et al. 2020): Nature Conservation; Climate, Water and Energy; Marine and Maritime Policy; Natural Risk; Urban and Spatial Planning; Green Infrastructure; Agriculture and Forestry; Business, Industry and Tourism; Health. These domains were selected since they were suggested to be as the main challenges in the current policy and decision-making domain in Europe.

Regarding the Carpathian conditions as well as our personal focus on nature and biodiversity specifically, we have also defined the following areas as those of utmost importance to this paper: nature conservation (chapter 3.2), urban and spatial planning (chapter 3.3), and green infrastructure, agriculture and forestry (included in chapter 3.5). We pay special attention to the involvement of stakeholders in this process (chapter 3.4).

The so-called "mainstreaming" of ecosystem services in policy and decision-making shows various ways that human well-being is dependent on ecosystems, and how human well-being is affected by changes in the environment. This inclusion of the ES into the policy context we discuss in chapter 3.5.

3.2 Nature and landscape protection

The definition of landscape in the recently proposed ES glossary by Potschin et al. (2014) does not place sufficient emphasis on the interactions between natural and human processes: "A heterogeneous mosaic of land cover, habitat patches, physical conditions or other spatially variable elements viewed at scales relevant to ecological, cultural-historical, social or economic considerations". According to this definition, a landscape can be an area of (widely) varying size that for various reasons is relevant to consider a coherent unit. Besides recognizing that a landscape can have ecological, cultural, social, and economic importance, this indicates that landscapes can have varying spatial extent.

The ecosystem service concept has a great potential to be applied in landscape planning, which aims at enhancing, restoring or creating landscapes and related services. This is demonstrated by the German landscape planning practice, which involves the analysis of the current state of landscape concerning a set of landscape functions and its capacity to fulfil human demands.
According to de Groot et al. (2010), there are some main research questions, related to specific steps that can be followed, in need to be resolved in order to better integrate ecosystem services in landscape planning, management and decision-making:

1) Understanding and quantifying how ecosystems provide services

- What is the state-of-the-art regarding the typology of ecosystem services?
- How can the relationship between landscape and ecosystem characteristics and their associated functions and services be quantified?
- What are the main indicators and benchmark-values for measuring the capacity of an ecosystem to provide services (and what are maximum sustainable use levels)?
- How can ecosystem/landscape functions and services be spatially defined (mapped) and visualized?
- How can relationships between ecosystem and landscape character and services, and their relevant dynamic interactions, be modelled?
- What is the effect of (changes in) dynamic conditions (temporal and spatial) of landscape functions on services, in terms of sustainability and resilience? Are there possible critical thresholds?

2) Valuing ecosystem services

- What are the most appropriate economic and social valuation methods for ecosystem and landscape services, including the role and perceptions of stakeholders?
- How to make an economic and social valuation of landscape and ecosystem services consistent and comparable?
- What is the influence of scaling-issues on the economic value of ecosystem and landscape services to society?
- How can standardized indicators (benchmark-values) help to determine the value of ecosystem services and how can aggregation steps be dealt with?
- How can values (ecological, social and economic) be mapped to facilitate the use of ecosystem services in (spatial) landscape planning and design?

3) Use of ecosystem services in trade-off analysis and decision making

- How can all the costs and benefits (ecological, socio-cultural and economic) of changes in ecosystem services and values of all stakeholders (in time and space), be taken into account properly in discounting and cost-effectiveness issues?
- How can analytical and participatory methods be combined to enable effective participatory policy and decision-making dialogues?
- How can spatial and dynamic ecosystem services modelling be linked to participatory trade-off assessment methods to optimize multi-functional use of the "green and blue space"?
- How can landscape design-alternatives be visualized and made accessible for decision-making, e.g. through expert systems and other decision and policy support tools?

4) Use of ecosystem services in Planning and Management

- How to incorporate resilience of landscape functions, and thresholds of service-use, into methods for landscape planning, design and management of 'green and blue space'?
- What are the main bottlenecks in data availability and reliability with regard to ecosystem services management and how can they be overcome?
- What is the relationship between ecosystem management state and the provision of ecosystem services (both on individual services and the total mix of ecosystem services)?

5) Financing sustainable use of ecosystem services

- What is the adequacy of current financing methods for investing in ecosystem and landscape services? How can they be improved (and linked to valuation-outcomes)?
- How to communicate ecosystem and landscape services, and their social and economic importance, to all stakeholders?

Focusing of biodiversity conservation legislation and policy on ecosystem services appears to provide a mechanism by which the integration of biodiversity conservation into other policy sectors might be achieved.

From a conservation perspective, it is clear that we need to gain a more comprehensive understanding of the relationships between biodiversity conservation actions and ecosystem service delivery. This is in order to avoid the risk of policy bias by focusing on a subset of ES which are easier to quantify such as food, water and climate regulation at the expense of those ES that are more difficult to quantify (Maes et al. 2012).

3.3 Spatial planning and environmental impact assessment

This section illustrates how ES considerations could be integrated into spatial or territorial planning and environmental impact assessment (EIA or SEA).

3.3.1 ES assessment and spatial planning

The obligation, content and methodology of spatial/landscape planning differ across European countries. Documents for the spatial/landscape planning are prepared for various territorial levels (from municipality to federal). Therefore, it is difficult to design a common model from which several countries would draw. Taking into consideration the spatial planning (i.e. in Slovakia), it can be stated that it is an evaluation of the current state of the landscape and its natural elements, which are perceived statically. However, natural capital – mainly ecosystems are dynamic and the benefits which they provide to people change over time. For the involvement of ecosystem approaches in spatial planning, it is important to take into account recent development in land use and at the same time determine its possible future development, based on the preferences of residents, stakeholders or business activities. The existing spatial/landscape planning system considers administrative boundaries, while natural capital with ES supply and demand do not respect artificial boundaries e. g. specific ES as many regulatory services are generated in one area and at the same time "consumed" in another.

The ecosystem services concept should be projected to the spatial/landscape planning by improvement and changes in the approach to planning in decision making, urban development and future investments. The first step involves the analysis of ecosystems and their current condition, especially the assessment of the capacity to fulfil the human demand provided by certain ecosystem services.

The main inputs of the ecosystem services mapping and assessment to the spatial planning (Ruskule et al. 2018):

- Identification of ecosystems, their current condition, assessment of ES potential and supply on selected spatial planning areas, especially identification of "hotspots" areas with the highest potential and supply of ES.
- Evaluation of ecosystems' sensitivity to a particular impact related to planning proposals/decisions, which might require planning solutions for their conservation or restoration.
- Evaluation of the planning activities and projects on ecosystems, their conservation status and ES potential/supply.
- Cost/benefit analysis of ES potential/supply and relevant planned activities, development projects (very relevant are GIS analysis with map outputs).
- Highlighting and map visualization of areas where ES potential/supply is significant; the combination of ES maps with actual use of ES.
- Integration of local stakeholders and decision-makers into spatial planning processes by communicating the overall benefits and disadvantages of the planning proposal with a special focus on ecosystems and planned changes to the state of ecosystems, which are related to the overall quality of providing necessary ES on the local, regional and national level.

- Special emphasis should be dedicated to the integration of citizens in the planning and decision making, due to their local knowledge related to land use and ecosystems, as well as a conducted survey of citizens' preferences of land use and/or preservation of existing ES, and identification of ES, which are the most important for their well-being.

According to the Preston & Raundsepp-Hearne (2017), the ES assessment should be integrated into the existing land use planning steps:

Table 14 - Land use planning steps

Spatial/Land Use planning	Considering ecosystems and their services
Survey of current conditions of the environment, society, economy, and governance structures; identify data gaps and resource needs	Survey of identification of ecosystems, their current conditions; identify data gaps and resource needs
Qualify goals and objectives based on human activities	Qualify goals and objectives in way of ecosystems conservation and restoration
Analysis of gaps and needs	Analysis of ES potential or/and supply, demand – ES maps
Completing the analyses	Definition of indicators to evaluate ES supply and demand, analyse the trade-offs between ES provision and other land use plans
Definition of scenarios, alternative opinions, and their evaluation	Scenarios of future supply and demand of ES
Involvement of decision-makers and selection of preferred opinion	Integration of citizens and decision-makers and selection of preferred opinion
Develop official plan document and develop implementation and monitoring plans, if relevant associated policies	
Implementation, monitoring, and evaluation	

3.3.2 ES assessment and environmental impact assessment

Environmental impact assessment (EIA) was one of the first instruments to proactively identify and assess the consequences of human actions on the environment and to avoid irremediable consequences. Today, EIA is the process of identifying, predicting, evaluating and mitigating the biophysical and other relevant effects of development proposals prior to major decisions being taken and commitments made (IAIA & IEA 1999). Both, EIA and SEA help to prevent, reduce or avoid the negative impact of planning projects or developments in different scopes – such as dams, airports, highways, transmission lines, power plants, large industries, urban infrastructure developments and irrigation projects. EIA can be defined as a process of evaluating the environmental impact of planning/future projects or developments with the involvement of relevant stakeholders, as well as local communities.

According to Slootweg & Van Buekering (2008) assessment of ES in the EIA/SEA process should have a lot of benefits as the following (based on 20 case studies): a. Recognizing of ES will enhance the transparent and engaged impact assessment process; b. In the early processes of impact planning, the recognition of ES and identification of stakeholders can provide important clues and can help to highlight the poverty and equity issues; c. Valuing ES supports the financial sustainability of environmental and resource management, promotes the social equity issues and provides a better view into the long and short-term trade-offs of planning decisions; d. Expression of ES in monetary units puts biodiversity considerations on many decision-makers´ agenda. Politicians may react more positively once they realize that environmental services have an economic value; e.g. SEA/EIA involves stakeholders and decision-makers in its processes and urges them to take valuation results into account.

The legislation and practices in the EIA process differ around the world, but the fundamental components of the EIA process are mentioned in guidelines created by CBD (SCBD & NCEA 2006) and Slootweg et al. (2010). The screening stage is about determining which projects or developments have to be a subject of EIA. This stage is usually legally given. The scoping part of the EIA process mainly identifies which potential impacts are relevant to be assessed. Another important part of the scoping stage is the foundation of alternative solutions that avoid, mitigate or compensate for negative effects on biodiversity. Both analyses are usually based on legislative requirements, international convention, expert knowledge or stakeholder involvement. This stage of EIA process has to lead to derive terms of reference for the impact assessment. The next step is an environmental statement and environmental management plan. In other words, this stage is about the identification or prediction of environmental impacts of planning projects, as well as detailed evaluation of alternatives that result in an EIA report. The fourth stage is review and promotion of EIA reports within different involved stakeholders including authorities and other public audiences. The fifth step in the EIA process is about decision-making whether the proposal project should be realised or should not. The following step is monitoring during project implementation and implementation of the environmental managed plan.

From the point of view of identification and assessment of ESs, the EIA´s stages screening and scoping are the most important. According to Wittmer (2010), one of the main questions in the *scoping part* of EIA is whether the proposed project should harm important ES. And subsequently on this question is needed to prepare the map of ecosystems or map of ecosystem services and link them to stakeholders and beneficiaries, as well as other public. Furthermore, the monetary value of ES which should be influenced by planning projects would be very important during the discussion with stakeholders. The example of ES provided by the ecosystem also shows Appendix 2 in Slootweg at al. (2006).

Based on Slootweg at al. (2006) during the *screening process*, it should be identified whether the proposed project surpasses the carrying capacity of related ecosystems and the maximum allowable disturbance of resource, population or ecosystems. In other words, the evaluation of which ES will be affected, the extent of their affection, who actually benefits from these ES and how the proposed project affected the user of these ESs. One of the recommended first steps of the screening stage is a biodiversity screening map (created by experts in relevant fields and legally approved) which promote ecosystem services in geographically defined areas. If there is scientific research about the types of ecosystems in the selected area in which the proposed project should be realised, it is possible to assess the related services. There are several methods used to evaluate the capacity or supply of ecosystems to provide services which are mentioned in Chapter 1.3.

Another view on the basic recognizable levels of ES assessment methods is provided by Slootweg & Van Buekering (2008): 1. *Identification of ES* – the list of ES from the qualitative point of view can easily influence the future planning project and decision-making processes because the identification of ES should bring a new view on the topic that had been overlooked as well as stakeholders. 2. *Quantification of ES* – using a quantitative scale (e. g. -2, -1, 0, 1, 2) to express different capacities of ecosystems to provide certain ES can be easily understood by stakeholders and decision-makers and on the other hand, the different alternatives of impacts of proposed projects can be easily compared. 3. *Social valuation of ES* – many benefits from ecosystems can be expressed in the social-cultural, socio-economic or ecological way. For example, number of workplaces related to service, amount of final products, and number of inhabitants that benefit from specific ES. From the ecological aspect, the number of protected species or habitats (national importance, European interest – under Habitats Directive or species in red lists). 4. *Monetary valuation of ES* – economic valuation of benefits provided by ecosystems is one of the most complicated methods, but it is also the most comprehensive and provides a comprehensive picture of the true value of a given ESs. At the same time, it is an expression of the value of ES in the units that people understand best. The monetary assessment of ES needs to be approached very responsibly and precisely because it is best suited to people and may be misunderstood or misused. All the above-mentioned types of methodologies of valuation of ES could be very relevant and important information for decision-makers and stakeholders in the impact assessment process.

As mentioned above, the scoping stage of the EIA process is about finding the alternative solutions that avoid, mitigate or compensate negative effects on biodiversity, as well as ES. In this stage should be also proposed **compensatory measures** of ES. Some of ES can be easily defined in geographical units e. g. provision services (wood, crops), others e. g. regulatory services such as carbon sequestration, air quality regulation, global climate regulation, water flow regulation or pollination as well as pest and disease control can be difficult to express in precise geographical units, but a scientists accepted map of ecosystem is still a very good base because ES are often related to specific ecosystem/habitat types. There are many published methodologies based on which ES can be assigned to a given habitat type (as in Chapter 1.3). That's why a loss of certain ES can be compensated with creation of new habitat or restore degraded habitat in the close distance which provides particular ES. These compensatory measures should be involved in each environmental managed plan even in the EIA report.

3.4 Stakeholders involvement

All ES assessment processes should involve some level of stakeholder engagement. Stakeholders can help identify the relevant ES to assess at the site; provide sources of data, information and knowledge that can result in a more robust assessment; help to validate ES assessment results; and ensure that assessment results are actually used for management or policy decisions. Including stakeholders from the beginning also helps build trust and ensure that the information produced during the assessment process will be accepted by the people or groups who will ultimately be responsible for the management of the site (Neugarten et al. 2018).

Stakeholder involvement refers to the participation of interest groups (i.e. representatives of locally affected communities, national or local government authorities, politicians, civil society organizations and businesses) in a planning or decision-making process. To define 'stakeholders', we propose to use the definition of Hein et al. (2006), a 'stakeholder' being "[a]ny group or individual who can affect or is affected by the ecosystem's services".

Four main stakeholder groups who – in different ways – relate to the biological or physical resource(s) and its ecosystem (dis)service can be distinguished (Demeyer & Turkelboom 2014):

- stakeholders who **directly benefit** (= beneficiaries);
- stakeholders who are **negatively affected** (burden);
- stakeholders who **directly impact on ecosystem (services)** - e.g. land owner, resource manager;
- stakeholders who **indirectly influence the ecosystem (services)** - e.g. decision-maker, civil society organisation.

In reality, one ecosystem service usually has most of these stakeholder groups involved, while one specific stakeholder group could fulfil several of these roles. The levels and forms of stakeholder involvement are manifold.

The US Environmental Protection Agency, for example, refers to the International Association of Public Participation (IAP2), which suggests five levels of engagement:

- The **first level** of participation is to keep the stakeholders informed.
- The **second level** is the consultation level, gaining feedback from the public on analysis, alternatives or decisions.
- The **third level** is the involvement level. The idea is to work directly with stakeholders and consider their input throughout the decision-making process.
- The **fourth level** is the collaborative level. The goal is a process that allows for effective partnering and engagement in all key activities and decisions.
- Finally, the **fifth level** of empowerment is when the public makes an informed decision, which is implemented by the responsible agency.

The role of stakeholders in the mapping and modelling approaches is conceived differently among many studies. Stakeholders can be seen as the focal target group of a study (they are the beneficiaries), and therefore the mapping and modelling of ecosystem services from this viewpoint should be done in a bottom-up manner, i.e. taking stakeholder perceptions and views as starting points. Consequently, these bottom-up techniques are applied in participatory approaches. On the other hand, in most symposium contributions the mapping and modelling were carried out in a top-down way, focusing on the larger scale processes and interactions, deducting the potential consequences for stakeholders from that perspective. To optimize the applicability of the ecosystem service approach, the linkages of these two distinct concepts have to be considered more thoroughly, preferably merging the bottom-up and the top-down strategies.

BOX 1.

*As a concrete example of this approach, during the ALPBIONET2030 project (https://www.alpine-space.eu/projects/alpbionet2030/en), aimed at studying and preserving the ecological connectivity through the Alps and resolving human-nature conflicts, in the study area Prealpi Giulie/Triglav (Italy/Slovenia), stakeholders of both areas have been involved in a participation process on management tools for pastures in areas of great natural values. Participative procedure was characterized by stakeholders' engagement thanks to interviews, questionnaires for residents and tourists, targeted workshops and meetings highlighting issues in the Pilot Region and establishing collaborative relationships among experts and people involved in conflict situations. Following a specific approach, two maps were created: a Relationship Map and a Transhumance Map. The Relationship Map highlighted positive and negative aspects related to pasture management in areas of great natural value. To do so, it was necessary to identify: resources to be managed (landscape, infrastructures, soil and structures - such as cheese huts and shelters -, biodiversity – including herds, wild herbs, wildlife and large carnivores), engaged stakeholders (residents, tourists, hunters, shepherds and herds owners, wild herbs pickers, landowners), managing authorities (Municipalities, Park, Region – Regional Forestry Corps, Health Services Agency) and bodies providing technical assistance or involved in the research field (Associations and Universities). Moreover, existing relationships among the parties involved in the project were analysed. In addition to the foregoing, the Map is useful to examine management tools already in use, to identify their strengths and weaknesses and to make proposals concerning conflict management and minimization. The main objectives of the Transhumance Map were to identify paths covered by transhumance herds and their staging points within the Park and in the neighbouring areas; to identify conflicts highlighted in the Relationships Map; to identify the so-called "hot spots" (within Park borders) in relation to conflicts. On the Map, conflicts are marked as points or extended areas, depending on available data (limited data available: points; several data available: areas). Conflict intensity refers to an area considered as homogeneous (the reference territorial unit is the 500m * 500m cell) and it is given by the summation of persistent conflicts in each area. Moreover, the Map shows areas influenced by limitations in terms of time and number of animals stated by the Park Conservation and Development Plan and also other areas with a fixed load capacity. The Map is an easy-to-use and updatable tool useful to: identify high conflicting areas within the Park and in the neighbouring areas; analyse the type and the intensity of conflicts; address efforts and available resources towards mitigation measures; understand and decide where and when to put in place some monitoring activities concerning specific species; understand where and when to develop activities focused on "man-nature" conflict awareness.*

Stakeholder involvement is likely to result in the valuable knowledge and information exchange which will be possible due to the different background of the stakeholders (e.g. local or indigenous knowledge). In order to ensure the quality of research results as well as governance processes (Keune et al. 2013), transdisciplinary research processes can be helpful. Stakeholder engagement is also important for promoting and sharing the knowledge and learning across and between cases (Geneletti et al. 2020). Communities of practice (Keune et al. 2015) can take on different subjects areas and, by supporting the outreach to wider communities of interest and involvement, they can also facilitate general social learning practices (Reed et al. 2009). In relation to the ES, such communities could be organized not only across regions, but also across problem-types and sectors and, if scientists are also involved, this would help to promote transdisciplinarity.

A transdisciplinary research process, according to Lang et al. (2012), aims at the inclusion of stakeholders in research and can therefore be conceptualised as a sequence of the following three phases: collaboratively framing the problem and building a collaborative research team (Phase A); co-producing solution-oriented and transferable knowledge through collaborative research (Phase B); and (re-)integrating and applying the produced knowledge in both scientific and societal practice (Phase C).

3.5 Mainstreaming of ES

Considering the rapid decline of biodiversity over the last decades, maintaining the provision of essential (ecosystem) services requires immediate action and collective engagement of society, governmental agencies, non-governmental organisations and the private sector alike. It is necessary to integrate biodiversity, ecosystems and their services into sustainable use and development processes and in sector policies in a systematic way (notably in agriculture, forestry and fisheries, among others). The concept of ecosystem services cannot be only an academic issue, but also needs to be included in all relevant partial areas and policies such as nature conservation, land use/spatial planning, environmental impact assessment (EIA), etc. For instance, Dzeraviaha (2017) considers if the mainstream methods could be used to tackle environment problems effectively and suggests that all environment externalities could be accounted in the existing production-consumption system that could help to transform the existing pricing system and provide effective institutional reforms to ensure sustainable development.

In this section, we present several approaches to the use of this concept in some Carpathian countries. More details with some examples are listed in Annex 2.

In **Hungary**, the results of the MAES-HU project contribute to the sustainable management of environmental resources, enhance the development of green infrastructure and improve the incorporation of the results into sectoral policies. This includes possible incorporating ES into support systems and subsidies and resolving conflicts of land use, providing a decision support tool for investments and developments or other directions - establishing professional (strategic and long-term) planning inside the nature conservation sector, establishing and monitoring continuous activities (e.g. management) of nature conservation, and strengthening communication and advocacy for nature conservation.

In **Poland**, the importance of this concept is growing. The term "ecosystem services" is mentioned directly in the National Spatial Development Concept 2030 and in the Act on Preventing and Repairing Environmental Damage. Within nature conservation, it is often mentioned indirectly, e.g. in the Act on the protection of nature, in the National Strategy for Conservation and Sustainable Use of Biodiversity, and in the Environmental Protection Act. ES were not so long ago reflected in the Polish environmental policies almost exclusively in an indirect, latent form, and the concept was almost absent in more detailed, executive decrees (Maczka et al. 2016; see also Stępniewska et al. 2018b). However, currently all the most important strategic documents explicitly address ecosystem services as one of the key concepts used for the evaluation of nature value for the country's economy and planning the sustainable use of natural capital.

In **Slovakia,** the term "ecosystem services" is reflected in some environmental policies e.g. Act on Nature and Landscape Protection and Act on Fisheries. From strategies there is a reflection on the concept of ES in the Greener Slovakia - Environmental Policy Strategy of the Slovak Republic until 2030; or last National Biodiversity Strategy to 2020. Regarding the Land-use or Spatial planning the concept of ES is closely associated with the Green Infrastructure concept that is linked to the NECONET (National Ecological Network) and the Territorial Systems of Ecological Stability (Územný systém ekologickej stability - ÚSES).

Chapter 4: RECOMMENDATIONS AND CHALLENGES IN THE ES ASSESSMENT

This chapter provides insights into current experiences with the application of the ES mapping and assessment for policy and decision-making and related recommendations and challenges. It is based on the paper of Geneletti et al. (2020) – a meta-analysis of fourteen case studies (among others also from Carpathian countries such as Czechia, Hungary and Poland) and our country-by-country brief reports (see also description in chapter 2.4.).

According to Geneletti et al. (2020) policy-makers increasingly acknowledge ES as an important concept in supporting decision-making, due to its holistic understanding of interactions between nature and humans and its ability to reveal synergies and trade-offs between environmental and socio-economic goals. From the practice, the following general recommendations can be defined:

- ES mapping and assessment studies should focus on specific policy issues or decision-making challenges. This has an impact on the selection of the ecosystems and services to be assessed, as well as on methods to be applied.
- Stakeholders involvement should be ensured through an iterative process to increase awareness and acceptance of the ES mapping and assessment results, as well as to support their implementation, in particular decision-making contexts.
- Downscaling the EU objectives to the national level, hence integrating national priorities, is a good strategy to use MAES for addressing national challenges.
- Use of success stories to communicate how ES mapping and assessment can make a difference in the decision-making process.

Furthermore, ES provide a comprehensive framework for trade-off analysis, addressing compromises between competing land uses and assisting to facilitate planning and development of decisions across sectors, scales and administrative boundaries. The use of the ES concept in nature conservation, agriculture and forestry bear a high potential for applying the ES concept, for instance, the relationships between biodiversity conservation actions and ecosystem service delivery or increasing synergies of recreation and carbon sequestration with timber production in forests or pollination and biological control in agricultural environments (see chapter 3.2). In spatial planning, it provides greater opportunities to integrate environmental considerations into decision-making on land use change or management at strategic and practical levels (see chapter 3.3.1). In practice, the ES concept can be included within the impact assessment procedures, thus extending the scope of impact assessment from purely environmental considerations to other dimensions of human well-being (see chapter 3.3.2).

It is highlighted the importance of starting **stakeholder dialogue** early in the process (see chapter 3.4), which can generate interest and confidence in the project and increase the willingness to cooperate. In particular, the involvement of local authorities and public institutions is emphasised as they can play significant roles as cooperating partners. From all stakeholder groups, it is suggested to involve key individuals such as “bridge people” (or knowledge brokers) who have connections to many local actors and are able to represent their views or have a high ability to influence decisions or information flows.

In the context of **mapping and assessment** carried out to be compliant with the EU Biodiversity Strategy, in particular, such typologies need to be in line with the MAES definitions of ecosystem types at level 2. Besides the general consistency with existing typologies and an appropriate level of detail, the typology should reflect the relevant ecosystem types frequently present in the study area, as well as address priority habitats according to European, national and regional schemes. Therefore, the close interaction of experts and the co-identification of relevant ecosystem types together with stakeholders is useful. The selection of ES should follow the identified policy, societal or business questions relevant for the study area. As a rule of thumb, the selection should cover the common ES categories (provisioning, regulating and cultural ES), in order to enable the analysis of trade-offs, synergies and interactions amongst the different ES. In general, it is found that the integration of methods and results is essential for providing a comprehensive overview integrating different perspectives (e.g. social, economic). For example, focusing on social methods alone may underestimate the value of some more 'unknown' ES, such as water purification or infiltration. On the other hand, focusing on biophysical methods only would overlook some important intangible values or conflicts between ES.

The interface between science and decision-making in policy, business and society is crucial for evidence-based environmental governance. An appropriate and efficient **dissemination and communication** of (often complex) scientific findings to potential users from policy- and decision-making is at the core of a successful science-policy-society interface. Connecting ES mapping and assessment-related research and relevant, competent authorities is thus key to ensure effective use of monitoring, research and science in policy-making. The results of the ES mapping and assessment should be made available as (open access) publications, the main instrument for a comprehensive exchange of knowledge, in order to support the reproduction of the assessment in other study areas. Generally, it is important to tailor the final message as a possible input for regional and local landscape planning and management strategies or other relevant ongoing processes. Finally, for the public, dissemination and communication should be informative and, at the same time, attractive and easily understandable with an appropriate language. The involvement of stakeholders should not be limited only to the initial stages of the ES mapping and assessment process; rather it is important to keep their involvement throughout the process, for example, by organising feedback workshops with practitioners and stakeholders. In fact, there is the need for training technicians and civil servants – a tailored programme, with different levels of complexity (e.g. starting, advanced), for different stakeholders, to demonstrate the benefits of applying the ES approach and to build institutional capacity.

In the next part we present a more detailed description of the challenges of applying the concept of ecosystem services in 5 Carpathian countries (Czech Republic, Hungary, Poland, Romania and Slovakia).

Recommendations and challenges for Carpathian countries (common for five EU members):

Based on analysis of the situation and suggestions of relevant case studies it is recommended:

- Continue in implementing EU policies related to ecosystem services into national, regional and local legislation (e.g. nature conservation, spatial planning, EIA/SEA).
- Continue in assessing ES, their supply and demand of ES, monetary valuations of ES most relevant for each country.
- Start a discussion about opportunities with economic and financial ministries on how to integrate economic values of ES into accounting and reporting systems, find a shared language and tools to include biodiversity/natural capital to decision making.
- Develop, improve knowledge and tools to take ecosystems and their services systematically into account, in order to improve sustainability and restore biodiversity e. g. identify stakeholders and start a discussion with them (participatory methods).

Czech Republic

To improve ES implementation into environmental policies in the Czech Republic it is also necessary to:

- Uptake by horizontal policies is not possible until the mapping is finished, and the concept is widely recognised by the Government (namely in cooperation of the Ministry of Environment, Ministry of Agriculture, Ministry of Finance, and the Ministry of Industry and Trade).
- Fulfil the need above the first step are action plans of different sectors that do reflect the ES concept.
- Payment scheme in place to compensate for delivery of public goods, enabling ecosystem services (e.g. Common Agricultural Policy of the EU can be up taken), this could open the scene for completely new business models of the society and the EU can become a front-runner.
- Catalogue of sanctions for harming the ecosystem services to be paid to fully implement EU "polluter pays" principle.

Hungary

All of the 6 expert MAES-HU groups have their specific challenges to ES assessment in Hungary. Just a few examples:

- How do you differentiate nature's contribution to crop yield from human inputs?
- How do you tackle the spatial mismatch (source vs. beneficiary areas) in case of flood protection in the mapping (i.e. upstream forests protect downstream areas)?
- If your mapping is based on current ES, how do you show the ES potentials that would need land use change?
- National habitat mapping was realized between 2003–2006 (MÉTA; Molnár et al. 2007).

Poland

To improve MAES process in Poland it is necessary to:

- Identify and assess landscapes throughout Poland's territory and analyse their characteristics and the forces and pressures transforming them.
- Harmonise and make available nationwide high-resolution environmental data, particularly soil and geological maps.

Slovakia

In terms of nature protection in Slovakia, the ES concept is relatively new and is still not sufficiently implemented in this area. The basic framework is provided by Act No. 543/2002 Coll. on nature and landscape protection in the currently valid version, which was the first to define the ES at the national level and provided an initial legislative anchor. The ES concept is also incorporated in the Environmental Policy Strategy of the Slovak Republic 2030. Even the Fisheries Act also introduced the concept of ES related to fish protection in its latest update.

The ES concept is gradually being introduced in Slovakia but has so far been underpinned mainly by international commitments. It is necessary to continue to develop it in the Slovak Republic - not only within the framework of nature and landscape protection, but also in decision-making on landscape management, spatial and territorial planning, and environmental impact assessments, in local strategy papers, which are mandatory as part of applications for EU financial support.

More details from Carpathian countries with some examples are listed in **Annex 2.**

Chapter 5: BEST PRACTICE EXAMPLES

This chapter provides a knowledge marketplace with recent examples on natural capital and ecosystem services case studies. Its purpose is to bring knowledge and inspiration for better management of nature and protected areas.

The case studies are selected for people with diverse needs and interests - from science, policy and practice; public, private and voluntary sectors; organisations large and small, as well as individuals.

5.1 Case studies from the world

This subchapter contains a collection of different approaches from case studies from around the world. Many can also be inspiring for the context of the Carpathian countries.

BOX 2.

Retention forestry to improve biodiversity conservation and ecosystem services in Southern Patagonia, Argentina

Aim: *Quantifying the impacts of traditional forest management on biodiversity and ecosystem services values and developing new forest management strategies using the retention capacity of the forest.*

Benefits: *The study demonstrates the advantages of the different proposals on biodiversity and ES values, and the costs for companies and society. The case-study improves the local forestry with practical recommendations, improving conservation in the managed forests.*

Transferability of the result: *The benefits of the projects were received mainly by ranchers and sawmill owners (e.g. certification processes and improvement of management methods), as well as technicians of the main regional institutions (e.g. forest and agricultural agencies) and national government. Local people and NGOs interested in nature will also benefit from better holistic management of the forest and grassland. Representative members of our case study advisory board will receive the news and the preliminary results of our studies.*

Lessons learned: *The landscape planning in Southern Patagonia is based mainly in provisioning Ecosystem Services, however other Ecosystem Services (e.g. cultural) have increased in importance during the last decades due to the increase in population and tourism-based companies. The synergies and trade-offs among the different Ecosystem Services provision and also with the biodiversity conservation have an effect on management planning and lead to the development of new strategies. The lesson learned is that biodiversity values and the different Ecosystem Services should be taken into account in management strategies at landscape level. Finally, the most employed methods in well-developed countries need a lot of data that are usually not available for remote areas like Patagonia. We therefore need to develop new alternatives that are suitable for our requirements and database availability.*

Reference: *https://oppla.eu/casestudy/17262*

BOX 3.

Optimising ecosystem service delivery: what to do where to gain best bang for buck in Oxfordshire and Gloucestershire, England

Aim: *Viridian were asked to model an entire lowland catchment of approximately 750 km^2 for a basket of ecosystem services, so the client could better understand where to focus effort on the ground, assist with planning, inform stakeholder engagement and influence policy formation.*

Actions: *Viridian sourced all data (mainly open source), carried out all modelling and created both data layers and final maps for the client. The modelling combined hydraulic flows, vegetation interactions and soil effects to rank every 5m pixel across the catchment for its current ability to reduce flooding, diffuse pollution, erosion/sedimentation, and to improve groundwater recharge. Whole flow paths across the landscape were then analysed to understand where interventions would make the most impact on local problems, then understand which habitat types should be created on those locations to optimise the benefits. The output data layers ranked every 5m pixel for the degree of impact it offered by optimising its habitat type, so it was simple to identify where actions should be targeted. Where the most effective interventions were not possible due to local considerations, the next effective locations could be considered and so on until agreement was reached. Data layers were produced for each service individually, as well as the most effective compromise for the provision of all services simultaneously. Some example of output maps can be viewed here http://viridianlogic.com/windrush-catchment-scale-planning/*

Benefits: *This was a commercial application of ecosystem service modelling. The client - a wildlife trust - wanted to understand how improving natural habitats within the catchment could also improve ecosystem services, especially around water quantity and quality. This could be used for decision support on conservation activities and to engage stakeholders beyond environmental conservation. Such stakeholders included landowners for wider benefits of landuse change, funders for PES (including natural flood management), residents for active involvement, and regulators for policy support. The outputs were particularly useful for these objectives, since the model ranked every 5m pixel across the catchment for its ability to improve local problems through nature based solutions, but did so using whole flow paths across the entire landscape. It also showed which habitat type should be created in each location. This meant that the optimising of ecosystem services could be balanced with other local priorities, restrictions and trade-offs. The understandable, visual presentation of results facilitated discussions with non-technical parties to achieve agreement.*

Transferability of the result: *The modelling was developed from the Natural Capital Project's RIOS system, and is appropriate for international use. Many of the datasets currently used are European or world-wide in scope. The outputs are in simple GIS format, so can be integrated with any other such modelling or surveys, including wider ecosystem service analyses. The model has been applied in mountainous, upland and lowland settings. It could be applied to urban setting, with appropriate data provision.*

Lessons learned: *The prioritisation of impact gives a much richer result than the normal GIS opportunity mapping. It is important to keep output maps simple to understand. Quantification of flood reductions from NBS would be useful; this is now being developed by Viridian.*

Reference: *Angus Middleton, angus@viridianlogic.com*

BOX 4.

Management and impact of Invasive Alien Species in Lough Erne, Northern Ireland

Aim: *The AQUACROSSCase Study examines the implications of the regulation on Invasive Alien Species (IAS) (i.e. non-native plants and animals harming the local ecosystem) for practical management in Lough Erne, Northern Ireland, in the context of existing environmental commitments under EU legislation.*

Benefits: *The case study brought together a range of stakeholders from public service and NGOs, both north and south of the Northern Irish/Republic of Ireland border in a series of workshops. Mental models called "Fuzzy Cognitive Maps" of the Erne system were developed based on stakeholder inputs and were used to infer how the social and ecological systems behave. The models predict a likely decline in future water quality related to agricultural activities in the catchment. Models were used to map the impacts of altering lake levels on agricultural production in areas adjacent to the lake. Lough Erne sustains multiple competing primary activities each with different requirements from the system in terms of ecosystem services and biophysical abstraction. The Erne Loughs are heavily modified water bodies, and also contain a range of non-native origin with a very long history of introductions. Balancing the needs of competing uses while also meeting the additional legislative burden of the Invasive Alien Species Directive requires consensus on ecosystem end-points as well as effective cross border cooperation.*

Transferability of the result: *This project is a Case Study under the Horizon 2020 project AQUACROSS, which builds on work undertaken in the previous pillars to develop concepts, practices and tools for better implementation of Ecosystem-Based Management. This includes identifying and understanding the linkages between aquatic ecosystems and human well-being and identifying innovative management responses for aquatic ecosystems.*

Lessons learned: *The case study revealed the importance of considering the interconnections between policies. Potential solutions to the problem of Invasive Alien Species in Lough Erne will affect achievement of Water Framework Directive goals, as well as obligations under the regulation on Invasive Alien Species. At the same time, these goals cannot be considered in isolation from the overall driver of the Common Agricultural Policy.*

Reference: *Tim O'Higgins, MaREI, University College Cork, tim.ohiggins@ucc.ie*

BOX 5.

Biodiversity management for rivers in the Swiss Plateau, Switzerland

Aim: *Freshwater ecosystems in the Swiss plateau are threatened by multiple stressors that deteriorate water quality and hydromorphology. This is the result of channelization, dams, wastewater, and agriculture, among other causes. To restore these ecosystems and stop the biodiversity decline, multiple management measures will be implemented over the next decades. We propose methods for prioritising the location and timing of restoration measures to maximise their effectiveness, considering many sectors and multiple societal objectives.*

Actions: *Using the concepts underlying the AQUACROSS Assessment Framework, we developed a procedure to prioritise restoration measures by maximising the ecological state of a catchment under a given budget constraint, while considering other societal needs and other sources of impairment: In close collaboration with stakeholders from federal and cantonal authorities and environmental consulting companies, we integrated procedures for chemical, physical and biological assessment at the river reach scale and proposed a spatially explicit ecological assessment at the catchment scale. We applied the catchment scale assessment to search for management strategies that optimise the overall ecological state of catchments, while increasing or not significantly decreasing services (e.g. recreation) demanded by society.*

Benefits: *We developed a methodology that supports environmental managers in the integrative assessment of restoration measures at the catchment scale. This methodology is based on ecological principles, such as maximising resilience and fish migration potential and minimising fragmentation. An optimisation procedure provides a set of near-optimal combinations of measures to reach the highest ecological state for a given budget. This list of potential measures can support the development of a cantonal planning, which also requires stakeholder involvement.*

Transferability of the result: *This project is a Case Study under the Horizon 2020 project AQUACROSS, which builds on work undertaken in the previous pillars to develop concepts, practices and tools for better implementation of Ecosystem Based Management. This includes identifying and understanding the linkages between aquatic ecosystems and human well-being and identifying innovative management responses for aquatic ecosystems.*

Lessons learned: *This Case Study concludes that in order to prioritise river restoration, managers need to consider location and also consider broad descriptors of ecosystem health. The consideration of different types of impairments, such as hydromorphological degradation and chemical pollution, is important to increase effectiveness.*

Reference: *Nele Schuwirth (nele.schuwirth@eawag.ch) and Peter Reichert (reichert@eawag.ch), Eawag, Switzerland*

BOX 6.

Contribution of economic valuation methods to transparent decision processes in Donau-Auen NP, Austria

Aim: *In the planning process of the national park "Donau-Auen" in Austria, several variants of the national park area including hydroelectric power stations and engineering concepts have been worked out. Within the planning process a cost-benefit analysis was carried out to estimate the economic impacts of the four proposed development projects. One important objective was the valuation of the ecological quality of wetlands.*

Benefits: *Environmental goods were valued by means of a willingness-to-pay survey. Costs and benefits depending on direct "anthropocentric" use including energy production with hydroelectric power stations, shipping, groundwater protection, stabilisation of the river bed to stop channel erosion, visitors' benefits, forestry, farming, fishing, hunting and the costs of establishing a national park. The present value of these costs and benefits showed that, without ecological values, it would be highly efficient for the Austrian economy to build a hydroelectric power station. But including ecological values, the largest national park project is the best in terms of the benefit-cost ratio.*

Lessons learned: *Protection of natural goods, like wetlands, in a natural state might be more efficient even from an economic viewpoint than development projects.*

Reference: *https://www.sciencedirect.com/science/article/abs/pii/0921800995000585*

BOX 7.

Organic farming in Siberia's Amur region, Russia

Aim: *The uplands of Siberia's Amur region in far Eastern Russia are in large parts very fertile and have therefore been developed as farmland by Russian settlers since the mid-19th century. Even though local climate and soil offer excellent conditions for crop growing, farming practices such as burning straw or using large quantities of pesticides and herbicides have caused considerable damage. The project aims at testing and showcasing sustainable agricultural practices, through the development of a Demonstration Farm (460 ha) by the Muraviovka Park for Sustainable Land Use, instituted in 1996 and being the first independent, non-commercial, privately operated protected territory in Russia park, to show how sustainable agriculture fields near wetlands can offer breeding, roosting and feeding habitats for birds, while at the same time yield a good return. The principal crops planted on the demonstration farm were wheat, barley, oats, soybeans, and corn (to lure the cranes into the safety of the park).*

Benefits: *To solve the human-wildlife conflict, corn was intentionally planted as a lure crop for the birds to forage on and hence keep them out of agricultural fields and away from other crops. This measure helped reduce crop damage as well as disturbance to birds and therefore diminished the conflict between birds and farmers. As a result of education efforts and wildlife management, the number of cranes and storks in the park increased by 250% until 1998.*

Lessons learned: *A strong manager-agronomist, dedicated to organic or at least sustainable agricultural practices, should be on staff to develop good plans for crop rotation, secure proper seeds, and oversee the work of farmhands and proper functioning of machinery and equipment.*

Proper crop rotation, seed variety selection, and farming techniques (when and how to prepare the soil for the next growing season, how and when to treat the emerging and growing crops, and how and when to treat the fields after the harvest) will allow farmers to keep their fields clean from weeds and stop using herbicides.

Appreciate that entrenched/traditional agricultural practices are hard to change. Without local and regional political support, introduction of new strategies can produce suspicion and resistance. Perseverance and utilizing the demonstration farms educational capabilities will eventually change minds and help to initiate agricultural practices throughout a region that will provide economic benefits to people while preserving the ecosystem and its endangered or threatened species. At the same time, sales of crop yields from the demonstration farm help to provide financial support of the total project.

Reference: *Organic farming in private protected area, Russia (2013); http://www.teebweb.org/wp-content/uploads/2013/02/TEEBcase-Organic-farming-in-private-protected-area-Russia.pdf*

BOX 8.

Multifunctional urban greening in Malmö, Sweden

Aim: *The main purpose of the roof is to offer an unique green environment to the residents in the house. In the project every surface, also on the ground below, is maximized with greenery. The greenery offers a range of ecosystem services which also benefits the neighbours and the city.*

Benefits: *The roof provided a space with increased amount of green open spaces for residents, increased biodiversity, increased quality and quantity of green and blue infrastructures, improved connectivity and functionality of green and blue infrastructures, reduced load to sewer system, reduced run-off, flood peak reduction, reduced drought and flood risk, reduced risk of damages from drought, increased accessibility to green open spaces and changing image of the urban environment.*

Transferability of the result: *Small size enterprise with a lot of courage. Working closely with experts. Project funding that supports innovation. In this case the project was partly financed (40%) from VINNOVA, the Swedish Innovation Agency.*

Lessons learned: *That it is possible to create a wetland roof with extreme drought tolerance (we had 7 weeks without rain in the spring of 2018 but the wetland roof develops extraordinary nice).*

Financing: *Partly financed (40%) from VINNOVA, the Swedish Innovation Agency.*

Reference: *Multifunctional urban greening in Malmö, Sweden; https://oppla.eu/embedded-case-study/19011*

BOX 9.

Nature-based solutions for urban green connectivity and biodiversity, Berlin, Germany

Aim: *Berlin has approximately 40 % of green (parks, forests etc.) and blue (rivers, channels, lakes, ponds, etc.) areas within its borders. It aims to create connectivity across the city and a 'green belt' as a border boundary for urban growth and a protection against urban sprawl.*

Benefits: *Urban green policies are integrated into urban strategies at all levels of the administrative hierarchy from the Land (State) level down to the urban district (Bezirke) level. Furthermore, greening policies are integrated into the strategy for the greater metropolitan area, managed jointly by the City State of Berlin and the State of Brandenburg. The Joint State Development Plan Berlin-Brandenburg (LEP B-B) prepared an overall planning strategy for the region (Landesregierung Berlin, 2009), which includes goals for developing open spaces (Steuerung der Freiraumentwicklung) targeting approximately 30 % of the entire planning area to be kept free from urban development.*

The plan explicitly underlines the multiple functions of open spaces and aims to limit interruptions to connectivity within the areas. The plan justifies the protection of green areas, pointing to their multiple functions as recreational spaces, spaces for biodiversity, role models for improving urban climate and water management and carbon sinks.

Furthermore, some areas are specifically protected as areas for flood protection and prevention.

Lessons learned: *Bottom-up citizens' initiatives have helped to create important green infrastructure, influencing and transforming public policies. Public policies have to a certain extent tolerated and sometimes integrated these bottom-up activities into mainstream policies (e.g. leasehold contract for the Prinzessinnengarten).*

Financing: *co-financed by EU's ERDF funding*

Reference: *Berlin - NBS for urban green connectivity and biodiversity; https://oppla.eu/embedded-case-study/18090*

BOX 10.

BIOVEINS - connectivity of green and blue infrastructures in Almada, Portugal: living veins for a biodiverse and healthy city

Aim: *The main objective of the BIOVEINS is to use functional diversity (FD) to highlight the mechanisms underpinning the link between green and blue infrastructure (GBI), taxonomic diversity (TD) and ecosystem services (ESs) provisioning, and to provide, together with local stakeholders, the ecological and interdisciplinary knowledge to identify the critical features of GBI, to guide the establishment, management and restoration of GBI, and to mitigate the effects of major urban global challenges, like habitat fragmentation, air pollution, and urban heat island.*

Benefits: *Almost 80% of the population in developed countries lives in cities and a further increase is expected in the future. As a consequence, a further loss of green spaces is anticipated, causing strong alterations of ecosystem processes and trophic interactions with exotic species playing an increasingly important role.*

The project will provide a better understanding of the link between GBI distribution in cities and urban biodiversity and ecosystem services to cities. Through stakeholder engagement and outreach we will communicate these lessons and ideas to planners and residents of cities.

Lessons learned: *The project and the page are updated regularly as results, publications and reports are prepared.*

Transferability of the result: *This case study is part of the European BiodivERsA project BIOVEINS, with case studies in several European cities*

Financing: *This research was funded through the 2015-2016 BiodivERsA COFUND call for research proposals, with the national funders BelSPO (Belgium), FCT (Portugal), ANR (France) and ETAg (Estonia), NCN (Poland) and SNSF (Switzerland).*

Reference: *BIOVEINS - connectivity of green and blue infrastructures in Almada: living veins for a biodiverse and healthy city; https://oppla.eu/embedded-case-study/18420*

Numerous examples and case studies used in a different context from around the world can be found also here: http://www.teebweb.org/resources/case-studies/ or https://oppla.eu/case-study-keywords/97.

5.2 Case studies from the Carpathian countries

This chapter provides an overview of case studies in the Carpathian countries involved in the Centralparks project. Studies can be divided into regional and local levels. For the national level, see Annex 1.

Czech Republic

Various aspects of ecosystem services case studies have been developed in the Czech Republic. The methodology of the national ecosystem services assessment is thoroughly reflected in Vačkář et. al (2014, 2018). Important temporal (1845 - 2010) aspect of the Czech ecosystem services continuous development and delivery is presented in Frélichová & Fanta (2017).

From the latest advances on the ecosystem service implementation into national account we hereby mention several examples of the best practice which we assume to become an important part of future development in the Czech Republic.

i) The approach with the longest tradition (over 20 years) of elaboration in the Czech Republic is the one developed by assistant professor Jaroslav Seják from the Faculty of Environment, UJEP University. This method of monetary valuation of territorial ecological functions is relatively widely used in the Czech Republic although some oppose its wide scope and too liberal attitude towards evaluation of provided services. For more in depth understanding we further suggest the on-line introduction here: http://fzp.ujep.cz/projekty/BVM/BVM.pdf

ii) The recent works of assistant professor Pavel Cudlín and his team (from the Global Change Research Institute of the Czech Academy of Sciences) can be understood as broadening and deepening above mentioned approach with the inclusion of e.g. cities. The full list of publications can be found here: https://www.researchgate.net/profile/Pavel_Cudlin2/research

iii) The integrated and also accredited approach to the urban ES assessment is currently represented by the methods described e.g. in Frélichová et al. (2017), see: http://www.ecosystemservices.cz/userfiles/page/278/9171b6a2c9e2c8b20623795c0a6ea217.pdf. This proceeds partly from above mentioned but is already set up to fulfil the arising needs of public authorities for an approach that can be fully linked to budgeting and national accounts.

iv) This final stage is meant to be delivered by an integrated Life project guaranteed by the Czech Ministry of Environment and solved in the consortia of Nature Conservation Agency of the Czech Republic, Biology Centre of the Czech Academy of Sciences, Global Change Research Institute of the Czech Academy of Sciences, and Charles University Environment Centre, Czech Republic. For more information, see: https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=7002.

Hungary

There are several ongoing and completed ES projects in the country, many of which include local to regional case studies:

- Tisza river basin – ES assessment in the Hungarian and Romanian parts of the Tisza floodplain, see Petz et al. (2012): https://link.springer.com/article/10.1007/s10113-012-0284-7
- Kiskunság Sand Ridge region – ES assessment in the lowland area (e.g. pollination services), see Arany et al. (2019): http://eurogeographyjournal.eu/articles/9_Ildiko_Arani_final.pdf, Kovács-Hostyánszky et al. (2011): https://onlinelibrary.wiley.com/doi/10.1111/j.1461-9563.2010.00498.x
- Bükk National Park – a participative ES assessment in the protected area using social network analysis, see Kuslits et al. (2021): https://www.frontiersin.org/articles/10.3389/fevo.2021.635988/full
- Mátra Mountains – pest regulation service assessment in the forested mountain area, see Bereczki et al. (2014): https://www.sciencedirect.com/science/article/abs/pii/S0378112714002801
- Szeged – microclimate regulation service assessment in the urban environment, see Takács et al. (2016): https://doi.org/10.1016/j.proenv.2016.03.015

Several ES have been studied in the above-mentioned projects:

- Food provision: crop, animal, wild food, honey (Tisza, Kiskunság),
- Production of raw materials: timber and hay (Tisza, Kiskunság, Bükk),
- Medicinal resources (Tisza),
- Water quality regulation (Tisza, Bükk),
- Water flow regulation (Tisza),
- Soil quality regulation (Tisza),
- Habitat and population maintenance (genetic resources, birds) (Tisza, Kiskunság)
- Pollination (Kiskunság),
- Pest control (Tisza),
- Disease control: ragweed pollen (Kiskunság),
- Decomposition (Kiskun),
- Climate regulation: urban, global (Kiskunság, Szeged, Bükk),
- Recreation (Tisza, Kiskunság, Szeged, Bükk),
- Aesthetic value (Tisza),
- Cultural heritage (Tisza) (Czúcz et al. 2015).

Two of the above case studies (Kiskunság and Bükk) have been part of the below international ES projects.
OpenNESS was one of the first EU-wide projects on ES (http://www.openness-project.eu/), aiming to translate the concepts of Natural Capital and Ecosystem Services into operational frameworks. Kiskunság Sand Ridge area was one of the OpenNESS case studies. Some key ecosystem services were assessed and mapped based on extensive biodiversity and environmental monitoring data. Non-monetary valuation methods were used to estimate the social value of key ES. Participatory methods were applied to study and resolve the emerging conflicts between farmers, forest managers, nature conservation and water authorities. Results of this interdisciplinary research process provide input for the possible future restructuring of actual land use patterns, reflecting the importance of ecosystem services. Moreover, results may also be used as inputs for the participatory renewal of local and regional land use plans within the study area.

ECO KARST project performed **regional ES assessment** in the Bükk National Park - see http://www.interreg-danube.eu/approved-projects/eco-karst/section/pilot-areas. Main goal of this study is to provide a basis for action plans that benefit local development and livelihood of local people (so-called pro-biodiversity businesses) but also help to sustain the good condition of nature and biodiversity at the same time. Ecosystem condition (Biodiversity) and four ES (Nature attractiveness for tourism, Water quality protection, Timber and firewood provision, Carbon sequestration and storage) were mapped based on a wide range of data sources. The methods used are highly replicable, as the project also provides a detailed method description. The ES assessment was performed by stakeholder involvement based on social network analysis, as described by Kuslits et al. (2021).

Poland

The first **regional ES research** in Poland was conducted by the group of researchers from the Institute of Geography and Spatial Organization Polish Academy of Sciences within the project Ecosystem services in postglacial landscape - assessment of resources, threats and utilisation that started back in 2013. That comprehensive interdisciplinary assessment of the potential of nature to provide ES began with the definition of the theoretical framework and methodological solutions and ended with the detailed calculation of values for indicators measured, as well as the presentation of their spatial differentiation in the tested area – the Wigry National Park and its surroundings. For more information, see: https://www.igipz.pan.pl/news/items/elsevier-ecosystem-services-2019.html.

Common International Classification of Ecosystem Services (CICES), reports of MAES working group and definitions of ecosystem potential, as well as related assessment matrices proposed by Burkhard et al. (2014), constituted the conceptual and methodological framework of the research. Indices were calculated using two types of approach – an expert assessment drawing on scientific knowledge and field data, and a social (beneficiary) assessment obtained from the opinion of direct users of the landscape (inhabitants and tourists) on the basis of surveys conducted. The main research outcomes include the determination of: (a) nature potential to provide 29 ecosystem services based on 35 ES indicators calculated for different spatial units, (b) spatial patterns of ES potentials, (c) aggregated ES potentials and interactions among services, and (d) similarities among ecosystem types in relation to their ES potentials.

The authors also demonstrated how the actual use of ecosystem services and characteristics of individual beneficiaries (e.g. education, gender and age) impact social assessment of ES potentials (see Affek & Kowalska 2017: https://doi.org/10.1016/j.ecoser.2017.06.017).

The final project summary is a monograph entitled Ecosystem Service Potentials and their Indicators in Postglacial Landscapes: Assessment and Mapping (Affek et al. 2020): https://www.sciencedirect.com/book/9780128161340/ecosystem-service-potentials-and-their-indicators-in-postglacial-landscapes.

The book discusses the current developments in the ES concept, its origins and evolution. Based on the broad review of scientific papers, books and initiatives related to ecosystem services, the following issues have been addressed: ES terminology, classifications, indicators, spatiotemporal dimension and mapping, social perception, synergies and trade-offs and links with nature potential and biodiversity. In the second analytical part the book:

(1) outlines a transdisciplinary, holistic approach to assessing the overall potential of ecosystems and landscapes to support different ecosystem services; (2) proposes a range of direct, indirect, simple and complex measurement indicators for multifaceted estimation and mapping, and (3) presents tools and guidelines to help shape effective decision-making processes in nature conservation and environmental planning.

Examples of local approaches:

i) Assessment of the impact of riparian forest degradation on the provision of regulating services (6 selected sites in the middle Vistula valley, thorough field work, and multidimensional investigation of ecosystem condition: soil, fauna and flora, groundwater and climate characteristics) - for more information, see Kowalska et al. (2021): https://www.sciencedirect.com/science/article/pii/S1470160X2030772X

ii) Preliminary assessment of ecosystem services provision for the selected Ramsar site (the Wigry National Park). The project aimed to test and adapt the methodology of assessment and valuation of ecosystem services at the site scale - for more information, see: http://www.gdos.gov.pl/wycena-uslug-ekosystemowych-w-wigierskim-parku-narodowym-2 .

iii) Use of participatory mapping in the assessment of ecosystem services in 5 selected protected areas - for more information, see Pietrzyk-Kaszyńska et al. (2016): https://www.iop.krakow.pl/artykuly_1_548.html?wydawnictwo_id=339).

Slovakia

ES research at the regional and local levels is currently rapidly developing also in Slovakia. Based on published results, these main research topics could be highlighted:

i) Forest and mountain ES assessment - mainly in Tatra Mountains (Füzyová et al. 2009; Brezovská & Holécy 2009; Fleischer et al. 2017 - https://doi.org/10.3354/cr01461; Sitko, Scheer 2019 - https://doi.org/10.2478/forj-2019-0019).

ii) Monetary assessment of ES in national parks - Slovenský raj (Getzner 2009), Veľká Fatra (Považan et al. 2014a) and Muránska planina (Považan et al. 2015, Považan, Getzner & Švajda 2016 - https://doi.org/10.1553/eco.mont-7-2s61). The same methodology was used for all protected areas in order to obtain comparable results (Považan et al. 2014b) that was elaborated according to the handbook for rapid assessment of ES in protected areas in the Carpathians by WWF (Bucur & Strobel 2012).

iii) Agro-ecosystem and soil-related ES assessment - in a regional and national context Makovníková et al. (2019) (https://doi.org/10.15201/hungeobull.68.2.5) and Makovníková et al. (2020) (https://doi.org/10.2478/euco-2020-0015), local studies see e.g. Kanianska et al. (2017) (https://doi.org/10.5593/sgem2017/32/S13.023), Makovníková et al. (2017) (https://doi.org/10.15201/hungeobull.66.1.4).

iv) Multi-functional rural landscape with traditional farming as a provider of multiple ES - research in different parts of Slovakia, e.g. Špulerová et al. (2018) (https://doi.org/10.3390/land7020074), Bezák et al. (2020) (https://doi.org/10.3390/land9060195).

v) Cultural ES assessment - in mountains and rural regions, e.g. Liptov, Malá Fatra (Vrbičanová et al. 2020 - https://doi.org/10.3390/su12052138), Vtáčnik (Tomaškinová, Tomaškin & Soporská 2019 - https://doi.org/10.15244/pjoes/90623); in agroecosystems (Makovníková et al. 2016 - https://doi.org/10.17221/109/2015-SWR); or in cities - Trnava (Mederly et al. 2017 - http://147.213.211.222/node/6087), Nitra (Rózová, Turanovičová & Stašová 2020 - https://doi.org/10.2478/eko-2020-0014).

vii) Stakeholder involvement into ES research - e.g. Bezák & Bezáková (2014) (https://doi.org/10.2478/eko-2014-0031), Sarvašová & Dobšinská (2016) (https://doi.org/10.17221/48/2016-JFS), Izakovičová et al. (2017) (http://147.213.211.222/node/6088), Moyzeová (2018) (https://doi.org/10.2478/eko-2018-0005).

CONCLUSIONS

The Carpathians belong to the most important European eco-regions. Biodiversity loss and increasing pressures threaten its outstanding natural values. Centralparks project was developed with the aim to improving management capacities of protected areas, support nature protection and local sustainable development, improve integrated environmental management capacities and policies, enhance transnational cooperation, and mitigate current threats and pressures to biodiversity. Different policy support documents and tools have been developed within the project, tailored for decision-makers and protected area managers, focus on enhancing biodiversity and landscape conservation, local sustainable tourism development, integrated nature conservation planning, habitat evaluation, communication with local communities, and assessment of ecosystem services. Experts from different Carpathian countries, nominated to the transnational thematic task forces, worked on important strategies and guidelines for various stakeholders in the Carpathians, including the toolkit for ecosystem services assessment, based on good practice in the Carpathian countries and in the world. Decision makers on regional and local level in Central Europe, however, often lack the necessary expertise and precise information for making decision on long-term investments in contrasting human-nature conflicts.

The Carpathian Ecosystem Services Toolkit (CEST) is thus intended to support the governmental institutions and other stakeholders in considering ecosystem services in evidence-based decision making, policy development and management practices. It provides a practical set of procedures for understanding what might be gained or lost from a given management choice and the human dimensions of such effects (Preston & Raudsepp-Hearne 2017). It can help managers to better comprehend and address potential issues and reduce conflict.

The separate deliverable developed within the project - step-by-step guidance to complete a comprehensive ES assessment was included in the Toolkit as its integral part. This includes guidance about the information, analysis, and process needed, using experience from similar ES assessments and will depend on what is required to address.

Extensive glossary of related terms and numerous resources for further understanding and capacity building to use ES assessment and to help reflect ES considerations in environmental management and decision-making are included in the CEST as well.

We hope that this interdisciplinary Toolkit for managers and analysts for ES assessment, adapted to Carpathian/ Central European conditions, will be a useful tool for analysis and decisions and related to many issues, especially area-based planning, regulatory decision analysis, environmental damages assessment and management. The CEST will be available for use of any audience (including other Contracting Parties to the Carpathian Convention) also beyond the project lifetime and can be translated to other languages as appropriate and disseminated in other European Regions (Alps, Danube, Adriatic).

The CEST will be tested in trainings for local/regional authorities and users of the Toolkit are encouraged to correspond with the lead authors to provide feedback on their experience. Educational institutions are invited to spread the information to the rising generation of environmental managers.

GLOSSARY

Definitions in this glossary are oriented to the use of terms in the context of ES work. It is based on a comprehensive MAES Glossary that was compiled in the ESMERALDA project (Potschin-Young et al. 2018); it focuses on mapping and assessment of ES and therefore more directly supports the MAES process. From the total 301 terms described in the Potschin-Young glossary, we made a new selection from relevant terms that were originally included in the 'Mapping Ecosystem Services' book (Burkhard & Maes 2017), with newer definition according to Potschin-Young et al. (2018) and several added terms. Together, this glossary contains 135 terms relevant to the mapping and assessment of ES in the Carpathian countries.

TERM	DEFINITION	SOURCE
Abiotic	Referring to the physical (non-living) environment, for example, temperature, moisture and light, or natural mineral substances.	Modified from Lincoln et al. (1998: 1)
Agro-ecosystem	An ecosystem, in which usually domesticated plants and animals and other life forms are managed for the production of food, fibre and other materials that support human life while often also providing non-material benefits.	Burkhard & Maes (2017)
Aquaculture	Breeding and rearing of aquatic organisms (fish, molluscs, crustaceans and aquatic plants) in ponds, enclosures, or other forms of confinement in either fresh or marine waters for direct harvest of the product.	MEA (2005), extended by FAO yearbook Fishery and Aquaculture Statistics (2011)
Assessment	The analyses and review of information derived from research for the purpose of helping someone in a position of responsibility to evaluate possible actions or think about a problem. Assessment means assembling, summarising, organising, interpreting and possibly reconciling pieces of existing knowledge and communicating with an appropriate person so that they are relevant and helpful to the intelligent but inexpert decision-maker.	Parson (1995), also used in Maes et al. (2014, 2018)
Bayesian [Belief] Network (BBN)	A probabilistic graphical model for reasoning under uncertainty, consisting of an acyclic, directed graph describing a set of dependence and independence properties between the variables of the model represented as nodes and a set of (conditional) probability distributions that quantify the dependence relationship.	adapted from Kjærulff & Madsen (2013)
Beneficiary	A person or group whose well-being is changed in a positive way by (in this case) an ecosystem services.	OpenNESS
Benefit Transfer	Estimates economic values by transferring existing benefit estimates from studies already completed for another location or issue.	Potschin-Young et al. (2018)
Benefits	Positive change in wellbeing from the fulfilment of needs and wants.	TEEB (2010), also used in Maes et al. (2014, 2018)
Biodiversity	The variability amongst living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Biodiversity is a contraction of ‚biological diversity'.	(cf. Article 2 of the Convention on Biological Diversity, 1992), also used in Maes et al. (2014, 2018)
Biodiversity Offsets	Conservation activities that are designed to give biodiversity benefits to compensate for losses – ensuring that when a development damages nature (and this damage cannot be avoided via prevention or mitigation) new, bigger or better nature sites will be created. They are different from other types of ecological compensation as they need to show measurable outcomes that are sustained over time.	Potschin-Young et al. (2018)
Bioenergy	Renewable energy made available from materials derived from biological sources.	Common usage

Biomass	The mass of tissues in living organisms in a population, ecosystem, or spatial unit derived by the fixation of energy though organic processes.	MEA (2005)
Biome	The largest unit of ecological classification that is convenient to recognise across the entire globe. Terrestrial biomes are typically based on dominant vegetation structure (e.g. forest, grassland). Ecosystems, within a biome, function in a broadly similar way, although they may have very different species composition. For example, all forests share certain properties regarding nutrient cycling, disturbance and biomass that are different from the properties of grasslands. Marine biomes are typically based on biogeochemical properties. The WWF biome classification is used in the MA.	MEA (2005)
Biophysical Structure	The architecture of an ecosystem as a result of the interaction between the abiotic, physical environment and the biotic communities, in particular vegetation.	Maes et al. (2014)
Biophysical Valuation	A method that derives values from measurements of the physical costs (e.g. in terms of labour, surface requirements, energy and material inputs) of producing given goods or a service.	TEEB (2010), as used in Maes et al. (2014)
Capacity (for an ecosystem service)	The ability of a given ecosystem to generate a specific 'Ecosystem service' in a sustainable way.	SEEA-EEA (2012), as used in Maes (2018)
Capacity Building	A process of strengthening or developing human resources, institutions, organisations or networks. Also referred to as capacity development or capacity enhancement.	UK NEA (2011)
Carbon Sequestration	The process of increasing the carbon content of a reservoir other than the atmosphere.	MEA (2005)
Cartography	The art and science of representing geographic data by geographical means.	Burkhard & Maes (2017)
Classification System [for ES]	An organised structure for identifying and organising ES into a coherent scheme.	Common usage
Conservation	The protection, improvement and sustainable use of natural resources for present and future generations.	Burkhard & Maes (2017)
Contingent Valuation	A stated preference method that uses survey approaches to ask respondents how much they are willing to pay (or accept) for specified changes in the provision of 'Ecosystem services'.	MEA (2005), as used in Potschin-Young et al. (2018)
Coordinate System	It is used to define the positions of the mapped phenomena in space. Furthermore, it acts as a key to combine and integrate different datasets based on their location.	Burkhard & Maes (2017)
Cost-Benefit Analysis	An evaluation method that involves summing up the value of the costs and benefits of an investment/policy/project and comparing options in terms of their net benefits (the extent to which benefits exceed costs).	Potschin-Young et al. (2018)
Cost-Effectiveness Analysis (CEA)	An evaluation method that involves identifying the least cost option that achieves a specified goal.	Potschin-Young et al. (2018)
Cultural Ecosystem Service (CES)	All the non-material, and normally non-consumptive, outputs of ecosystems that affect physical and mental states of people. CES are primarily regarded as the physical settings, locations or situations that give rise to changes in the physical or mental states of people, and whose character are fundamentally dependent on living processes; they can involve individual species, habitats and whole ecosystems. The settings can be semi-natural as well as natural settings (i.e. can include cultural landscapes) providing they are dependent on in situ living processes. In CICES, a distinction between settings that support interactions that are used for physical activities such as hiking and angling, and intellectual or mental interactions involving analytical, symbolic and representational activities is made. Spiritual and religious settings are also recognised. The classification also covers the 'existence' and 'bequest' constructs that may arise from people's beliefs or understandings.	CICES
Damage Cost Avoided	Calculates the damage costs that are avoided due to the regulation of environmental flows by a 'Ecosystems' (e.g. flood attenuation, storm buffering).	Potschin-Young et al. (2018)
Decision-maker	A person, group or an organisation that has the authority or ability to decide about actions of interest.	MEA (2005)

Direct Use Value (of ecosystems)	The economic or social value of the goods or benefits derived from the services provided by an ecosystem that are used directly by an agent. These include consumptive uses (e.g., harvesting goods) and non-consumptive uses (e.g. enjoyment of scenic beauty). Agents are often physically present in an ecosystem to receive direct use value.	adapted from MEA (2005) and Rubicode (2010), as used in Potschin-Young et al. (2018)
Disservice	Negative contributions of ecosystems to human well-being; undesired negative effects resulting from the generation of other ecosystem services.	Potschin-Young et al. (2018), modified TEEB
Ecological Process	An interaction amongst organisms and/or their abiotic environment.	Mace et al. (2012)
Economic Valuation	The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) in monetary terms.	TEEB (2010), also used in Maes et al. (2014, 2018)
Ecosystem	Dynamic complex of plant, animal and microorganisms' communities and their non-living environment interacting as a functional unit. Humans may be an integral part of an ecosystem, although the expression ‚socio-ecological system' is sometimes used to denote situations in which people play a significant role, or where the character of the ecosystem is heavily influenced by human action.	Modified MEA (2005), also used in Maes et al. (2014, 2018)
Ecosystem Accounting	Ecosystem accounting is a coherent and integrated approach to the measurement of ecosystem assets and the flows of services from them into economic and other human activity.	SEEA-EEA (2012), as used in Maes (2018)
Ecosystem Approach	A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use. An ecosystem approach is based on the application of appropriate scientific methods focused on levels of biological organisation, which encompass the essential structure, processes, functions, and interactions among organisms and their environment. It recognises that humans, with their cultural diversity, are an integral component of many ecosystems.	MEA (2005)
Ecosystem Assessment	A social 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.	UK NEA (2011), as used in Maes et al. (2014, 2018)
Ecosystem Asset	Any set of ecosystem units in their respective conditions. Ecosystem assets represent stocks in an accounting context.	based on SEEA-EEA (2012), as used in Czúcz & Condé (2017)
Ecosystem Capacity	The ability of a given ecosystem to generate a specific ecosystem service in a sustainable way.	based on SEEA-EEA (2012), as used in Maes et al. (2018)
Ecosystem Condition	1. The capacity of an ecosystem to yield services, relative to its potential capacity. 2. The physical, chemical and biological condition or quality of an ecosystem at a particular point in time (definition used in MAES). 3. The SEEA-EEA defines ecosystem condition as the overall quality of an ecosystem asset in terms of its characteristics. 4. The overall quality of an ecosystem unit, in terms of its main characteristics underpinning its capacity to generate ecosystem services.	1. MEA (2005) 2. Maes et al. (2018) 3. SEEA-EEA (2012) 4. Czúcz & Condé (2017)
Ecosystem Function	The subset of the interactions between biophysical structures and ecosystem processes that underpin the capacity of an ecosystem to provide ecosystem services. See ecosystem capacity and ecosystem condition.	TEEB (2010), as used in Maes et al. (2018)
Ecosystem Functioning	The operating of an ecosystem. Very often, there is a normative component involved, insofar as ecosystem functioning not only refers to (any) functioning/ performance of the system but to ‚proper functioning' and thus implies a normative choice on what is considered as a properly functioning ecosystem (operating within certain limits).	Based on Jax (2010)
Ecosystem Integrity	Integrity is often defined as an environmental condition that exhibits little or no human influence, maintaining the structure, function and species composition present, prior to, and independent of, human intervention [i.e. integrity is closely associated with ideas of natural conditions, particularly the notion of pristine wilderness [after Angermeier and Karr (1994), Callicott et al. (1999)].	Hull et al. (2003)
Ecosystem Process	Any change or reaction, which occurs within ecosystems, physical, chemical or biological. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy.	MEA (2005), as used in Maes et al. (2014, 2018)
Ecosystem Properties	Attributes which characterise an ecosystem, such as its size, biodiversity, stability, degree of organisation, as well as its functions and processes (i.e. the internal exchanges of materials, energy and information amongst different pools).	MEA (2005), UK NEA (2011)
Ecosystem Services (ES)	The contributions of ecosystems to benefits obtained in economic, social, cultural and other human activity. Note: The concepts of ‚ecosystem goods and services', 'final ecosystem services', and 'nature's contributions to people' are considered to be synonymous with ES in the MAES context.	TEEB, (2010) & SEEA-EEA (2012)

Ecosystem State	The physical, chemical and biological condition of an ecosystem at a particular point of time.	
Ecosystem Status	Ecosystem condition defined among several well defined categories with a legal status. It is usually measured against time and can be compared to agreed policy targets, e.g. in EU environmental directives (e.g. Habitats Directive, Water Framework Directive, Marine Strategy Framework Directive), e.g. "conservation status".	Maes et al. (2018)
Ecosystem Structure	A static characteristic of an ecosystem that is measured as a stock or volume of material or energy, or the composition and distribution of biophysical elements. Examples include standing crop, leaf area, % ground cover, species composition (cf. ecosystem process).	Potschin-Young et al. (2018)
Ecosystem Type	A specific category of an ecosystem typology.	Maes et al. (2018)
Ecosystem Typology	A classification of ecosystem units according to their relevant ecosystem characteristics, usually linked to specific objectives and spatial scales.	Maes et al. (2018)
Ecosystem Unit	An instance of an ecosystem type within a basic spatial unit. In cases when the spatial resolution is relatively fine, it is a meaningful simplification to assume that each basic spatial unit is occupied by just a single ecosystem unit, in which case these two concepts (BSU, EcU) will coincide.	Czúcz & Condé (2017)
Environmental Accounting	See term ‚Natural Capital Accounting'.	
ES Accounting	A structured way of measuring the economic significance of nature that is consistent with existing macro-economic accounts. Ecosystem service accounting involves organising information about natural capital stocks and ecosystem service flows, so that the contributions that ecosystems make to human well-being can be understood by decision makers and any changes tracked over time. Accounts can be organised in either physical or monetary terms.	Potschin-Young et al. (2018)
ES Assessment	An appraisal of the status and trends in the provision of ecosystem services in a specified geographic area. The general aim of an ecosystem service assessment is to highlight and quantify the importance of ecosystem services to society. Ecosystem service assessments are multidisciplinary in nature, applying and combining biophysical, social and economic methods.	Potschin-Young et al. (2018)
ES Bundle (supply side)	A set of associated ES that are linked to a given ecosystem and that usually appear together repeatedly in time and/or space.	OpenNESS
ES Bundle (demand side)	A set of associated ecosystem services that are demanded by humans from ecosystem(s).	OpenNESS
ES Classification	A classification of ecosystem services according to the ecological processes they rely on, and the benefits they contribute to.	Czúcz & Condé (2017)
ES Demand	The need for specific ES by society, particular stakeholder groups or individuals. It depends on several factors such as culturally-dependent desires and needs, availability of alternatives, or means to fulfil these needs. It also covers preferences for specific attributes of a service and relates to risk awareness.	Burkhard & Maes (2017)
ES Flow	The amount of an ecosystem service that is actually mobilized in a specific area and time.	OpenNESS, as used in Maes et al. (2018)
ES Mapping	The process of creating a cartographic representation of (quantified) ecosystem service indicators in geographic space and time.	Burkhard & Maes (2017)
ES Model	A scientific (usually computer-based) for quantifying various socio-ecological indicators of an ecosystem service.	Burkhard & Maes (2017)
ES Potential	This describes the natural contributions to ES generation. It measures the amount of ES that can be provided or used in a sustainable way in a certain region. This potential should be assessed over a sufficiently long period of time.	Burkhard & Maes (2017)
ES Supply	The provision of a service by a particular ecosystem, irrespective of its actual use. It can be determined for a specified period of time (such as a year) in the present, past or future.	Burkhard & Maes (2017)
Existence Value	The value that individuals place on knowing that a resource exists, even if they never use that resource (also sometimes known as conservation value or passive use value).	MEA (2005)

Generalisation (map)	This aims to represent the ES-information on a level of detail appropriate for a given scale, user group and use context. It is necessary in cases where the visual density in maps is increasing too rapidly, symbols overlap or topological conflicts become evident due to graphical scaling.	Burkhard & Maes (2017)
Geographic Information System (GIS)	A computer-based system for the Input, Management, Analysis and Presentation (IMAP) of spatially referenced data.	Burkhard & Maes (2017)
Goods	The objects from ecosystems that people value through experience, use or consumption, whether that value is expressed in economic, social or personal terms. Note: the use of this term here goes well beyond a narrow definition of goods simply as physical items bought and sold in markets and includes objects that have no market price (e.g. outdoor recreation). The term is synonymous with benefit (as proposed by the UK NEA) and not with service (as proposed by the MA).	UK NEA (2011)
Governance	The process of formulating decisions and guiding the behaviour of humans, groups and organisations in formally, often hierarchically organised decision-making systems or in networks that cross decision-making levels & sector boundaries.	Rhodes (2007), Saarikoski et al. (2013)
Green Infrastructure (GI)	A strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ES. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings.	European Commission (2013)
Habitat	1. [in a general context]: The physical location or type of environment in which an organism or biological population lives or occurs, defined by the sum of the abiotic and biotic factors of the environment, whether natural or modified, which are essential to the life and reproduction of the species. 2. [in a MAES context]: A synonym for 'ecosystem type' Note: the Council of Europe definition is more specific: the habitat of a species, or population of a species, is the sum of the abiotic and biotic factors of the environment, whether natural or modified, which are essential to the life and reproduction of the species within its natural geographic range.	based on EEC, (1992), as used in Maes et al. (2018)
Health (Human)	A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. The health of a whole community or population is reflected in measurements of disease incidence and prevalence, age-specific death rates and life expectancy.	UK NEA (2011)
Hedonic Pricing	A revealed preference method that estimates the influence of environmental characteristics on the price of marketed goods to identify the marginal willingness to pay for changes in those environmental characteristics.	Potschin-Young et al. (2018)
Hemeroby	The degree of the anthropogenic influence on a land use (LU) or land cover (LC) type.	Burkhard & Maes (2017)
Human Inputs	Encompass all anthropogenic contributions to ES generation such as land use and management (including system inputs such as energy, water, fertiliser, pesticides, labour, technology, knowledge), human pressures on the system (e.g. eutrophication, biodiversity loss) and protection measures that modify ecosystems and ES supply.	Burkhard & Maes (2017)
Human Well-Being	A state that is intrinsically (and not just instrumentally) valuable or good for a person or a societal group, comprising access to basic materials for a good life, health, security, good physical and mental state, and good social relations.	MEA (2005), as used in Maes et al. (2018)
Impact	Negative or positive effect on individuals, society and/or environmental resources resulting from environmental change.	Harrington et al. (2010)
Indicator	An indicator is a number or qualitative descriptor generated with a well-defined method which reflects a phenomenon of interest (the indicandum). Indicators are frequently used by policy-makers to set environmental goals and evaluate their fulfilment.	Heink & Kowarik (2010), as used in Maes et al. (2018)
Indirect Use Value	The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem. (Compare Direct use value).	MEA (2005)

Intrinsic Value	Intrinsic value is the value something has independent of any interests attached to it by an observer or potential user. This does not necessarily mean that such values are independent of a valuer (i.e. values which exist per se); they may also require a (human) valuer (but this is a matter of disagreement amongst philosophers).	OpenNESS, as used in Burkhard & Maes (2017)
Land Cover (LC)	The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Related to, but not synonymous with, Land Use.	UK NEA (2011)
Landscape	An area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors. The term "landscape" is thus defined as a zone or area as perceived by local people or visitors, whose visual features and character are the result of the action of natural and/or cultural factors. Recognition is given to the fact that landscapes evolve through time and are the result of natural and human activities. Landscape should be considered as a whole - natural and cultural components are taken together, not separately.	European Landscape Convention Article 1, as used in Burkhard & Maes (2017)
Landscape Metrics	Landscape metrics capture composition and configuration of landscape structure in mathematical terms. Not only spatial but also temporal properties of processes can be characterised by a quantifying landscape pattern.	Burkhard & Maes (2017)
Land Use (LU)	The human use of a piece of land for a certain purpose such as irrigated agriculture or recreation. Influenced by, but not synonymous with, land cover.	UK NEA (2011)
Map	The main product of cartographic work is the graphic representation of features of an area of the Earth or of any other celestial body drawn to scale.	Burkhard & Maes (2017)
Mapping	Graphical representation of a procedure, process, structure, or system that depicts arrangement of and relationships among its different components, and traces flows of energy, goods, information, materials, money, personnel.	Potschin-Young et al. (2018)
Market Price	Prices for 'Ecosystem services' that are directly observed in markets. Very often such prices need to be adjusted for market distortions.	Potschin-Young et al. (2018)
Model (scientific)	A simplified representation of a complex system or process including elements that are considered to be essential parts of what is represented. Models aim to make it easier to understand and/or quantify by referring to existing and usually commonly accepted knowledge.	Burkhard & Maes (2017)
Monetary Valuation (for ES)	The process whereby people express the importance or preference they have for the service or benefits that ecosystems provides in monetary terms. See 'Economic valuation'.	OpenNESS from TEEB, as used in Potschin-Young et al. (2018)
Multi-Criteria Decision Analysis (MCDA)	A decision-support method that helps to systematically explore the pros and cons of different alternatives, by comparing them against a set of explicitly defined criteria. These criteria account for the most relevant aspects in a given decision-making process. Operationally, MCDA supports structuring decision problems, assessing the performance of alternatives across criteria, exploring 'trade-offs,' formulating a decision and testing its robustness.	Adem Esmail & Geneletti (2018)
Multifunctionality	The characteristic of ecosystems to simultaneously perform multiple functions which may be able to provide a particular ES bundle or bundles.	OpenNESS, as used in Burkhard & Maes (2017)
Multiple-use Management	Management of land or resources for more than one purpose.	Burkhard & Maes (2017)
Narrative Assessment	Aims to understand and describe the importance of nature and its benefits to people with their own words. By using narrative methods, we allow the research participants (residents of a certain place, users of a certain resource, or stakeholders of an issue) to articulate the plural and heterogeneous values of ecosystem services through their own stories and direct actions (both verbally and visually).	Potschin-Young et al. (2018)
Natural Asset	A component of Natural Capital.	OpenNESS, as used in Burkhard & Maes (2017)
Natural Capital	The elements of nature that directly or indirectly produce value for people, including ecosystems, species, freshwater, land, minerals, air and oceans, as well as natural processes and functions. The term is often used synonymously with natural asset, but, in general, implies a specific component.	Modified after MEA (2005)
Natural Capital Accounting	A way of organising information about natural capital so that the state and trends in natural assets can be documented and assessed in a systematic way by decision-makers.	OpenNESS, as used in Burkhard & Maes (2017)

Nature-Based Solutions (NBS)	Living solutions inspired by, continuously supported by and using nature, which are designed to address various societal challenges in a resource-efficient and adaptable manner and to provide simultaneously economic, social, and environmental benefits.	European Commission (2015)
Non-Monetary Valuation	The process whereby people express the importance or preference they have for the service or benefits that ecosystems provide in terms other than money. See Monetary Valuation.	OpenNESS, as used in Burkhard & Maes (2017)
Opportunity Costs	The next highest valued use of the resources used to produce an ecosystem service. As an economic method for quantifying value, the opportunity cost is the monetary value of the foregone alternative use of resources. For example, the opportunity cost of ecosystem services from a natural ecosystem might be the value of agricultural output if the land is converted to agricultural instead of conserved in a natural state.	Potschin-Young et al. (2018)
Participatory Approach	Family of approaches and methods to enable (rural) people to share, enhance, and analyse their knowledge of life and conditions, to plan and to act, to monitor and evaluate.	Chambers (1997)
Payments for Ecosystem Services (PES)	Conditional payments offered to providers (e.g., farmers or landowners) in exchange for employing management practices that enhance 'Ecosystem service' provision.	Tacconi (2012)
Policy Maker	A person with the authority to influence or determine policies and practices at an international, national, regional or local level.	UK NEA (2011)
Preference Assessment	A direct and quantitative method to demonstrate the social importance of ecosystem services by analysing social motivations, perceptions, knowledge and associated values of 'ecosystem services' demand or use.	Potschin-Young et al. (2018)
Provisioning Ecosystem Services	Those material and energy outputs from ecosystems that contribute to human well-being.	Shortened from CICES
Public Good	A benefit where access to the benefit cannot be restricted.	UK NEA (2011)
Public Pricing	Public expenditure or monetary incentives (taxes/subsidies) for an ES is used as a proxy of the value of the 'Ecosystem service'.	Potschin-Young et al. (2018)
Pragmatics (graphics)	Analyse the relationships between signs and their users.	Burkhard & Maes (2017)
Regulating Ecosystem Services	All the ways in which ecosystems and living organisms can mediate or moderate the ambient environment so that human well-being is enhanced. It therefore covers the degradation of wastes and toxic substances by exploiting living processes.	Modified after CICES
Replacement Cost (alternative cost method)	The cost of replacing an 'Ecosystem service' with a man-made service is used as a proxy of the value of the replaced 'Ecosystem service'.	Potschin-Young et al. (2018)
Restoration Cost	The cost of restoring degraded ecosystems to ensure provision of 'Ecosystem service' as a proxy of the value of the 'Ecosystem service'.	Potschin-Young et al. (2018)
Rivalry	The degree to which the use of one ES prevents other beneficiaries from using it. Non-rival ES, in return, provide benefits to one person and do not reduce the amount of benefits available for others.	as used in Potschin-Young et al. (2018)
Scale (spatial and temporal)	The physical dimensions, in either space or time, of phenomena or observations. Regarding temporal aspects of ES supply and demand, hot moments are equally as important as spatially relevant hotspots.	as used in Burkhard & Maes (2017)
Scale (on a map)	Represents the ratio of the distance between two points on the map to the corresponding distance on the ground.	Burkhard & Maes (2017)
Scenario	Plausible, but simplified descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces and relationships. Scenarios are not predictions of what will happen, but are projections of what might happen or could happen given certain assumptions about which there might be great uncertainty.	OpenNESS, modified from UK NEA (2011)
Semantics (graphics)	The study of the relationships between signs and symbols and what they are actually representing.	Burkhard & Maes (2017)
Service Benefiting Area (SBA)	Spatial unit to which an ecosystem service flow is delivered to beneficiaries. SBAs spatially delineate groups of people who knowingly or unknowingly benefit from the ecosystem service of interest.	Burkhard & Maes (2017)

Service Connecting Area (SCA)	Connecting space between non-adjacent ecosystem service-providing and service-benefiting areas. The properties of the connecting space influence the transfer of the benefit.	Burkhard & Maes (2017)
Service Providing Area (SPA)	Spatial unit within which an ecosystem service is provided. This area can include animal and plant populations, abiotic components as well as human actors.	Burkhard & Maes (2017)
Socio-Economic System	Our society (which includes institutions that manage ecosystems, users that use their services and stakeholders that influence ecosystems).	Maes et al. (2014, 2018)
Social-Ecological System	Interwoven and interdependent ecological and social structures and their associated relationships.	OpenNESS, as used in Burkhard & Maes (2017)
Socio-Cultural Valuation	The process whereby the perceived importance or preference people have for a specific element of the MAES framework is estimated in terms other than money.	OpenNESS, as used in Czúcz & Condé (2017)
Species	A taxon of the rank of species; in the hierarchy of biological classification the category below genus; the basic unit of biological classification.	Lincoln et al. (1998: 280)
Stakeholder	Any group, organisation or individual who can affect, or is affected by, the ecosystem's services.	OpenNESS
Stakeholder Analysis	Can be defined as a process that: i) defines aspects of a social and natural phenomenon affected by a decision or action; ii) identifies individuals, groups and organisations who are affected by or can affect those parts of the phenomenon (this may include nonhuman and non-living entities and future generations); and iii) prioritises these individuals and groups for involvement in the decision-making process.	Reed at al. (2009)
Sustainability	A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs. Weak sustainability assumes that needs can be met by the substitution of different forms of capital (i.e. through trade-offs); strong sustainability posits that substitution of different forms of capital is seriously limited.	UK NEA (2011)
Synergies	Ecosystem service synergies arise when multiple services are enhanced simultaneously.	Raudsepp-Hearne et al. (2010)
Tiered Approach	A classification of available methods according to level of detail and complexity with the aim of providing advice on method choice. The provision and integration of different tiers enables ES assessments to use methods consistent with their needs and resources.	Burkhard & Maes (2017)
Total Economic Value (TEV)	A widely used 'framework' to disaggregate the components of utilitarian value in monetary terms, including direct use value, indirect use value, option value, quasi-option value, and existence value.	OpenNESS
Trade-offs	'Ecosystem service' trade-offs arise from management choices made by humans. Such choices can change the type, magnitude, and relative mix of 'Ecosystem service' provided by an 'ecosystem'. Trade-offs occur when the provision of one 'Ecosystem service' is reduced as a consequence of increased use of another 'Ecosystem service'. Note: In some cases, a trade-off may be an explicit choice, in others, trade-offs arise without awareness that they are taking place.	Rodríguez et al. (2006)
Transdisciplinarity	A reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge.	Lang et al. (2012)
Travel Cost	A revealed preference method that estimates a demand function for recreational use of a natural area using data on the observed costs and frequency of travel to that destination.	Potschin-Young et al. (2018)
Travel Costs Analysis	Economic valuation techniques that use observed costs to travel to a destination and to derive demand functions for that destination.	MEA (2005)
Uncertainty	An expression for the degree to which a condition or trend (e.g. of an ecosystem) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even what can be known. It may have many types of sources, from quantifiable errors in the data to ambiguously defined terminology or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g. a range of values calculated by various models) or by qualitative statements (e.g. reflecting the judgement of a team of experts).	UK NEA (2011)

Valuation	The process whereby people express the importance or preference they have for the service or benefits that ecosystems provide. Importance Value can be expressed in monetary or non-monetary terms. See 'monetary valuation' and 'non-monetary valuation'.	IPBES (2016)
Value	The contribution of an action or object to user specified goals, objectives, or conditions. The worth, usefulness, importance of something. Thus, value can be measured by the size of the 'well-being' improvement delivered to humans through the provision of good(s). In economics, value is always associated with trade-offs, i.e. something only has (economic) value if we are willing to give up something to get or enjoy it.	MEA (2005), after UK NEA (2011), Mace et al. (2012) & de Groot (2010), as used in Maes et al. (2014, 2018)
Well-Being	see the term "Human Well-Being".	

LIST OF ABBREVIATIONS

BE	Belgium
CBD	Convention on Biological Diversity
CEC	Consumption of Ecosystem Capital
CEST	Carpathian Ecosystem Services Toolkit
CICES	the Common International Classification of Ecosystem Services
CIF	Common Implementation Framework
CLES	Consolidated Layer of Ecosystems
COP	Conference of Parties
CORINE	coordination of information on the environment
CZ	Czech Republic
DK	Denmark
DPSIR	driving forces, pressures, states, impacts, responses framework
EAP	Environment Action Programme
EC	European Commission
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ES	ecosystem services
ESMERALDA	Enhancing ecosystem services mapping for policy and decision making project
EU	European Union
EUNIS	European Nature Information Service
FI	Finland
GE	Germany
GIS	geographic information system
GR	Greece
HU	Hungary
IAS	invasive alien species
ICLEI	Local Governments for Sustainability
IE	Ireland
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IT	Italy
LIFE	the European Union's funding instrument for the environment and climate action
LT	Lithuania
LU	Luxembourg
MAES	Mapping and Assessment of Ecosystems and their Services
MEA	The Millennium Ecosystem Assessment
MESH	Mapping Ecosystem Services to Human well-being - integrative modelling platform
NEAT	National Ecosystem Approach Toolkit
NECONET	National Ecological Network
NEPA	National Environmental Protection Agency
NESP	National Ecosystem Services Partnership
NGO	non-governmental organisation
NINA	Norwegian Institute for Nature Research
NL	the Netherlands
Oppla	EU Repository of Nature-Based Solutions
OpenNESS	EU funded project Operationalisation of natural capital and ecosystem services
OPERAs	European research project Ecosystem Science for Policy & Practice
PES	Payments for Ecosystem Services
PT	Portugal
RAWES	Rapid assessment of wetland ecosystem services

RO	Romania
ROSA	Romanian Space Agency
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SEIS	Shared Environmental Information System
SNA	System of National Accounts
SOC	soil organic carbon
SP	Spain
TEEB	The Economics of Ecosystems and Biodiversity
UK	United Kingdom
UNEP	United Nations Environment Programme
US	United States
WWF	World Wildlife Fund / World Wide Fund for Nature

REFERENCES

Adem Esmail, B. & Geneletti, D. (2018): Multi-criteria decision analysis for nature conservation: A review of 20 years of applications. Methods in Ecology and Evolution 9(1): 42-53.

Affek, A., Degórski, M., Wolski, J., Solon, J., Roo-Zielińska, E., Kowalska, A., Grabińska, B. & Kruczkowska, B. (2020). Ecosystem Service Potentials and their Indicators in Postglacial Landscapes: Assessment and Mapping. Elsevier, New York, 300 pp. ISBN: 978-012-8161-34-0.

Affek, A. & Kowalska, A. (2017). Ecosystem potentials to provide services in the view of direct users. Ecosystem Services 26: 183-196. https://doi.org/10.1016/j.ecoser.2017.06.017

Arany, I., Vári, Á., Aszalós, R., Kelemen, K., Kelemen, M.A., Bone, G., Lellei-Kovács, E., Czúcz, B. (2019). Diversity of Flower-Rich Habitats as a Persistent Source of Healthy Diet for Honey Bees. European Journal of Geography Volume 10, Number 2: 89-106.

Arany, I., Vári, Á., Tanács, E., Czúcz, B. & Kovács-Hostyánszki, A. (2018). Integrated ES assessment at national level - the Hungarian MAES. In: Potschin-Young, M. (ed.). Multifunctional assessment methods and the role of map analyse - Using an Integrated Ecosystem Service Assessment Framework. Deliverable D4.8, EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007, 186 pp.

Barbarosa, de Aruajo C.C., Atkinson, P.M., Dearing, J.A. (2015). Remote sensing of ecosystem services: A systematic review. Ecological Indicators 52: 430–443. https://doi.org/10.1016/j.ecolind.2015.01.007

Barton, D.N. & P.A. Harrison (eds.) (2017). Integrated valuation of ecosystem services. Guidelines and experiences. EU FP7 OpenNESS Project Deliverable 33-44, European Commission FP7.

Bereczki, K., Ódor, P., Csóka, G., Mag, Z. & Báldi, A. (2014). Effects of forest heterogeneity on the efficiency of caterpillar control service provided by birds in temperate oak forests. Forest Ecology and Management 327: 96-105.

Bezák, P., Mederly, P., Izakovičová, Z., Špulerová, J. & Schleyer, C. (2017). Divergence and conflicts in landscape planning across spatial scales in Slovakia: opportunity for an ecosystem services-based approach? In: International Journal of Biodiversity Science, Ecosystem Services & Management 13 (2): 119-135. http://dx.doi.org/10.1080/21513732.2017.1305992

Braat, L. C., E. Gómez-Baggethun, B. Martín-López, D. N. Barton, M. García-Llorente, E. Kelemen & Saarikoski, H. (2014). Framework for integration of valuation methods to assess ecosystem service policies. EU FP7 OpenNESS Project Deliverable 4.2., European Commission FP7.

Brezovská, K. & Holécy, J. (2009). Ocenenie rekreačnej funkcie lesov Vysokých Tatier metódou cestovných nákladov. Acta Facultatis Forestalis Zvolen, Suppl. 1: 151–162.

Bucur, C. & Strobel, D. (2012). Valuation of Ecosystem Services in Carpathian Protected Areas – Guidelines for rapid assessment. Braşov: Green Steps. 26 pp.

Burkhard, B., Kandziora, M., Hou, Y., Müller, F. (2014). Ecosystem service potentials, flows and demands-concepts for spatial localisation, indication and quantification. Landscape Online 34: 1-32.

Burkhard, B. & Maes, J. (eds.) (2017). Mapping Ecosystem Services. Sofia: Pensoft Publishers, 374 pp.

Burkhard, B., Maes, J., et al. (2018). Mapping and assessing ecosystem services in the EU - Lessons learned from the ESMERALDA approach of integration. One Ecosystem 3: e29153.

Burkhard, B., Santos-Martin, F., Nedkov, S. & Maes, J. (2018). An operational framework for integrated Mapping and Assessment of Ecosystems and their Services (MAES). One Ecosystem 3: e22831.

Chambers, R. (1997). Whose Reality Counts? Putting the First Last Intermediate Technology Publications, London.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P. & van den Beltet, M. (1997). The value of the world's ecosystem services and natural capital. Nature 15 (387): 253–260.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S., Kubiszewski, I., Farber, S. & Turner, R. K. (2014). Changes in the global value of ecosystem services. Global Environmental Change 26: 152-158.

Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S. & Grasso, M. (2017). Twenty years of ecosystem services: how far have we come and how far do we still need to go? Ecosystem Services. 28: 1-16.

Czúcz, B. & Condé, S. (2017). Note on definitions related to ecosystem conditions and their services based on different glossaries. Technical Paper 4/201. https://www.researchgate.net/publication/323053577_Note_on_definitions_related_to_ecosystem_conditions_and_their_services_based_on_different_glossaries

Czúcz, B., Báldi, A. & Petz, K. (eds.) (2015). ESMERALDA. Enhancing ecosystem services mapping for policy and decision making: Country Fact Sheet: Hungary (HU). https://catalogue.biodiversity.europa.eu/uploads/document/file/1310/Esmeralda_country_fact_sheet_Hungary.pdf

Černecký, J., Gajdoš, P., Ďuricová, V., Špulerová, J., Černecká, Ľ., Švajda, J., Andráš, P., Ulrych, L., Rybanič, R. & Považan, R. (2020a). Hodnota ekosystémov a ich služieb na Slovensku. Banská Bystrica: ŠOP SR, 166 pp. ISBN 978-80-8184-078-4.

Černecký, J., Gajdoš, P., Špulerová, J., Halada, Ľ., Mederly, P., Ulrych, L., Ďuricová, V., Švajda, J., Černecká, L. & Andráš, P. (2020b). Ecosystems in Slovakia. Journal of Maps 16 (2): 28-35.

Demeyer, R. & Turkelboom, F. (2014). The ecosystem services stakeholder matrix. In: Lovens A. et al. (eds.): OpenNESS manual: Stakeholder analysis for environmental decision-making at local level. EC FP7 Grant Agreement no. 308428. INBO, Brussels.

de Groot., R.S., Alkemade, R., Braat, L., Hein, L. & Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecological Complexity 6: 453-462.

Dick, J., Turkelboom, F., Woods, H., Iniesta-Arandia, I., Primmer, E., Saarela, S.R., Bezák, P., Mederly, P., Leone, M., Verheyden, W., ..., Zulian, G. (2018). Stakeholders' perspectives on the operationalisation of the ecosystem service concept: Results from 27 case studies. Ecosystem Services 29: 552-565.

Dunford, R., Harrison, P., Smith, A., Dick, J., Barton, D.N., Martin-Lopez, B., Kelemen, E., Jacobs, S., Saarikoski, H., Turkelboom, F., Verheyden, W., Hauck, J., ..., Pelkonen, V.Y. (2018). Integrating methods for ecosystem service assessment: Experiences from real world situations. Ecosystem Services 29: 499-514.

Dzeraviaha, I. (2018). Mainstream economics toolkit within the ecological economics framework. Ecological Economics 148: 15-21.EEC (1992). Council directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and flora and fauna.

Ehrlich, P.R. & Ehrlich, A.H. (1981). Extinction: The Causes and Consequences of the Disappearance of Species. Random House, New York, p. 72-98.

Erhard, M., Teller, A., Maes, J., Meiner, A., Berry, P., Smith, A., Eales, R., Papadopoulou, L., Bastrup-Birk, A., Ivits, E., Gelabert, E.R., Dige, G., Petersen, J. A., Reker, J., Cugny-Seguin, M., Kristensen, P., Uhel, R., Estreguil, C., Fritz, M., Murphy, P., Banfield, N., Ostermann, O., Abdul Malak, D., Marín, A., Schröder, C., Conde, S., Garcia-Feced, C., Evans, D., Delbaere, B., Naumann, S., Davis, M., Gerdes, H., Graf, A., Boon, A., Stoker, B., Mizgajski, A., Santos Martin, F., Jol, A., Lükewille, A., Werner, B., Romao, C., Desaulty, D., Wugt Larsen, F., Louwagie, G., Zal, N., Gawronska, S. & Christiansen, T. (2016). Mapping and assessing the condition of Europe's ecosystems: Progress and challenges. Publications Office of the European Union, Luxembourg.

European Commission (2011). Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions. Our life insurance, our natural capital: an EU biodiversity strategy to 2020. COM/2011/0244.

European Commission (2013). Green Infrastructure (GI) — Enhancing Europe's Natural Capital. COM(2013) 249 final, Brussels, 6.5.2013.

European Commission (2015). Towards an EU research and innovation policy agenda for nature-based solutions and re-naturing cities. Final Report of the Horizon 2020 expert group on nature-based solutions and re-naturing cities. Brussels.

European Commission (2019). Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions. The European Green Deal. COM/2019/640.

European Commission (2020). Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions. The EU Biodiversity Strategy for 2030. Bringing nature back into our lives. COM/2020/380.

Fenessy, M.S., Jacobs, A.D. & Kentula, M.E. (2007). An evaluation of rapid methods for assessing the ecological condition of wetlands. Wetlands 27 (3): 543-560.

Finisdore, J., Rhodes, Ch., Haines-Young, R., Maynard, S., Wielgus, J., Dvarskas, A., Houdet, J., Quétier, F., Lamothe, A.K., Ding, H., Soulrad, F., Van Houtven, G. & Rowcroft, P. (2020). The 18 benefits of using ecosystem services classification systems. Ecosystem Services 45: 101160. https://doi.org/10.1016/j.ecoser.2020.101160

Fleischer, P., Pichler, V., Fleischer, P. Jr., Holko, L. et al. (2017). Forest ecosystem services affected by natural disturbances, climate and land-use changes in the Tatra Mountains. Climate Research, pp. 1–15. doi.org./10.3354/cr01461.

Frélichová, J., Vačkář, D., Pártl, A., Loučková, B., Harmáčková, Z.V. & Lorencová, E. (2014). Integrated assessment of ecosystem services in the Czech Republic. Ecosystem services 8: 110-117. https://doi.org/10.1016/j.ecoser.2014.03.001.

Frélichová, J. & Fanta, J. (2015) Ecosystem service availability in view of long-term land-use changes: a regional case study in the Czech Republic, Ecosystem Health and Sustainability, 1: 10, 1-15, DOI: 10.1890/EHS15-0024.1

Füzyová, Ľ., Lániková, D. & Novorolský, M. (2009). Economic Valuation of Tatras National park and Regional Environmental Policy. Polish J. of Environ. Stud. 18 (5): 811–818.

Geijzendorffer, R.I. & Roche, K.P. (2013). Can biodiversity monitoring schemes provide indicators for ecosystem services? Ecological Indicators 33: 148– 157. https://doi.org/10.1016/j.ecolind.2013.03.010

Geijzendorffer, R.I., Martín-López, B. & Roche, K.P. (2015). Improving the identification of mismatches in ecosystem services assessments. Ecological Indicators 52: 320–331. https://doi.org/10.1016/j.ecolind.2014.12.016.

Geneletti, D. & Adem Esmail, B. (2018). Guidelines and recommendations to support the application of the final methods. Deliverable D5.4, EU Horizon 2020 ESMERALDA Project.

Geneletti, D., Adem Esmail, B. et al. (2018). Report illustrating the application of the final methods in policy and decision-making. Deliverable D5.3, EU Horizon 2020 ESMERALDA Project.

Geneletti, D., Adem Esmail, B., Cortinovic, C., Arany, I., Balzan, M., van Beukering, P., Bicking, S., Borges, P. A., Borisova, B., Broekx, S., Burkhard, B., Gil, A., Inghe, O., Kopperoinen, L., Kruse, M., Liekens, I., Lowicki, D., Mizgajski, A., Mulder, S., Nedkov, S., Ostergard, H., Picanco, A., Ruskule A., Santos-Martín, F., Sieber, I.M., Svensson, J., Vačkář, D. & Veidemane, K. (2020). Ecosystem services mapping and assessment for policy- and decision-making: Lessons learned from a comparative analysis of European case studies. One Ecosystem 5: e53111. https://doi.org/10.3897/oneeco.5.e53111

Getzner, M. (2009). Economic and cultural values related to Protected Areas. Part A: Valuation of Ecosystem Services in Tatra (PL) and Slovenský Raj (SK) national parks. Final report, 53 pp.

Gómez-Baggethun, E. & de Groot, R. (2010). Chapter 5. Natural Capital and Ecosystem Services: The Ecological Foundation of Human Society. In: Harrison, R. M. & Hester, R.E. (eds.). Ecosystem Services [online]. Cambridge: Royal Society of Chemistry, p. 105-121. Issues in Environmental Science and Technology.

Gómez-Baggethun, E., Martín-López, B., Barton, D., Braat, L., Kelemen, E., Garcia Llorente, M., Saarikoski, H., Bergh, J., Arias-Arévalo, P., Berry, P., Potschin, M., Dunford, R., Keene, H., Schröter-Schlaack, Ch. & Harrison, P. (2014). State-of-the-art report on integrated valuation of ecosystem services. EU FP7 OpenNESS Project Deliverable 4.1., European Commission FP7.

Haines-Young, R. & Potschin, M.B. (2018). Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure, UK, 53 pp. https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf

Haines-Young, R., Potschin-Young, M. & Czúcz, B. (2018). Report on the use of CICES to identify and characterise the biophysical, social and monetary dimensions of ES assessments. Deliverable D4.2, EU Horizon 2020 ESMERALDA Project, 106 pp.

Harrington, R., Dawson, T.P, de Bello, F., Feld, C.K., Haslett, J.R., Kluvánkova-Oravská, T., Kontogianni, A., Lavorel, S., Luck, G.W., Rounsevell, M.D.A., Samways, M.J., Skourtos, M., Settele, J., Spangenberg, J.H., Vandewalle, M., Zobel, M. & Harrison, P.A. (2010). Ecosystem services and biodiversity conservation: concepts and a glossary. Biodivers. Conserv 19: 2773- 2790.

Hein, L., Van Koppen, Ch., Groot, R. & van Ierland, E. (2006). Spatial scales, stakeholders and the valuation of ecosystem services. Ecological economics 57 (2): 209-228.

Heink, U. & Kowarik, I. (2010). What are indicators? On the definition of indicators in ecology and environmental planning. Ecological Indicators 10(3): 584-593.

Hull, R.B., Richert, D., Seekamp, E., Robertson, D. & Buhyoff, G.J. (2003). Understandings of environmental quality: Ambiguities and values held by environmental professionals. Environmental Management 31: 1-13.

IAIA & IEA (International Association for Impact Assessment & Institute of Environmental Assessment) (1999). Principles of Environmental Impact Assessment Best Practice, UK, 4 pp. https://www.iaia.org/uploads/pdf/principlesEA_1.pdf.

IPBES (2016). Preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services (IPBES Del. 3 d).

IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Brondizio, E. S., Settele, J., Díaz, S. & Ngo, H. T. (eds). IPBES Secretariat, Bonn, Germany.

Izakovičová, Z., Miklós, L. & Miklósová, V. (2018). Integrative assessment of land use conflicts. Sustainability 10 (9): 1-30.

Jax, K. (2010). Ecosystem functioning. Cambridge University Press, Cambridge.

Kelemen, E., Barton, D., Jacobs, S., Martín-López, B., Saarikoski, H., Termansen, M., Bela, G., Braat, L, Demeyer, R., García-Llorente, M., Gómez-Baggethun, E., Hauck, J., Keune, H., Luque, H., Palomo, I., Pataki, G., Potschin, M., Schleyer, C., Tenerilli, P. & Turkelboom, F. (2015). Preliminary guidelines for integrated assessment and valuation of ecosystem services in specific policy contexts. EU FP7 OpenNESS Project Deliverable 4.3., European Commission FP7.

Keune, H., Bauler, T. & Wittmer, H. (2013). Ecosystem Services Governance: Managing Complexity? In: Jacobs, S., Dendoncker, N. & Keune, H. (eds.). Ecosystem Services – Global Issues Local Practices. Elsevier, New York, p. 135-155.

Keune, H., Dendoncker, N., Popa, F., Sander, J., Kampelmann, S., Boeraeve, F., Dufrêne, M., Bauler, T., Casaer, J., Cerulus, T., De Blust, G., Denayer, B., Janssens, L., Liekens, I., Panis, J., Scheppers, T., Simoens, I., Staes, J., Turkelboom, F., Ulenaers, P., Van der Biest, K. & Verboven, J. (2015). Emerging ecosystem services governance issues in the Belgium Ecosystem Services Community of Practice. Ecosystem Services 16: 212–219.

Kjærulff, U.B. & Madsen, A. (2013). Bayesian Networks and Influence Diagrams: A Guide to Construction and Analysis. Information Science and Statistics, Springer.

Kondracki, J. (2002). Geografia regionalna Polski. Wyd. Naukowe PWN, Warszawa.

Kovács-Hostyánszki, A., Batáry, P. & Báldi, A. (2011). Local and landscape effects on bee communities of Hungarian winter cereal fields. Agricultural and Forest Entomology 13: 59-66.

Kovács-Hostyánszki, A., Bereczki, K., Czúcz, B., Érdiné Szekeres, R., Fodor, L., Kalóczkai, Á., Kiss, M., Kovács, E., Attila Takács, A., Tanács, E., Török, K., Vári, Á., Zölei, A., & Zsembery, Z. (2018). The Hungarian ecosystem services assessment – an example for a national level science-policy interface. https://doi.org/10.17011/conference/eccb2018/107702.

Kowalska, A., Affek, A., Wolski, J., Regulska, E., Kruczkowska, B., Zawiska, I., Kołaczkowska, E. & Baranowski, J. (2021). Assessment of regulating ES potential of lowland riparian hardwood forests in Poland. Ecological Indicators 120: 106834.

Kuslits B., Vári Á., Tanács E., Aszalós R., .. & Arany I. (2021). Ecosystem Services Becoming Political: How Ecological Processes Shape Local Resource-Management Networks. Front Ecol Evol 9. https://doi.org/10.3389/fevo.2021.635988

Lacina, D. (2019). Mapping and assessment of ecosystem services in the Czech Republic. V4+4 meeting, Smolenice, March 2019, unpublished.

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M. & Thomas, Ch. J. (2012). Transdisciplinary research in sustainability science – practice, principles, and challenges. Sustainability Science 7: 25-43.

La Notte, A., D´Amato, D., Mäkinen, H., Prachcini, L.M., Liquete, C., Eogh, B., Geneletti, D. & Crossman, D.N. (2017). Ecosystem services classification: A systems ecology perspective of the cascade framework. Ecological Indicators 74 (2017): 392–402. https://doi.org/10.1016/j.ecolind.2016.11.030

Lincoln, R., Boxshall, G. & Clark, P. (1998). A dictionary of ecology, evolution and systematics Cambridge, Cambridge University Press.

Mace, G.M., Norris, K. & Fitter, A.H. (2012). Biodiversity and ecosystem services: a multi-layered relationship. Trends in Ecology and Evolution 27(1): 19-26.

Maczka, K., Matczak, P., Pietrzyk-Kaszyńska, A., Rechciński, M., Olszańska, A., Cent, J. & Grodzińska-Jurczak, M. (2016). Application of the ecosystem services concept in environmental policy - A systematic empirical analysis of national level policy documents in Poland. Ecological Economics 128: 169-176. https://doi.org/10.1016/j.ecolecon.2016.04.023.

Maes, J., Paracchini, M., Zulian, G., Dunbar, M. & Alkemade, R. (2012). Synergies and trade-offs between ecosystem service supply, biodiversity, and habitat conservation status in Europe. Biol. Conserv. 155: 1-12.

Maes, J., Liekens, I. & Brown, C. (2018). Which questions drive the Mapping and Assessment of Ecosystems and their Services under Action 5 of the EU Biodiversity Strategy? One Ecosystem 3: e25309.

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L., Berry, P., Egoh, B., Puydarrieux, P., Fiorina, C., Santos, F., Paracchini, M.L., Keune, H., Wittmer, H., Hauck, J., Fiala, I., Verburg, P.H., Condé, S., Schägner, J.P., San Miguel, J., Estreguil, C., Ostermann, O., Barredo, J.I., Pereira, H.M., Stott, A., Laporte, V., Meiner, A., Olah, B., Royo Gelabert, E., Spyropoulou, R., Petersen, J.E., Maguire, C., Zal, N., Achilleos, E., Rubin, A., Ledoux, L., Brown, C., Raes, C., Jacobs, S., Vandewalle, M., Connor, D. & Bidoglio, G. (2013). Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg.

Maes, J., Teller, A., Erhard, M., Murphy, P., Paracchini, M.L., Barredo, J.I., Grizzetti, B., Cardoso, A., Somma, F., Petersen, J.E., Meiner, A., Gelabert, E.R., Zal, N., Kristensen, P., Bastrup-Birk, A., Biala, K., Romao, C., Piroddi, C., Egoh, B., Fiorina, C., Santos, F., Naruševičius, V., Verboven, J., Pereira, H., Bengtsson, J., Gocheva, K., Marta-Pedroso, C., Snäll, T., Estreguil, C., San Miguel, J., Braat, L., Grêt-Regamey, A., Perez-Soba, M., Degeorges, P., Beaufaron, G., Lillebø, A., Malak, A., Liquete, C., Condé, S., Moen, J., Östergård, H., Czúcz, B., Drakou, E.G., Zulian, G. & Lavalle, C. (2014). Mapping and Assessment of Ecosystems and their Services. Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. (2nd MAES Report) Publications office of the European Union, Luxembourg.

Maes, J., Liquete, C., Teller, A., Erhard, M., Paracchini, M.L., Barredo, J.I., Grizzetti, B., Cardoso, A., Somma, F., Petersen, J.E., Meiner, A., Gelabert, E.R., Zal, N., Kristensen, P., Bastrup-Birk, A., Biala, K., Piroddi, CH., Egoh, B., Degeorges, P., Fiorina, Ch., Santos-Martín, F., Naruševičius, V., Verboven, J., Pereira, H.M., Bengtsson, J., Gocheva, K., Marta-Pedroso, C., Snäll, T., Estreguil, Ch., San-Miguel-Ayanz, J., Pérez-Soba, M., Grêt-Regamey, A., Lillebø, A.I., Malak, D.A., Condé, S., Moen, J., Czúcz, B., Drakou, E.G., Zulian, G. & Lavalle, C. (2016). An indicator framework for assessing ecosystem services in support of the EU Biodiversity Strategy to 2020, Ecosystem Services 17: 14–23. https://doi.org/10.1016/j.ecoser.2015.10.023

Maes, J., Zulian, G., Thijssen, M., Castell, C., Baró, F., Ferreira, A.M., Melo, J., Garrett, C.P., David, N., Alzetta, C., Geneletti, D., Cortinovis, C., Zwierzchowska, I., Louro Alves, F., Souto Cruz, C., Blasi, C., Alós Ortí, M.M., Attorre, F., Azzella, M.M., Capotorti, G., Copiz, R., Fusaro, L., Manes, F., Marando, F., Marchetti, M., Mollo, B., Salvatori, E., Zavattero, L., Zingari, P.C., Giarratano, M.C., Bianchi, E., Duprè, E., Barton, D., Stange, E., Perez-Soba, M., van Eupen, M., Verweij, P., de Vries, A., Kruse, H., Polce, C., Cugny-Seguin, M., Erhard, M., Nicolau, R., Fonseca, A., Fritz, M. & Teller, A. (2016). Mapping and Assessment of Ecosystems and their Services. Urban Ecosystems. Publications Office of the European Union, Luxembourg.

Maes, J., Teller, A., Erhard, M., Grizzetti, B., Barredo, J.I., Paracchini, M.L., Condé, S., Somma, F., Orgiazzi, A., Jones, A., Zulian, A., Vallecilo, S., Petersen, J.E., Marquardt, D., Kovacevic, V., Abdul Malak, D., Marin, A.I., Czúcz, B., Mauri, A., Loffler, P., Bastrup-Birk, A., Biala, K., Christiansen, T. & Werner, B. (2018). Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg.

Maes, J., Teller, A., Erhard, M., Condé, S., Vallecillo, S., Barredo, J.I., Paracchini, M.L., Abdul Malak, D., Trombetti, M., Vigiak, O., Zulian, G., Addamo, A.M., Grizzetti, B., Somma, F., Hagyo, A., Vogt, P., Polce, C., Jones, A., Marin, A.I., Ivits, E., Mauri, A., Rega, C., Czúcz, B., Ceccherini, G., Pisoni, E., Ceglar, A., De Palma, P., Cerrani, I., Meroni, M., Caudullo, G., Lugato, E., Vogt, J.V., Spinoni, J., Cammalleri, C., Bastrup-Birk, A., San Miguel, J., San Román, S., Kristensen, P., Christiansen, T., Zal, N., de Roo, A., Cardoso, A.C., Pistocchi, A., Del Barrio Alvarellos, I., Tsiamis, K., Gervasini, E., Deriu, I., La Notte, A., Abad Viñas, R., Vizzarri, M., Camia, A., Robert, N., Kakoulaki, G., Garcia Bendito, E., Panagos, P., Ballabio, C., Scarpa, S., Montanarella, L., Orgiazzi, A., Fernandez Ugalde, O. & Santos-Martín, F., 2020. Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment, EUR 30161 EN, Publications Office of the European Union, Ispra, 2020, ISBN 978-92-76-17833- 0, doi:10.2760/757183, JRC120383.

MEA (Millennium Ecosystem Assessment) (2005). Ecosystems and human well-being: wetlands and water. Synthesis. World Resources Institute, Washington, DC.

Mederly, P., Bezák, P., Lieskovský, J., Halabuk, A., Izakovičová, Z. & Dobrucká, A. (2017). Vybrané metódy hodnotenia ekosystémových služieb – projekt Open-NESS a prípadová štúdia Trnava. Životné Prostredie 51: 205-212. ISSN 0044-4863.

Mederly, P., Černecký, J., Špulerová, J., Izakovičová, Z., Jančovič, M., Ďuricová, V., Gusejnov, S., Hreško, J., Petrovič, F., Štefunková, D., Šatalová, B., Močko, M., Vrbičanová, G., Kaisová, D., Turanovičová, M., Kováč, T. & Laco, I. (2019). Katalóg ekosystémových služieb Slovenska. Banská Bystrica, Slovakia: SNC SR, 2019, ISBN: 978-80-8184-067-8.

Mederly, P., Černecký, J., Špulerová, J., Izakovičová, Z., Ďuricová, V., Považan, R., Švajda, J., Močko, M., Jančovič, M., Gusejnov, S., Hreško, J., Petrovič, F., Štefunková, D., Šatalová, B., Vrbičanová, G., Kaisová, D., Turanovičová, M., Kováč, T. & Laco, I. (2020). National ecosystem services assessment in Slovakia – meeting old liabilities and introducing new methods. One Ecosystem 5: e53677. https://doi.org/10.3897/oneeco.5.e53677

Mederly, P. & Černecký, J. (eds). (2020). A Catalogue of Ecosystem Services in Slovakia. Benefits to Society. Springer International Publishing, ISBN 978-3-030-46507-0, 244 pp. https://doi.org/10.1007/978-3-030-46508-7.

Molnár, Z., Bartha, S., Seregélyes, T., Illyés, E., Botta-Dukát, Z., Tímár, G., Horváth, F., Révész, A., Kun, A., Bölöni, J., Biró, M., Bodonczi, L., József, A. D., Fogarasi, P., Horváth, A., Isépy, I., Karas, L., Kecskés, F., Molnár, C., Ajkai, A.O. & Rév, S. (2007). A GRID-based, satellite-image supported, multi-attributed vegetation mapping method (MÉTA). Folia Geobotanica 42: 225–247.

NCAL (2020). LIFE ecosystem services project toolkit (Latvia). Nature Conservancy Agency of Latvia online toolkit. Online: https://ekosistemas.daba.gov.lv/public/eng/toolkit/

NEAT (2014). National Ecosystem Approach toolkit – Ecosystem services tools. Birmingham University, UK. Online: http://neat.ecosystemsknowledge.net/ecosystem-services-tools.html

NEPA (National Environmental Protection Agency) (2017). Assessment of Ecosystems and Ecosystem Services in Romania. NEPA, NINA, ROSA, WWF Romania, 197 pp. ISBN 978-606-8038-23-0.

NESP (National Ecosystem Services Partnership) (2016). The Federal Resource Management and Ecosystem Services Guidebook. Online: https://nespguidebook.com.

Neugarten, R.A., Langhammer, P.F., Osipova, E., Bagstad, K.J., Bhagabati, N., Butchart, S.H.M., Dudley, N., Elliott, V., Gerber, L.R., Gutierrez Arrellano, C., Ivanić, K.-Z., Kettunen, M., Mandle, L., Merriman, J.C., Mulligan, M., Peh, K.S.-H., Raudsepp-Hearne, C., Semmens, D.J., Stolton, S. & Willcock, S. (2018). Tools for measuring, modelling, and valuing ecosystem services: Guidance for Key Biodiversity Areas, natural World Heritage Sites, and protected areas. Gland, Switzerland: IUCN. x + 70pp.

Nikolova, M., Nedkov, S., Arany, I., Aszalós, R., Kovács-Hostyánszki, A., Czúcz, B., Marta-Pedroso, C., Adamescu, C.M., Cazacu, C., Brown, C., Burns, A., Arnell A., Stępniewska, M., Łowicki, D., Lupa, P., Mizgajski, A., Roche, P., Campagne, C.S., Balzan, M., Haines-Young, R., Potschin-Young, M. & Potschin-Young, M. (2018). Report on Multifunctional assessment methods and the role of map analyse - Using an Integrated Ecosystem Service Assessment Framework: Deliverable D4.8, EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007, 186 pp.

Olander, L., Mason, S., Warnell, K. & Tallis, H. (2018). Building Ecosystem Services Conceptual Models. National Ecosystem Services Partnership Conceptual Model Series No. 1. Durham, NC: Duke University, Nicholas Institute for Environmental Policy Solutions.

Parson, E.A. (1995). Integrated Assessment and Environmental Policy Making, in Pursuit of Usefulness. Energy Policy 23(4/5): 463–476.

Peh, K.S.H., Balmford, A., Bradbury, R.B., Brown, C., Butchart, S.H.M., Hughes, F.M.R., Stattersfield, A., Thomas, D.H.L., Walpole, M., Bayliss, J., Gowing, D., Jones, J.P.G., Lewis, S.L., Mulligan, M., Pandeya, B., Stratford, C., Thompson, J.R., Turner, K., Vira, B., Willcock, S. & Birch, J.C. (2013). TESSA: a toolkit for rapid assessment of ecosystem services at sites of biodiversity conservation importance. Ecosyst. Serv. 5: 51–57. https://doi.org/10.1016/j.ecoser.2013.06.003

Petz, K, Minca, E.L., Werners, S.E. & Leemans, R. (2012). Managing the current and future supply of ecosystem services in the Hungarian and Romanian Tisza River Basin, Regional Environmental Change 12: 689-700.

Pierce, R. J. (2014). Local Integrated Planning Toolkit for Biodiversity and Ecosystem services. A Report for ICLEI Cities Biodiversity Center. ICLEI Africa Secretariat, 92 pp.

Pietrzyk-Kaszyńska, A., Rechciński, M., Olszańska, A., Mączka, K., Matczak, P., Niedziałkowski, K., Cent, J., Peek, B. & Grodzińska-Jurczak, M. (2016). Usługi ekosystemów na obszarach cennych przyrodniczo z perspektywy różnych grup interesariuszy [Ecosystem services in protected areas from the perspective of various stakeholder groups], IOP PAN, Kraków.

Potschin, M. & Haines-Young, R. (2011). Ecosystem services. Progress in Physical Geography 35 (5): 575-594.

Potschin, M., Haines-Young, R., Heink, U. & Jax, K. (2014). OpenNESS Glossary (V2.0). [online]. Available from: http://www.openness-project.eu/library/referencebook

Potschin, M., Haines-Young, R., Fish, R. & Turner, K. R. (2016). Routledge handbook of ecosystem services. 1. ed. New York: Routledge, Taylor & Francis Group, 630 pp.

Potschin-Young, M., Burkhard, B., Czúcz, B. & Santos Martín, F. (2018). Glossary for Ecosystem Service mapping and assessment terminology. Deliverable D1.4 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007, 49 pp.

Považan, R., Getzner, M. & Švajda, J. (2014a). Value of ecosystem services in mountain national park. Case study of Veľká Fatra National Park (Slovakia). Polish Journal of Environmental studies 23 (5): 1699-1710. ISSN 1230-1485.

Považan, R., Getzner, M. & Kadlečík, J. (2014b). Hodnotenie ekosystémových služieb v chránených územiach Karpát so zameraním na Slovensko – Metodický postup pre rýchle hodnotenie. Quaestiones rerum naturalium 1 (2): 7–44.

Považan, R., Getzner, M. & Švajda, J. (2015). Valuation of ecosystem services in the NP Muránska planina (Slovakia) – case study. Eco.mont: Journal on Protected Mountain Areas Research and Management 7 (1): 61–69.

Preston, S. M. & Raundsepp-Hearne, C. (eds.) (2017). Ecosystem Service Toolkit: Completing and Using Ecosystem Service Assessment for Decision-Making: An Interdisciplinary Toolkit for Managers and Analysts. Federal, Provincial, and Territorial Governments of Canada, Ottawa. Ottawa: Environment and Climate Change Canada Enquiry Centre, 276 pp. ISBN: 978-0-660-07074-2.

Raudsepp-Hearne, C., Peterson, G.D. & Bennett, E.M. (2010). Ecosystem service bundles for analysing tradeoffs in diverse landscapes. Proceedings of the National Academy of Sciences. doi/10.1073/pnas.0907284107

Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, Ch., Quinn, C.H. & Stringer, L.C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of Environmental Management 90: 1933-1949.

Rey-Valette, H., Mathé, S. & Salles, J.M. (2017). An assessment method of ecosystem services based on stakeholders perceptions: The Rapid Ecosystem Services Participatory Appraisal (RESPA). Ecosystem Services, 28, 311-319. https://doi.org/10.1016/j.ecoser.2017.08.002.

Rhodes, R. A.W. (2007). Understanding Governance: Ten Years On. Organization Studies 28(8): 1243-1264.

Rodríguez, J.P., T.D. Beard, Jr., E.M. Bennett, G.S. Cumming, S. Cork, J. Agard, A.P. Dobson & Peterson, G.D. (2006). Trade-offs across space, time, and ecosystem services. Ecology and Society 11(1): 28.

Rosin Z., Takacs V. et al. (2011). Ecosystem services as an efficient tool of nature conservation: a view from the Polish farmland (in Polish), Chrońmy przyrodę ojczystą, 1, 3-20.

Rounsevell, M.D.A., Dawson, T.P. & Harrison, P.A. (2010). A conceptual framework to assess the effects of environmental change on ecosystem services. Biodivers Conserv 19: 2823–2842. https://doi.org/10.1007/s10531-010-9838-5

Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Ricketts, T., Bhagabati, N., Wood, S.A. & Bernhardt, J. (2015). Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. Ecological Economics 115: 11-21.

Ruskule, A., Vinogradovs, I. & Pecina, M. V. (2018). The Guidebook on "The Introduction to the Ecosystem Service Framework and its Application in Integrated Planning". Riga: University of Latvia, 63 pp. ISBN: 978-9934-556-39-5.

Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., Kumar, R. & Davidson, N. (2013). The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP, London and Brussels; Ramsar Secretariat, Gland.

Saarikoski, H., Raitio, K., & Barry, J. (2013). Understanding 'successful' conflict resolution: Policy regime changes and new interactive arenas in the Great Bear Rainforest. Land Use Policy 32: 271-280.

Santos-Martín, F., Kelemen, E., García-Llorente, M., Jacobs, S., Oteros-Rozas, E., Barton, D.N., Palomo, P., Hevia, V. & Martín-López, B. (2017). Socio-cultural valuation approaches. In: Mapping Ecosystem Services. 1. ed. Sofia: Pensoft Publishers, 374 pp.

Santos-Martín, F. et al. (2018). Guidance report on a multi-tiered flexible methodology for integrating social, economic and biophysical methods. Deliverable D3.4. EU Horizon 2020 ESMERALDA Project.

SCBD & NCEA (Secretariat of the Convention on Biological Diversity & Netherlands Commission for Environmental Assessment) (2006). Biodiversity in Impact Assessment, Background Document to CBD Decision VIII/28: Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment. Montreal, Canada, 72 pp. www.cbd.int/doc/publications/cbd-ts-26-en.pdf.

SEEA-EEA (2012). System of Environmental-Economic Accounting 2012: Experimental Ecosystem Accounting.

Slootweg, R., Kolkoff, A. & Verheem, R. (2006). Biodiversity in EIA and SEA. Background document to CBD Decision VIII/28. The Netherlands Commission for Environment Assessment, Netherland, 81 pp. https://www.cbd.int/doc/publications/imp-bio-eia-and-sea.pdf.

Slootweg, R. & van Beukering, P.J.H. (2008). Valuation of Ecosystem Services and Strategic Environmental Assessment: Lessons from Influential Cases. Report of the Netherlands Commission for Environmental Assessment, Netherland, 40 pp. ISBN 978-90-421-2537-7. https://www.cbd.int/impact/case-studies/cs-impact-nl-sea-valuation-en.pdf

Slootweg, R., Rajvanshi, A., Mathur, V.B. & Kolhoff, A. (2010). Biodiversity in Environmental Assessment, 154–204, In: Slootweg et al. 2010: Enhancing ecosystem services for human well-being. Cambridge: Cambridge University Press. ISBN 978-0-521-88841-7.

Stępniewska, M., Lupa, P. & Mizgajski, A. (2018a). Drivers of the ecosystem services approach in Poland and perception by practitioners. Ecosystem Services 33: 59–67. https://doi.org/10.1016/j.ecoser.2018.08.010.

Stępniewska, M., Zwierzchowska, I. & Mizgajski, A. (2018b). Capability of the Polish Legal System to Introduce the Ecosystem Services Approach into Environmental Management. Ecosystem Services 29: 271–281. https://doi.org/10.1016/j.ecoser.2017.02.025.

Sunderland, T. & Butterworth, T. (2016). Meeting local economic decision-maker's demand for environmental evidence: The Local Environment and Economic Development (LEED) toolkit. Ecosystem Services, 17, 197-207, https://doi.org/10.1016/j.ecoser.2015.12.007.

Tacconi, L. (2012). Redefining payments for environmental services. Ecological Economics 73(1): 29-36.

Takács, Á., Kiss, M., Hof, A., Tanács, E., Gulyás, Á. & Kántor, N. (2016). Microclimate Modification by Urban Shade Trees – An Integrated Approach to Aid Ecosystem Service Based Decision-making. Procedia Environmental Sciences. 32. 97-109. 10.1016/j.proenv.2016.03.015.

Tanács, E., Belényesi, M., Lehoczki, R., Pataki, R., Petrik, O., Standovár, T., Pásztor, L., Laborczi, A., Szatmári, G., Molnár, Zs., Bede-Fazekas, Á., Kisné Fodor, L., Varga, I., Zsembery, Z. & Maucha, G. (2019). Országos, nagyfelbontású ökoszisztéma-alaptérkép: módszertan, validáció és felhasználási lehetőségek. Természetvédelmi Közlemények 25, 34–58, 10.20332/tvk-jnatconserv.2019.25.34

TEEB (2010). The Economics of the Ecosystem and Biodiversity: Mainstreaming the Economics of Nature. A Synthesis of the Approach, Conclusions and Recommendations of TEEB. Geneva: United Nations Environment Programme, 36 pp.

UK NEA (2011). The UK National Ecosystem Assessment. Technical Report. UNEP-WCMC, Cambridge.

UNEP/GRID-Warszawa (2015). Mapowanie i ocena ekosystemów i ich usług w Polsce, 180 pp.

UNEP (2021). Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies. Nairobi. https://www.unep.org/resources/making-peace-nature

UN General Assembly (2015). Transforming our world: the 2030 Agenda for Sustainable Development, A/RES/70/1, https://www.refworld.org/docid/57b6e3e44.html.

Vačkář, D., Frélichová, J., Lorencová, E., Pártl, A., Harmáčková, Z. & Loučková, B. (2014). Metodologický rámec integrovaného hodnocení ekosystémových služeb v České republice. http://www.ecosystemservices.cz/cs/metodologicky-ramec-integrovaneho-hodnoceni-ekosystemovych-sluzeb-v-ceske-republice.
Vačkář, D., Grammatikopoulou, I., Daněk, J. & Lorencová, E. (2018). Methodological aspects of ecosystem service valuation at the national level. One Ecosystem 3: e25508. https://doi.org/10.3897/oneeco.3.e25508.

Vihervaara, P., Mononen, L., Nedkov S., Viinikka, A., Adamescu, C., Arnell, A., Balzan, M., Bicking, S., Broekx, S., Burkhard, B., Cazacu, C., Czúcz, B., Geneletti, D., Grêt-Regamey, A., Harmáčková, Z., Karvinen, V., Kruse, M., Liekens, I., Ling, M. & Zulian, G. (2018). Biophysical mapping and assessment methods for ecosystem services. ESMERALDA Deliverable D3.3.

Villa, F., Bagstad, K.J., Voigt, B., Johnson, G.W., Portela, R., Honzák, m., Batker, D. (2014). A Methodology for Adaptable and Robust Ecosystem Services Assessment. PLoSONE 9, 3, e91001. doi:10.1371/journal.pone.009100

Wittmer, H. (ed.) (2010). Chapter 6: Spatial planning and environmental assessment, pp. 105–123 In: TEEB - The Economics of Ecosystems and Biodiversity for Local and Regional Policy Makers, Bonn: UNEP, 207 pp. ISBN 978-3-9812410-2-7.

WLE (2016). Mapping Ecosystem Services to Human well-being (MESH): ES integrative modelling platform. Research Programme on Water, Land and Ecosystems. https://wle.cgiar.org/solutions/mapping-ecosystem-services-human-well-being-mesh

Zulian, G., Stange, E., Woods, H., Carvalho, L., Dick, J., Andrews, CH., Baró, F., Vizcaino, P., Barton, D.N., Nowel, M., Rush, G.M., Autunes, P., Fernandes, J., Ferraz, D., Ferreira dos Santos, R., Aszalós, R., Arany, I., Czúcz, B., Priess, J.A., Hoyer, CH., Bürger-Patricio, G., Lapola, D., Mederly, P., Halabuk, A., Bezak, P., Kopperoinen, L. & Viinikka, A. (2018). Practical application of spatial ecosystem service models to aid decision support. Ecosystem Services 29: 465-480.

Further reading

Albert, C., Geneletti, D. & Kopperoinen, L. (2017). Application of ecosystem services in spatial planning. In: Burkhard, B. & Maes, J. (eds.). Mapping Ecosystem Services. Pensoft Publishers, Sofia, 374 pp.

Bateman, I.J., Harwood, A.R., Mace, G.M., Watson, R.T., Abson, D.J., Andrews, B., Binner, A., Crowe, A., Day, B.H., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., Hulme, M., Kontoleon, A., Lovett, A.A., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G., van Soest, D. & Termansen, M. (2013). Bringing ecosystem services into economic decision-making: land use in the United Kingdom. Science 341(6141): 45–50.

Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D. H., Jäger, J. & Mitchell, R.B. (2003). Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences 100(14): 8086-8091.

Cimon-Morin, J., Darveau. M. & Poulin, M. (2013). Fostering synergies between ecosystem services and biodiversity in conservation planning: a review. Biol Conserv. 166: 144–154.

Hauck, J., Stein, Ch., Schiffer, E. & Vandewalle, M. (2015). Seeing the forest and the trees: Facilitating participatory network planning in environmental governance. Glob. Environ. Change 35: 400–410.

Maes, J., Fabrega, N., Zulian, G., Barbosa, A., Viziano, P., Ivits, E., Polce, C. H., Vandecasteele, I., Rivero, I. M., Guerra, C., Castillo, P. C., Vallecillo, S., Baranzelli, C., Barranco, R., Silva, B. F., Crisoni, CH. J. & Trombetti, M. (2015). Mapping and Assessment of Ecosystems and their Services: Trends in ecosystems and ecosystem services in the European Union between 2000 and 2010. Luxembourg: Publications Office of the European Union 2015, 131 pp. ISSN 1831-9424.

Musacchio, L.R. (2013). Key concepts and research priorities for landscape sustainability. Landscape Ecol 28 (6): 995–998.

Sarewitz, D. & Pielke, Jr. R. A. (2007). The neglected heart of science policy: reconciling supply of and demand for science. Environmental Science and Policy 10(1): 5-16.

Seppelt, R., Beckmann, M., Ceauşu, S., Cord, A.F., Gerstner, K., Gurevitch, J., Kambach, S., Klotz, S., Mendenhall, C., Phillips, H.R.P., Powell, K., Verburg, P.H., Verhagen W., Winter, M. & Newbold, T. (2016). Harmonizing biodiversity conservation and productivity in the context of increasing demands on landscapes. BioScience 66 (10): 890-896. https://doi.org/10.1093/biosci/biw004.

Slootweg, R. (2017). Global state of the application of biodiversity-inclusive impact assessments. Report for the Secretariat of the Convention on Biological Diversity Information document CBD/SBSTTA/21/INF/13, 79 pp.

Termorshuizen, J. & Opdam, P. (2009). Landscape services as a bridge between landscape ecology and sustainable development. Landscape Ecol 24(8): 1037–1052.

Vejre, H., Jensen, F.S. & Thorsen, B.J. (2009). Demonstrating the importance of intangible ecosystem services from peri-urban landscapes. Ecological Complexity 7(3): 338-348. https://doi.org/10.1016/j.ecocom.2009.09.005.

Weichselgartner, J. & Kasperson, R. (2010). Barriers in the science-policy-practice interface: Toward a knowledge-action-system in global environmental change research. Global Environmental Change 20 (2): 266-277.

Young, J. C., Jordan, A., Searle, K.R., Butler, A., Chapman, D.S., Simmons, P. & Watt, A.D. (2013). Does stakeholder involvement really benefit biodiversity conservation? Biological Conservation 158: 359-370.

Zhang, L., Fu, B., Lü, Y. & Zeng, Y. (2015). Balancing multiple ecosystem services in conservation priority setting. Landscape Ecol. 30: 535–546.

Annex 1

National ES assessment in Carpathian countries

Czech Republic

The process of mapping and assessment of ecosystem services in the Czech Republic can be described within the figure below:

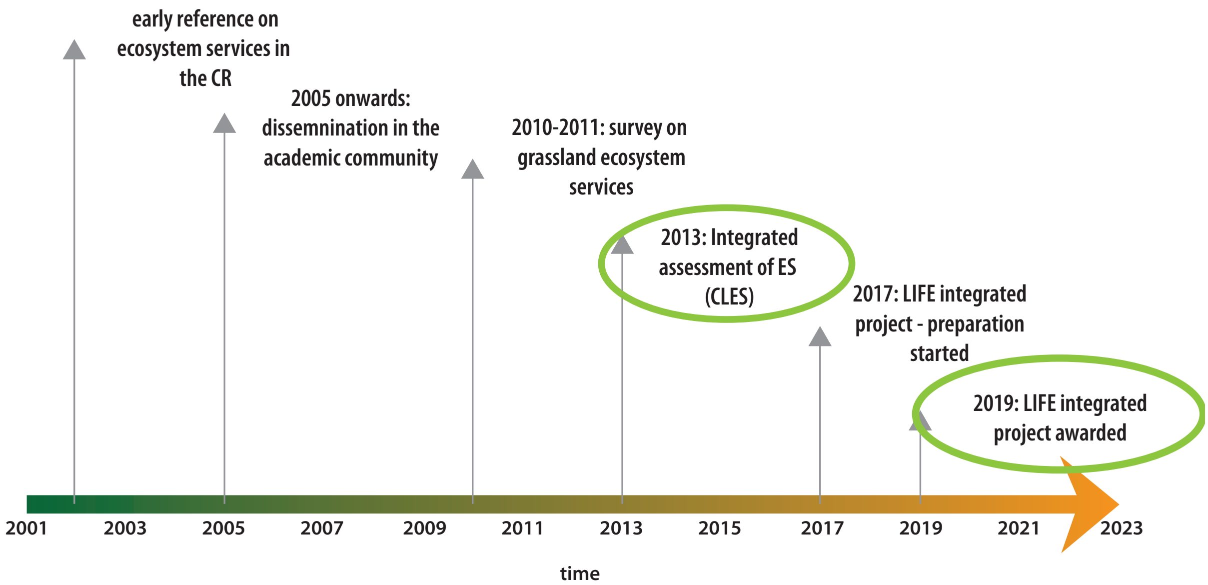

Figure 1.1 - ES assessment in the Czech Republic: Timeline (Source: Lacina 2019)

The study "Integrated assessment of ecosystem services in the Czech Republic" (Frélichová et al. 2014) represents the first attempt on ecosystem services assessment at the national level in the Czech Republic. The study has been initiated by experts and accepted by the Czech Nature Conservation Agency and Ministry of Environment of the Czech Republic as an initiation of the national ecosystem assessment, following TEEB national assessments and CBD and EU strategic targets related to ecosystem services assessments and accounting. The aim of the study was to identify, and value ecosystem services delivered in the Czech Republic.

Methodology and Results

- Mapping of ecosystems (in cooperation with the Nature Conservation Agency) - Consolidated Layer of Ecosystems "CLES" (2013): The structure of the assessment is given by six ecosystem types (agricultural ecosystems, grasslands, forests, aquatic ecosystems, wetlands and urban areas) and 17 ecosystem services delivered from these ecosystems. Ecosystem types are further classified into 41 ecosystem categories based on a habitat approach.
- Database of ecosystem services values.
- Systematic literature review - to collect input data for the database on biophysical and economical values; it was followed by a specific search strategy in two electronic journal databases - Web of Science (WoS) and Scopus.

The ECOSERV database of 197 values of ecosystem services is a result and approximately half of them have been used for a benefit transfer to calculate total ecosystem values in the Czech Republic.

The total aggregated value of ES provided by ecosystems in the Czech Republic annually - that means approx. 1.5 x GDP.

State of the Target 2, Action 5 the Biodiversity Strategy 2020 in the Czech Republic (Lacina 2019):

- Map the state of ecosystems - DONE
- Consolidated Layer of Ecosystems
- Update scheduled for 2020
- Assess the state of ecosystems
- Assess the services and their economic value - DONE
- Outcomes of the CzechGlobe projects
- Promote the integration of these values into accounting and reporting systems

Future plans (Lacina 2019):

Integrated LIFE project for the Natura 2000 network in the Czech Republic – LIFE-IP: N2K Revisited (2019–2026).

Ministry of Environment, Nature Conservation Agency + 3 scientific partners.

Main objective: more effective management system of the Natura 2000 sites, accompanied by cooperation with site land users that effectively utilize advanced knowledge of benefits provided by natural capital within the sites to society and considers relevant costs.

Expected results:

- Ecosystems' capacity to provide an ES supply quantified
- Key ecosystem services, entire area of the country
- Biophysical units, social values
- Web tool to explore
- Demand for ES provided by Natura 2000 sites quantified
- Incl. synergies and conflicts, trade-offs among services
- Methods to assess the benefits and costs associated with Natura 2000 developed
- Local level – to assess the impact of land-use change on the capacity to provide ES
- National level – regular monitoring and evaluation of the benefits of ES for the society
- National Ecosystem Services Platform established and meets regularly
- Intensified communication with land users in Natura 2000 sites
- ES as an argument to accept conservation management
- Analysis of Natura 2000 financing, discussions with stakeholders in charge of funding schemes (ENV, AGRI) in order to ensure funding of Natura 2000 needs (nature conservation)
- Benefits provided by ecosystems to the society (compared to costs) as an argument
- Training of nature protection authorities in order to put developed tools to practice.

Hungary

National MAES assessment is currently ongoing in Hungary.

The project "Strategic investigations on the long-term preservation and development of the natural heritage of Community Importance and on the implementation of the EU Biodiversity Strategy 2020 objective" led by the Ministry of Agriculture and EU-cofinanced has started in Hungary in 2016 to fulfil EU Biodiversity Strategy goals. The project has four main elements, one of them is "mapping and assessment of ES (MAES-HU)". The MAES-HU aims to build up spatial databases of ecosystems and ES in Hungary, and assess them by biophysical, economic and social indicators.

Methodology:

To ensure broad scale scientific, policy and social credibility, the project applies an integrated approach putting high emphasis on participatory planning and stakeholder involvement. At the time of writing this report, the project is ongoing still until May-2021, with a work plan consisting of several distinct tasks in a logical and temporal sequence building on previous results. Figure 1.2 shows the sequence of tasks in MAES-HU.

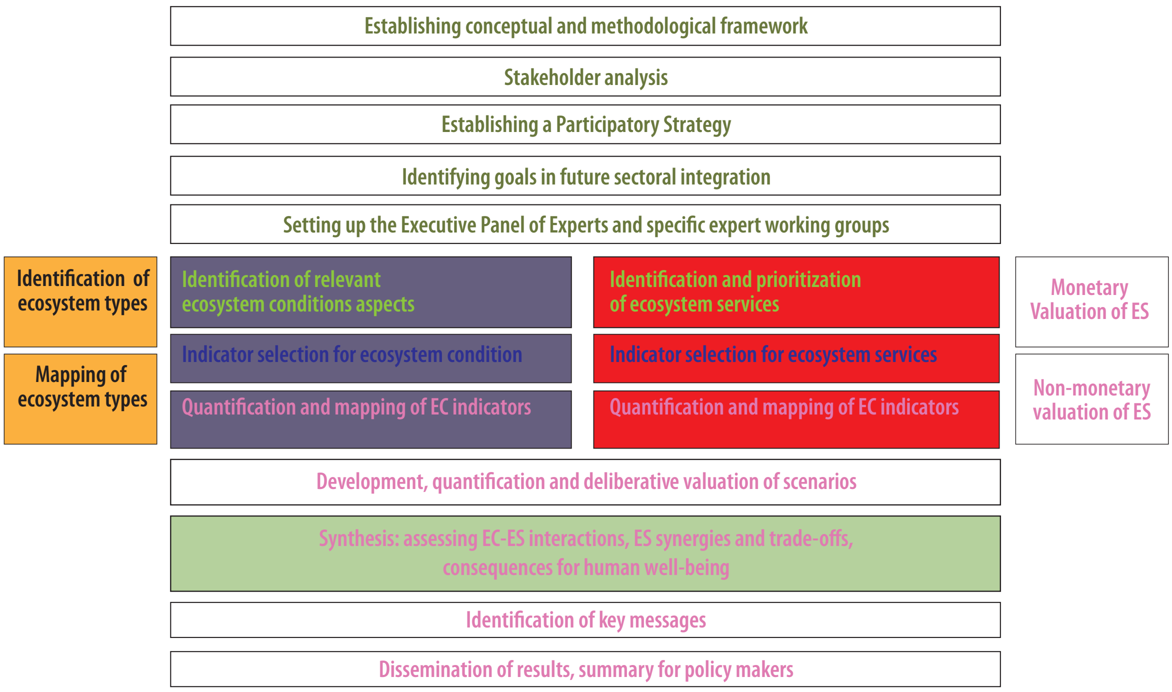

Figure 1.2 - Overview of the main blocks of MAES-HU.

Following a series of expert consultations,12 ES were chosen for mapping and assessment during the project implementation. The 12 selected ES consists of 3 provisioning, 7 regulating and 2 cultural services (Table 1.1). The methodology of the assessment is built on the guidelines of the EU MAES working group (Maes et al. 2014). The evaluation of the prioritized ES is being conducted in a four steps process along the four levels of the ES cascade model (Haines-Young and Potschin 2010): 1) condition of ecosystems, 2) capacity (potential supply) of the ecosystems for the selected ES, 3) actual use of the selected ES, 4) contributions of ES to human wellbeing. Quantitative assessment is performed by six expert working groups, involving around 40 experts from different fields. Graphical representations (i.e. mapping) takes place at the first three cascade levels based on a detailed ecosystem type map (Tanács et al. 2019). Both quantification and mapping of relevant ecosystem condition indicators (cascade level 1) is performed for all 12 ES. At cascade levels 2-4, quantification and mapping of each ES is shown in Table 1.1. In the last year of the project, building of potential future scenarios takes place based on the joint evaluation of the assessed ES.

Table 1.1 - Priority ES selected for MAES-HU, the major ecosystem categories where they were considered important and Quantification (q) / mapping (m) at the different levels of the cascade

Selected ES	Relevant major ecosystems	Cascade levels			
		1	2	3	4
Provisioning					
Cultivated crops for nutrition	Arable fields, grasslands, urban	q+m	q+m	q+m	q
Reared animals for nutrition	Arable fields, grasslands, water-based, urban	q+m	q+m	q+m	
Cultivated plants for energy resources	Arable fields, forests	q+m	q+m	q+m	
Regulation & Maintenance					
Filtration/sequestration/storage/ accumulation by ecosystems	Arable fields, forests, urban	q+m	q+m		
Mitigation of surface degradation and erosion control	Arable fields, forests, grasslands	q+m	q+m	q+m	
Hydrological cycle and water flow maintenance	Arable fields, forests, grasslands, water-based, urban	q+m	q+m		
Flood control and management of rainwater	Forests, urban	q+m	q+m		q
Pollination and seed dispersal	Arable fields, grasslands	q+m	q+m	q+m	
Global climate regulation by reduction of greenhouse gas concentrations	Arable fields, forests, urban	q+m	q	q+m	q
Micro and regional climate regulation	Forests, grasslands, urban	q+m	q+m	q+m	
Cultural					
Use of nature for recreation	Forests, water-based, urban	q+m	q+m		q
Cultural heritage	Arable fields, forests, grasslands, water-based	q+m	q+m	q+m	q

The results of the MAES-HU project will hopefully assist to sustainable management of environmental resources, the development of the green-infrastructures network, improved communication between different sectors, to incorporate the results into biodiversity and sectoral policies, and to reach the UN Sustainable Development Goals (Kovács-Hostyánszki et al. 2018).

Also in terms of **national natural capital accounting**, MAES-HU is the most progressive action. Its results are supposed to be up taken into national accounting after the project is finalised.

Poland

The development and implementation of Ecosystem Services Approach in Poland can be described within the table below:

Table 1.2 - Milestones for development of Ecosystem Services Approach in Poland [i] - international stimulus; [n] - national stimulus (Source: Stępniewska et al. 2018a, modified)

Year	Policy and legislation	Framework and pilot studies	Knowledge and experience dissemination
2001			The Millennium Ecosystem Assessment launched [i]
...			
2007			The Economics of Ecosystems and Biodiversity launched [i]
...			
2010			ECOSERV 2010 Symposium [n]
2011	National Spatial Development Concept 2030 [n]; EU Biodiversity Strategy 2020 [i]		
2012		MAES Working Group [i]	The projects OPERAs and OpenNESS launched [i]; ECOSERV 2012 Symposium [n]
2013	National Strategy for Adaptation to Climate Change [n]		The project: ES in young glacial landscape launched [n]; The Linkage project launched [i/n]
2014		MAES for Poland [n]	ECOSERV 2014 Symposium [n]
2015	Act on Marine Zones of the Republic of Poland and Marine Administration [n]; Programme of conservation and sustainable use of biodiversity [n]; Polish national Urban Policy [n]	Urban MAES for Poland [n]	Project ESMERALDA launched [i/n]
2016			ECOSERV 2016 Symposium [n]; PAEK Conference in Łochów [i/n]
2017	The Strategy for Responsible Development [n]		Project CONNECTING Nature launched [i/n];
2018			ECOSERV 2018 Symposium [i/n]; Conference Ecosystem Services - Potential of Landscape [n]
2019	The European Green Deal [i]; National Strategy of Regional Development 2030 [n]; The 2030 National Environmental Policy [n]		Monograph Ecosystem service potentials […] published by Elsevier [i/n]
2020			Project ECOSERV-POL launched [i/n]
2021	EU Biodiversity Strategy for 2030 [i]		SURE 2020/21 World Congress [i/n]

In 2015, a nationwide preliminary mapping of ecosystems and ES assessment was conducted by UNEP-GRID Warszawa. The work was ordered by the Ministry of Environment and financed by the National Fund for Environmental Protection and Water Management.

Project objectives:

- Determination of the types of ecosystems in Poland based on EUNIS ecosystem classification and CORINE Land Cover classification
- Delimitation of basic units of analysis, i.e. ecosystems
- Creation of assessment matrix showing ecosystem potentials/capacities to provide ES (ES classification according to CICES v 4.3)
- Analysis of the spatial distribution of ecosystem potentials to provide ES
- Development of indicators characterizing the level of ES provision/flow (selected ES)
- Analysis of the spatial distribution of ES provision (selected ES)

Methodology:

Theoretical framework:

- EU Biodiversity strategy to 2020, Target 2, Action 5
- Mapping and Assessment of Ecosystems and their Services (MAES)
- Common International Classification of Ecosystem Services (CICES)
- European Nature Information System (EUNIS)

Source data for mapping ecosystems (according to EUNIS level 2):

- CORINE Land Cover 2012
- High-resolution layers (Copernicus)
- Wetlands layers
- Central Register of Nature Conservation Forms
- BDOT10k – national, high-resolution topographic vector database
- Digital Elevation Model (Topographic Position Index - TPI)
- Map of forest types

Scale of assessment: 1 : 100 000

Minimum mapping unit: 10 ha

Source data for assessing ES potentials:

- CORINE Land Cover 2012
- COPERNICUS – High-Resolution Layers
- Groundwater monitoring data
- Flood risk maps
- Natura 2000 Sites and habitats
- Data of the State Environmental Monitoring
- BDOT10k – national, high-resolution topographic vector database
- Wetlands layers
- Data from the Central Statistical Office
- Data on agro-environmental payments
- Forest data bank
- Education and tourist facilities in forests
- Climate data
- Ecological corridors
- Road network

Some of the used databases were publicly available, some were available on request and free for scientific purposes, and some needed to be bought.

The capacity to provide ES was characterized by several dedicated indicators:

- Provisioning services: 15 indicators, including 3 optional ones
- Regulating services: 18 indicators, including 3 optional ones
- Cultural services: 12 indicators, including 6 optional ones

The conducted expert assessment resulted in the following outputs:

1. **Spatial database of basic assessment units (BAU)**

The database was elaborated at the resolution corresponding to scale 1 : 100 000. The thematic contents of the database included:

a) information on types of ecosystems based on EUNIS level 2,

b) characteristics of BAU's related to the relief, land cover, tree density, impermeable surfaces and meso-regions according to physio-geographical regionalisation by Kondracki (2002).

2. **Map of ecosystem types** at the scale 1 : 2 500 000 showing spatial differentiation of ecosystem types in Poland.

3. **Assessment matrix** – containing a list of 63 ecosystem types (BAU's) and 34 ecosystem services (14 provisioning, 15 regulating and 5 cultural) along with ranks (on the scale from 0 to 5) of potential of respective ecosystem types to deliver specific services.

4. **Spatial database of ecosystem service assessment** with information on ecosystem services: their spatial distribution, potential of respective ecosystems to their delivery, as well as selected assessment indicators related to basic assessment units (BAU's) and to communes: basic units (NUTS-5) of the country's administrative division.

5. **Maps of ecosystem service assessment** at the scale 1 : 2 500 000 presenting spatial differentiation of potential to deliver ecosystem services (in line with assessment matrix).

6. **The final expert report** (UNEP/GRID-Warszawa 2015).

There are more and more projects in Poland aiming at assessing nature potential to provide ES to people (natural capital accounting), e.g. assessment of the potential of riparian forests in the Vistula river valley to provide regulating services (Kowalska et al. 2021), or assessment of ES potentials in postglacial landscapes (Affek et al. 2020). However, the potentials are most often expressed only in physical and not monetary terms, and studies do not cover the Carpathian Region.

Romania

In Romania MAES process started in 2015 as part of the project "Demonstrating and promoting natural values to support decision-making in Romania" (briefly, Nature in public decision N4D or N4D). This project is implemented by the National Environmental Protection Agency (NEPA) in collaboration with World Wildlife Fund - Romania (WWF), Romanian Space Agency (ROSA) and Norwegian Institute for Nature Research (NINA).

Assessment of Ecosystems and Ecosystem Services in Romania - goals:

- The public policy analysis aims to assess the level of integration of the concept of ecosystems and ecosystem services (ecosystem approach) in public policy for the period 2014 - 2020 in order to develop recommendations on integrating the results of mapping and biophysical assessments in decision-making processes. The areas of public policies analysed are: biodiversity, climate change, fishing and aquaculture, agriculture and sustainable development, transport, energy, regional development, tourism, and marine and forest areas. An inventory was made of the responsible institutions, an institutional map and a questionnaire to identify institutional needs related to the MAES process.
- Analysis and data management for the MAES process. This is done by taking the following directions: identification of data sources, analysis of the availability, and analysis of the representativeness and update policies, data integration in the conceptual model and in the physical model of data organization. All these directions are in continuous development both regarding the contribution of the project partners, of the representatives of the Scientific Council and of the contributors to the core national research system.

Mapping and biophysical assessment of the priority ecosystems and ecosystem services (the MAES process itself). Major **results** were achieved regarding:

- Mapping ecosystems at the national level, achieving "Ecosystems classification in Romania EUNICE 3" (intermediate version), the development of tools for updating this distribution (a land field guide to identify the ecosystems, methodological guide for assessing the ecosystem services).
- Selection of methods for assessing the ecosystem services that are carried out continuously based on the matrix of indicators and on the comparative analysis of existing methods (example of results: Cascade model assessment - Cultural service - Education).

Input data used for mapping of ecosystems in Romania are described below (Table 1.3):

Table 1.3 - Input data used for mapping of ecosystems in Romania (Source: NEPA 2017)

Space theme	Source	Description	Scale/ resolution
CORINE Land Cover	European Environment Agency (EEA)	The spatial distribution of 44 land use classes, valid over time series (1990, 2000, 2006 and 2012).	1:100000
LPIS (Agricultural plot identification systems)	National Agency of Cadaster and Land Registration	The delimitation or land plots used for agricultural purposes with stable natural or artificial linear limits and which may include one or more agricultural plots. The physical block is uniquely identified in the geographical information system and represents the reference parcel adopted within the LPIS system in Romania.	1:5000
Orthophoto map	National Agency of Cadaster and Land Registration	Aerial images taken over by digital airborne photogrammetric cameras that are rectified and georeferenced; Orthophoto maps are obtained by orthophotographs processing. Orthophoto maps with national coverage, used for the discretization of natural Ecosystems. The need for discretization at this level of detail comes from the differences in the functionality of each ecosystem and thus in the services provided (Becker et al. 2007, Seabo et al. 2012), distinct in intensity or area)	1:5000
DTM LIDAR	Ministry of Environment	LIDAR data is a remote sensing technology for providing altitude data with a very good prediction. LIDAR scanning uses the laser technique to measure the distance between the aircraft and the ground, taking into account buildings, communication routes and vegetation distribution. LIDAR / FLI-MAP digital terrain models used in hydrological modelling processes, both in the ecosystem mapping stage and in the assessment or ecosystemservices (Quinn et al. 1991). Also, topographical features of the land have a major influence on hydrological, biological and geomorphological processes at its surface, resulting in large heterogeneity in a reduced space of associated ecosystems and ecosystem services (Moore et al. 1991).	Resolution 5 m

Satellite imagery SPOT	CNES (Centre national d'études spatiales)	SPOT satellite Images are high-resolution Earth observation commercial imagery designed to broaden knowledge of natural resources by detecting and forecasting events related to oceanography, climatology or anthropogenic activities. SPOT satellite imagery used to distinguish very similar classes in forest ecosystems, for example, where forest- based ecosystems or coniferous forest ecosystems can be extracted by supervised classification (Salajanu et al. 2001; Xiao et al. 2002).	Resolution MS: 5 m-6 m
Geological map	Geological Institute of Romania	The geological map of Romania, disposed in 50 individual sheets (the layout and nomenclature respect the Gauss. Kruger projection), presents the geological sections (the main features of the depth structure of the territory of each map sheet) and the stratigraphic columns (the ensemble of the existing formations, and formation which do not appear up to date). The material presents a written part on the lithological and paleontological contents of the formations, their distribution and considerations regarding the geological evolution of the territory.	1:200000
Soil map	National Research and Development Institute for Pedology, Agrochemistry and Environmental Protection.	The geological map of Romania, disposed in 50 individual sheets, describes the pedological characteristics of Romania' territory to subtype level.	1:200000
DEM - altitude - slope - exposition landforms, etc.	European Environment Agency (EEA)	EU-DEM: The Digital Terrain Model used is a combination of SRTM 90 and DTED data. SRTM (The Shuttle Radar Topography Mission) obtains large-scale elevation data to generate high-resolution digital models globally.	100*100m
Climatic data	WorldClim – Global Climate Data	Data generated by interpolation of climatic data with a monthly average frequency. The variables included are annual precipitation, monthly average, minimum and maximum temperatures, and 19 derivatives bioclimatic variables.	Resolution 1 km^2
Map of the potential natural vegetation of Europe	BfN, BOHN & NEUHAUSL 200/2003	EuroVegMap2.0.6 Representing on a Europe-wide scale areas of potential natural vegetation, which correspond to certain climatic conditions, soil properties, flora specific to various parts of Europe.	1:2,5 mil
Forest type map	Joint Research Centre, EC	Forest Type Map 2006 Map of forest types, especially for coniferous, hardwoods and water bodies.	25*25m
Natura 2000 network map	Ministry of Environment	The map of protected areas at community level and especially the map of SCIs at national level. Within these areas, the habitat types in Annex 1 of the Habitats Directive are delimited at national level.	1:5000

The methodology of ecosystems mapping:

- Plotting automation of EUNIS habitats, starting from CLC plotting by developing the EUNIS Tree browsing program in Access VBA with algorithm setting (logic scheme).
- Primary evaluation of EUNIS criteria by estimating how criteria are assessed.
- Identify the EUNIS departure criteria for each CLC code and identify on the CLC 2006/2012 map the parcels corresponding directly to a EUNIS level 3 habitat and the area occupied by each habitat obtained.
- Adjusting the database defining the EUNIS Manual as a structure (design tables, queries, reports, relationships establishment) and data (completion and redistribution).
- Creating custom applications (embedded / independent, ArcPython / Visual Basic, Visual C language), incorporating applications (ADD-IN) ArcGIS MAP, used programs ArcObjects 10.3 SDK for .NET + Visual Studio 2013 Express, ArcGIS Map integration – VS.
- Generation of maps for EUNIS criteria related to different abiotic parameters (e.g. pedology, hydrology) that reflect the distribution of the values of each criterion at national level.
- Developing the EUNIS habitats application, starting with primary data, adapting the existing application (with primary CLC data) to LPIS primary data (APIA).
- Make spatial associations at the national level from LPIS to CLC.
- Elaborate the map at the national level with the EUNIS habitats in the variants:
  - LPIS-CLC + spatial association CLC-EUNIS start-up association;
  - Table start association LPIS-EUNIS.
- Reporting of the surfaces of the two map variants at the national level with EUNIS starting levels (0, 1, 2, 3) and classes (A, B, C, D, E, F, G, H, I, J).
- Application development for EUNIS habitats: the creation of an interface for automatic application of a criterion (criterion for which spatial information that exists).
- Elaboration of the code for the automatic application of a criterion. Applying the principle of preserving the initial geometry and the principle of adopting the value of the criterion (decision) that occupies the maximum area on a given plot.
- Identification of parcels with a certain combination (start CLC + EUNIS current) and determination of the value of the applied criterion on each plot and of the new current EUNIS code (by the direct individual search method in the tables and by the combination of the tables).
- Application development for EUNIS habitats: Generalization for the application of all criteria for all plots associated with a specific CLC code.
- Optimization by setting the EUNIS start code and a minimum Tree of Criteria according to the LPIS code combination | CLC code - identifying possible combinations and associated EUNIS (creation of LPIS | CLC tables).

For automatic evaluation, generalization by choosing the primary data type (CLC, CLC | LPIS, LPIS, etc.) from a list and changing the data sources of the controls according to this choice.

Results

All 9 major ecosystem categories existing on the national level were evaluated and 79 EUNIS level 3 classes were identified.

Detailed ES Timber and Climate regulation have been assessed. The Cascade model was used for evaluation of other services and outputs are more or less graphical (Cascade model assessment - Cultural service - Education). It also includes a monetary evaluation of selected ES based on foreign scientific papers.

Slovakia

In 2014, an expert working group MAES-SK was established under the Ministry of the Environment, focusing on the achievement of Target 2 of the EU Biodiversity Strategy, i.e. mapping and assessing ecosystems and services provided by them. The group met more regularly in the period from 2014 to 2016 and met again in 2018. The group consists mainly of representatives of various ministerial professional organizations and institutions, academia and local governments. Experts from the State Nature Conservancy of the Slovak Republic (SNC SR) are also part of the expert group and they started the preparation of several activities and documents necessary for the assessment of the ES at the national level.

An initial **ecosystems map of Slovakia** was prepared (Černecký et al. 2020), using data from various sectors (mainly from nature protection, agriculture and forestry). In 2019, the verification process of the map commenced by botanists directly in the field (25 SNC SR employees) - in the first year about 10 % of the Slovak territory should be verified.

In the period from 2017 to 2018 Slovakia was represented by the Ministry of the Environment of the Slovak Republic in the international project ESMERALDA, funded by the EU Framework Program for research and innovation - Horizon 2020. Representatives of all EU Member States as well as some associated countries participated in the project. The project established a flexible methodology for mapping and assessing ecosystems and services provided by these ecosystems on a Pan-European, national and regional level. One of the outputs was the so-called MAES Explorer, a publicly available online tool to help implement EU Biodiversity Strategy Target 2 (available on the Internet: http://www.maes-explorer.eu/). Another tool provided was the so-called Methods Explorer, which provides a clear structured database of ES mapping and assessment methods.

Other activities related to the ES concept worth mentioning include in particular the systematic monitoring of habitats and species of European importance (66 habitat types and 196 species), which is an important database necessary for the assessment of many ES aspects (Mederly et al. 2020).

Ecosystems map of Slovakia:

The methodology mostly involves using GIS analytical tools (see Figure 1.3) to combine datasets on nature protection, forestry, and agriculture which list attributes related to habitat identification - the final habitat data were classified as ecosystem/habitat types in accordance with the EUNIS classification system (EUNIS level 1 and 3).

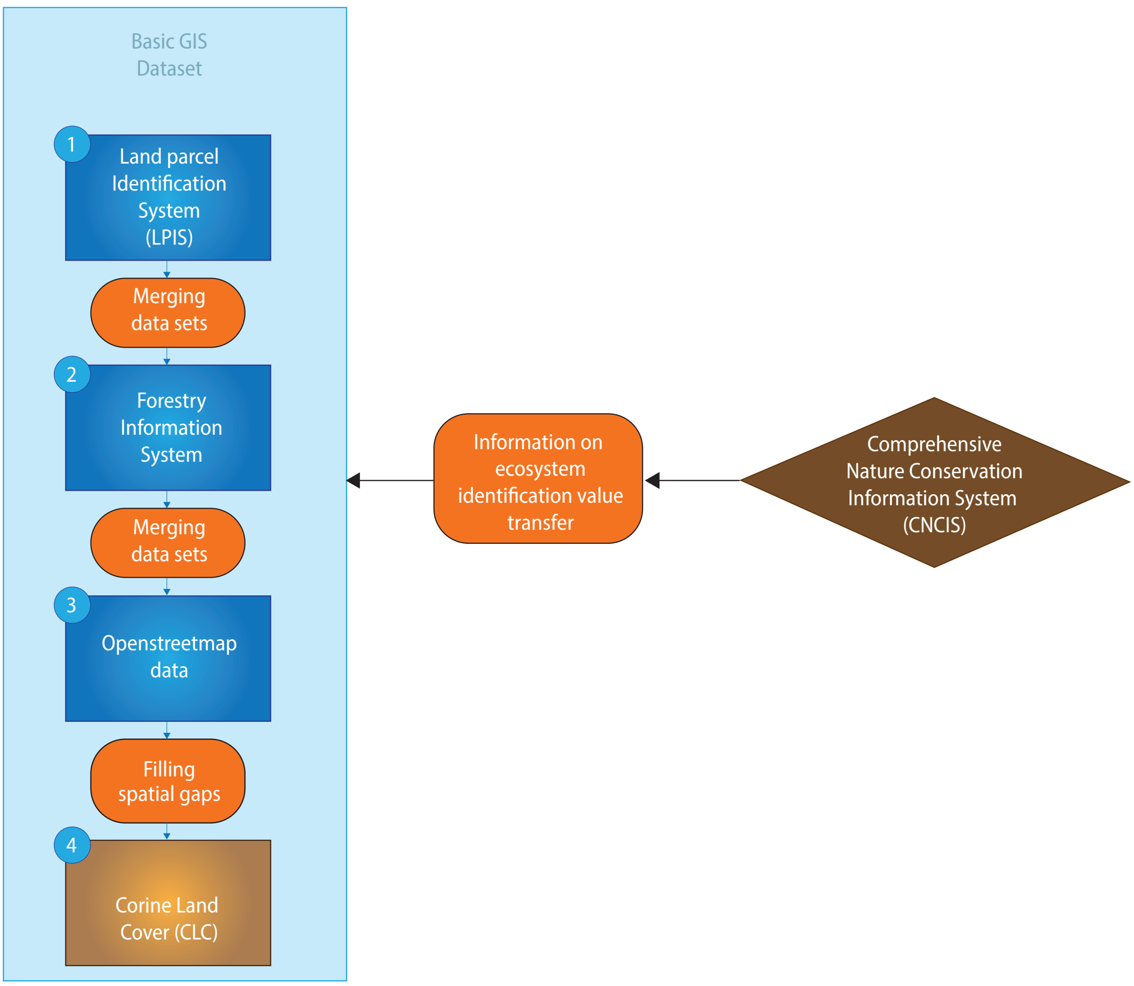

Figure 1.3 - Process of creating the map of ecosystems in Slovakia (Source: Černecký et al. 2020b)

The result - **Ecosystems map of Slovakia** (Figure 1.4) - can be used for ecosystem services assessment, spatial planning, nature protection analysis, and other related purposes. The spatial precision of the data is determined by that of the field data, which was mostly created at scales between 1 : 10 000 and 1 : 5 000. The data are stored in the form of a geodatabase containing more than 1 000 000 polygons.

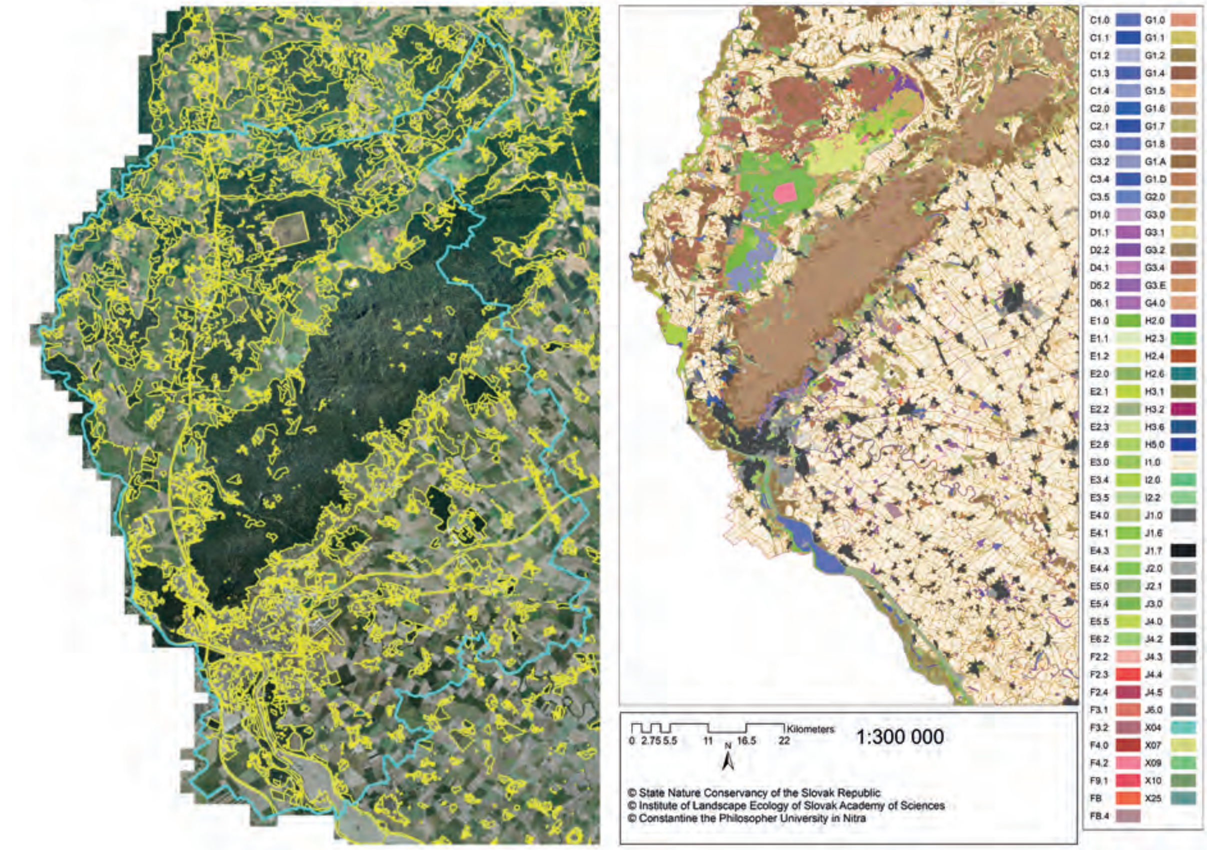

Figure 1.4 - An example from the map of ecosystems of Slovakia – Bratislava Region (Source: Černecký et al. 2020b)

Assessment of Ecosystem Services in Slovakia - framework, goal, methodology and results:

The pilot national ecosystem services assessment in Slovakia follows the MAES process and past ecosystem services research in Slovakia and is based on original research methodology using spatial and statistical data. An overview and results are described in the article of Mederly et al. (2020). The main goal of the publication "The Catalogue of Ecosystem Services in Slovakia" (Mederly & Černecký 2020) is to introduce the most relevant ES in the territory of Slovakia, and to provide initial assessments. The publication is divided into three main chapters – an overview of the theme, assessment of ES in Slovakia and conclusions. The first part of the publication includes review of the ES theory and assessment methods (history, classification, basic methods, recent publications in Europe and Slovakia). The major part of publication is devoted to characteristics of the main ES and assessment of potential capacity for ES in Slovakia. The Catalogue defines and describes 18 ES – 5 provisioning, 10 regulating and 3 cultural services; provides the methods used for the ES identification and assessment on the basis of current scientific articles/publications; characterises the main types/categories of landscape and ecosystems, which provide ES; describes the importance of ES from the view of nature and landscape conservation. Finally, the publication evaluates the capacity of the provision of all 18 selected ES. Conclusion of the publication is devoted to the overall assessment of the main ES groups, their relation to nature and landscape conservation and land use and definition of further tasks of ES assessment in Slovakia for the future.

The authors of the Catalogue used a total of 41 map inputs in raster format with the pixel size 25 m to evaluate the relative capacity for ES provision (the most important of them are: a map of land cover, the map of ecosystems, forestry data, data on protected areas, a digital relief model, and soil features data). The resulting landscape capacity maps present selected ES in the

0 - 100 relative scale in a uniform standardized pixel format of 1 km resolution. Background data contain about 49 000 pixels with individual ES values and thus represent a basic statistical file which is possible to use for further evaluation of the relationships and factors which affect ES provision (see Figure 1.4).

Assessed services:

- Provisioning ecosystems services
  - Biomass - agricultural crops (P1)
  - Biomass – Timber and fibre (P2)
  - Drinking water (P3)
  - Freshwater (P4)
  - Fish & Game / Wild food (P5)

- Regulatory ecosystem services and supporting ecosystem functions
  - Air quality regulation (R1)
  - Water quality regulation (R2)
  - Erosion & natural hazard regulation (R3)
  - Water flow regulation (R4)
  - Local climate regulation (R5)
  - Global climate regulation / Carbon sequestration (R6)
  - Biodiversity promotion (R7)
  - Lifecycle maintenance / Pollination (R8)
  - Pest and disease control (R9)
  - Maintenance of soil formation and composition (R10)

- Cultural ecosystems services
  - Recreation & tourism - physical use of nature & landscape (C1)
  - Landscape aesthetics - aesthetic values (C2)
  - Natural & cultural heritage - intellectual & scientific values (C3)

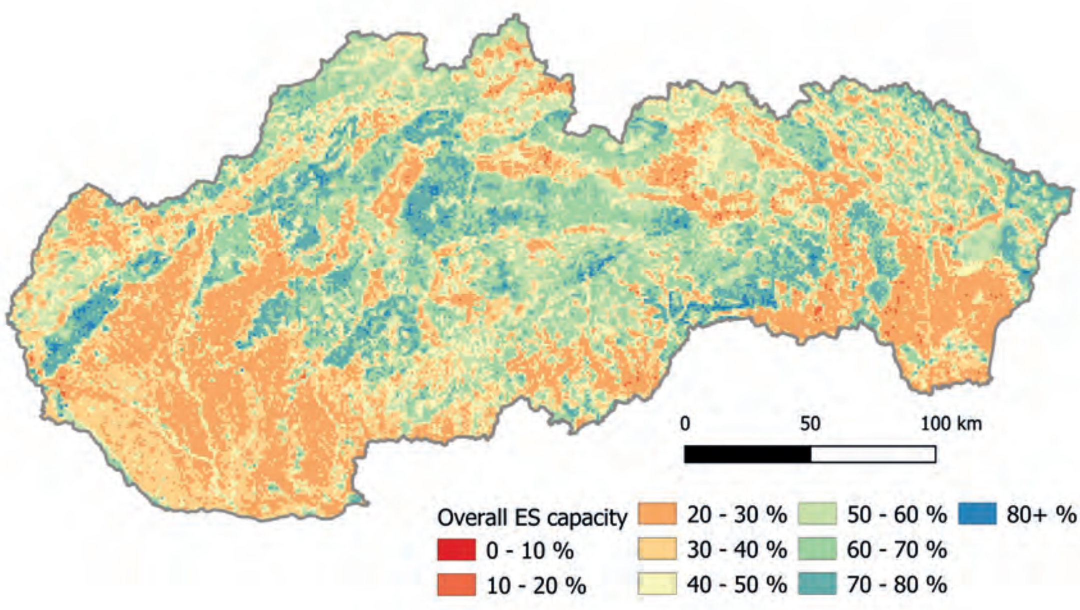

Figure 1.5 - The overall landscape ES capacity for the Slovak Republic (Source: Mederly & Černecký et al. 2019)

A quite different methodology based on the quality of ecosystems and their degradation rate was used in Černecký et al. 2020 in the publication "Value of ecosystem and their services in Slovakia" which presents the potential and supply of Slovak ecosystems to provide 11 regulatory (see Figure 1.6), 10 provisioning and 2 cultural ES by using modified Burkhard potential matrices. The important part of this publication is the initial monetary assessment of selected ES by the Value Transfer method according to prices in Frélichová et al. (2014).

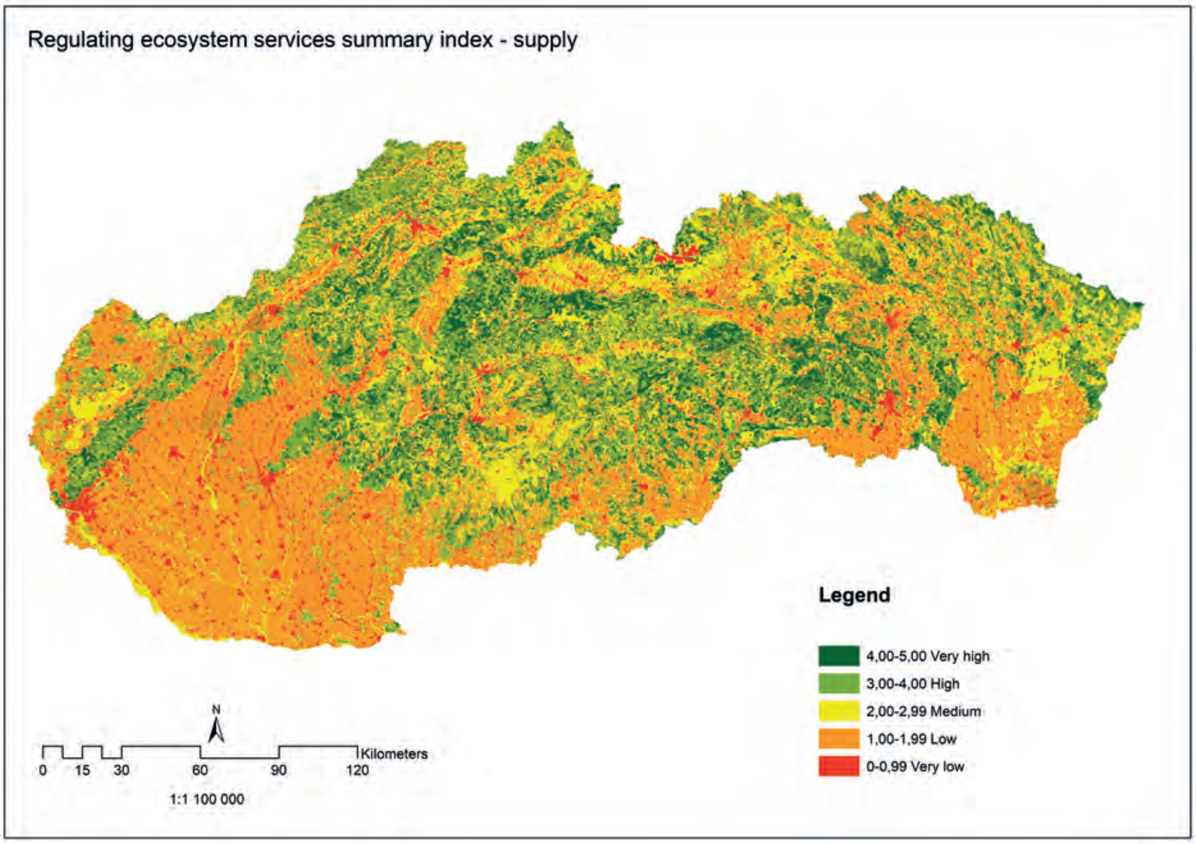

Figure 1.6 - Map of evaluation of supply for 11 regulatory ES according to the average values of the index (Source: Černecký et al. 2020a)

Regarding **national capital** there are some case studies, e.g. in protected areas in Slovakia that are assessing nature capital, respectively assessing ES in monetary terms (Veľká Fatra NP, Slovenský raj NP or Muránska planina NP – see case studies of monetary valuation from Slovakia in the Section 5.2). On the other hand, there is missing comprehensive accounting of natural capital at the national level yet.

Annex 2

Examples of mainstreaming of ES in Carpathian countries

Hungary

The results of the MAES-HU project are expected to contribute to the sustainable management of environmental resources, enhance the development of green infrastructure and improve the incorporation of the results into sectoral policies.

Examples of ES mainstreaming in policy and decision making:

Land use/Spatial planning
Possible directions of future uptake have been developed already in the early phase of the project. This includes incorporating ES into support systems and subsidies and resolving conflicts of land use.

Environmental impact assessment (EIA) / Environmental damages valuation
Possible directions of future uptake have been developed already at the early phase of the project. This includes providing a decision support tool for investments and developments.

Nature conservation (establishing and managing protected areas, management of species and habitats/ecosystems and conservation incentives)
MAES-HU is only one component of the "Strategic investigations on the long-term preservation and development of the natural heritage of Community importance and on the implementation of the EU Biodiversity Strategy 2020 objective" project, with the other component being the development of Green Infrastructure in Hungary. Results of ES mapping will certainly be incorporated into GI regulations in Hungary, but the details of that are still unknown at the time this document is being written.

A list of further possible directions of future uptake has been developed already at the early phase of the project. This includes establishing professional (strategic and long-term) planning inside the nature conservation sector, establishing and monitoring continuous activities (e.g. management) of nature conservation, and strengthening communication and advocacy for nature conservation.

Incorporation into the national policies, strategies, laws
This includes implementation of international and EU legislation, incorporating the results into statistical databases, assisting the authorities, incorporating ES into national legislation and sectoral strategies, establishing professional (strategic and long-term) planning outside the nature conservation sector, identifying research priorities.

However, there is no guarantee for the real uptake of results in this ambitious list of fields in the future, since ensuring this is out of the scope of the project. While not being able to guarantee, the strategic role of the Executive Panel of Expert members might enhance uptake of MAES-HU results, being key transmitters into sectoral policies and having various sectoral leaders among its members familiar with and dedicated to the project.

Poland

Examples of ES mainstreaming in policy and decision making:

Land use/Spatial planning
Growing relevance, the term ecosystem services mentioned directly in the National Spatial Development Concept 2030.

Environmental impact assessment (EIA) / Environmental damages valuation
Growing relevance, mentioned indirectly, e.g. in the Act on Preventing and Repairing Environmental Damage ("functions of environmental elements, understood as the usefulness of protected species, habitats, water or surface of the Earth to other environmental elements or people").

Nature conservation (establishing and managing protected areas, management of species and habitats/ecosystems and conservation incentives)
Little relevance yet, but often mentioned indirectly, e.g. in the Act on the protection of nature, National Strategy for Conservation and Sustainable Use of Biodiversity, the Environmental Protection Act and the Decree on the preparation of the protection plan for a national park, a nature reserve and a landscape park.

Incorporation into the national policies, strategies, laws
ES were not so long ago reflected in the Polish environmental policies almost exclusively in an indirect, latent form, and the concept was almost absent in more detailed, executive decrees (Maczka et al. 2016). See also Stępniewska et al. (2018b). However, currently all the most important strategic documents explicitly address ecosystem services as one of the key concepts used for the evaluation of nature value for the country's economy and planning the sustainable use of natural capital.

Key excerpts from the 4 strategic documents directly addressing ecosystem services

1. The Strategy for Responsible Development (SRD) for the period up to 2020 (including the perspective up to 2030) - main strategic document[6]
Adoption: 14 February 2017

Diagnosis
The natural environment is a natural capital and as such is a potential for the development of specific geographic space. Its resources (renewable and non-renewable) generate a stream of benefits referred to as ecosystem services.

Management of natural heritage resources

Objective: Comprehensive mapping, assessment and valuation of ***ecosystem services*** *for individual types of ecosystem on a national and regional scale is also envisaged.*

On this basis, an assessment and evaluation of individual landscapes and effective protection of habitats and species related to agriculture and rural areas will be made. Introduction of the above information to the investment management system, especially in case of environmental impact assessment, including impacts on the landscape and quality of life, will create an instrument supporting the decision-making process of spatial planning and the location of infrastructure investments (including water management) with a significant impact on the environment and its elements. In this context, among others, it is necessary to objectively assess the implementation of the Natura 2000 network, including verification of its spatial extent and the impact of this form of nature protection on the preservation of biodiversity of native nature and the effectiveness of management of other protected areas.

Actions to be completed by 2020
Mapping and valuation of ecosystem services.

6 https://www.gov.pl/web/fundusze-regiony/informacje-o-strategii-na-rzecz-odpowiedzialnego-rozwoju;
English summary: https://www.gov.pl/documents/33377/436740/SOR_2017_streszczenie_en.pdf

2. National Spatial Development Concept 2030[7]
Adoption: 13 December 2011

Vision of spatial development of Poland in 2030:
Preserved valuable natural and cultural landscapes and objects of material cultural heritage are used in socio-economic development, intensively supporting the development of local economies. The importance of touristic use of waterways - both new and revitalized - has increased while preserving the value of historic technical solutions. The development of settlement and the location of economic investments are locally corrected based on physiographic analyses and environmental impact assessments. In this context, the concept of ecosystem services illustrating the dependence of society on nature is gaining importance. The intensification of the negative effects of natural disturbance also affecting regional and territorial potentials and - in the longer term - the ability of ecosystems to provide specific services, indicate the need to develop an action plan for adapting space to climate change.

Areas that require shaping of development potential through programming of conservation activities - valuable natural areas:
The target network of protected areas includes objects currently covered by statutory nature protection and proposed to be covered with buffer zones, protecting habitats and species important for maintaining biodiversity of the country and continent, functional space referred to as ecological corridors or migration corridors, connecting individual areas with specific legally defined boundaries, and areas providing necessary ecosystem services in urban functional zones. In addition, other areas important for supplying the voivodship's natural system should be identified, including High Nature Value (HNV) areas used for agriculture or forestry.

The country's spatial policy affects the processes taking place in the environment and the ability of ecosystems to provide services used in the development process that determine the daily quality of life, as well as the competitiveness and cohesion of the territory. These include maintaining the sustainability of ecosystems and species, the sustainability of soil production potential and the possibility of its use, water availability and quality, atmospheric air quality, as well as safety in the event of disasters and natural hazards, adaptability of space in the conditions of climate change, preservation of cultural and landscape heritage, intergenerational sustainability of growth and development conditions.
This policy cannot remove the basic contradiction of the objectives of the strategy for the protection of natural resources and processes, and the objectives of socio-economic development going beyond the traditional use of the natural potential of regions, in other way than through postulating an analysis of the functions of the area and ecosystem services so that the planned development of space does not at least reduce the resilience of natural environment.
Some of the planned spatial structures affect the environment, among others, by simplifying the existing landscape and adversely changing its values - also economic. Contemporary cultural landscapes will affect the quality of life of the next generations and the state of preservation of natural diversity also due to the consequences of abandoning this type of analysis and the resulting actions. It was also proposed to apply the concept of ecosystem services to manage the functions of the emerging space and implement the principle of environmental compensation. The compensation principle defined in this way also applies to planning in the investment process the development of ecosystem functions - primarily CO2 absorption, water purification and storage, and other services useful to society that affect the quality of space for recreation and everyday use.

3. The 2030 National Environmental Policy – the Development Strategy in the Area of the Environment and Water Management[8]
Adoption: 16 July 2019

Priorities of the 2030 National Environmental Policy (PEP2030)
One of the priorities of PEP2030 will be the protection of Poland's natural heritage, among others, by taking actions to improve the state of biodiversity and a fuller coupling of its protection with the social and economic development of the country, including the improvement of the nature conservation system, the preservation and restoration of natural habitats and the populations of endangered species, as well as the maintenance and rebuilding of the functions of ecosystems which provide services to humans. The development process will be monitored by means of appropriate indicators enabling the assessment of aspects such as: improving water and air quality, limiting the impact on climate change and the appropriate conservation status of native species and habitats, as well as services provided by ecosystems.

Natural resources of Poland
The natural environment is a natural capital and as such it constitutes a potential for the development of a specific space which can be described in terms of geography. Its resources (renewable and non-renewable) generate a stream of benefits

7 http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WMP20120000252/O/M20120252-1.pdf;
English summary: http://www.espontheroad.eu/dane/web_espon_library_files/682/national_spatial_development_concept_2030_summary.pdf

8 https://bip.mos.gov.pl/fileadmin/user_upload/bip/strategie_plany_programy/Polityka_Ekologiczna_Panstwa/Polityka%20Ekologiczna%20Pa%C5%84stwa%202030%20ENG_wersja%20internet.pdf

defined as ecosystem services. The basic resources for economic and social development are energy potential, water resources, atmospheric air, climate, spatial and landscape resources and associated biodiversity (habitat, species and gene resources), soil and geological resources, and non-economic uses of the environment. The state and availability of these resources and the limited capacity of ecosystems to sustain an equilibrium and provide services to the economy affect investment opportunities and the satisfaction of basic living needs.

Forecast of socio-economic trends in environmental terms

The growing pressures on ecosystems
The EU vision until 2050 provides for the conservation and restoration of biodiversity and the valuation of ecosystem services in light of their effect on human welfare and economic growth. This increases the significance of agriculture and forestry for maintaining and strengthening biodiversity and the conservation status of the protected natural habitats of terrestrial ecosystems as well as that of fisheries for ensuring the sustainable use of aquatic ecosystems.
The socio-economic development requires the national and responsible management of the physical space, while taking into account the needs of food production, industry, urbanization, infrastructure and areas with natural values, as well as the condition of ecosystems and their services. In light of this, actions will be taken to better inventory the resources of habitats and species. This will improve the quality and efficiency of both the system for the management of natural resources and the system of environmental impact assessments, as well as other tools for development planning at the national, regional and local levels. The issue of the maintenance and reconstruction of the functions of ecosystems will apply to the whole territory of the country and be based on the assessment of the condition of ecosystems and their services. This requires the development of a system for the valuation of ecosystem services and the integration of these values into the development strategy, the planning system and the national accounting and reporting systems. As a result of this, biodiversity will regain the rank of the driver of social and economic development and, in consequence, its perception by the public will change. The integration of the values of ecosystem services into the national decision-making processes will make it possible to correctly assess the extent of the possible biodiversity loss, to apply compromise solutions and to improve the coordination of actions among the individual sectors and administration levels.
In a longer term, all these changes threaten the quality of the aquatic environment. This affects ecosystem services, such as the provision of sources of water intended for consumption (the contamination of groundwater with nitrogen and phosphorus compounds), fisheries and recreation.

The depletion of the existing sources of financing for environmental protection (cohesion policy)
There is the risk of a gradual depletion of the existing sources of financing for environmental protection, along with the need to provide, at the same time, further financial support to it, including in the form of non-returnable assistance in the case of actions related to projects intended to ensure access to key ecosystem services. Moreover, it should be expected that gradually more and more expenditures on environmental protection will be incurred by both consumers (households) and producers (enterprises), in accordance with the "polluter pays" principle. The amounts incurred should be based on estimated external costs. However, it seems necessary to take account of the fact that the "polluter pays" principle cannot always lead to security of access for the society to critical ecosystem services (very often of the nature of public goods, e.g. ensuring adequate air quality in urban areas). This situation means that there is still a need for the state support for investment, including non-repayable forms of assistance.

Specific objective II: Environment and economy. Sustainable management of environmental resources

Intervention: Managing the resources of natural and cultural heritage, including the improvement and protection of the state of biological and landscape diversity

Action: Mapping and valuation of ***ecosystem services***
- Task 1. Development of methodologies for the valuation of national natural capital
- Task 2. Development of national principles for including the valuation of ecosystem services in accounting and reporting systems

4. National Strategy of Regional Development 2030[9]
Adoption: 17 September 2019

In the perspective up to 2030, regional policy puts emphasis on sustainable development of the entire country, i.e. reducing disparities in the level of socio-economic development of various territories, and in particular supports the development of those areas that cannot fully develop their development potential or lose socio-economic functions. NSRD also recognizes the problem of climate change and takes into account the importance of natural resources as a potential factor for the development of the region, based on ecosystem services and implemented in a sustainable way, taking into account the needs of future generations.

Challenge 1: Adapting to climate change and reducing environmental risks
Nature plays an important role, among others in adapting to the effects of climate change and in preventing climate change (especially through forest ecosystems), and is also the basis for the development of sectors based on ecosystem services, e.g. forestry, agriculture, fisheries and tourism. Therefore, the challenge is to preserve the natural richness of the regions, which can become the basis for their development of sectors based on ecosystem services.

There is a decrease in the quality of life as a result of limited access to public services (e.g. education, health care, culture), as well as to ecosystem services provided by ecosystems subject to increasing pressure or a decrease in the quality of the environment, e.g. through noise and air pollution.

The regions of Eastern Poland [including the Podkarpackie Voivodeship covering the eastern part of the Polish Carpathians] are characterized by high natural richness, which may be one of the factors of these regions' development, and the related ecosystem services (e.g. clean air, the opportunity to spend free time in natural environment, tourist potential, favourable conditions for the production of high quality food, access to medicinal plants, etc.) increase their attractiveness for potential investors.

Objective 1. Increasing the coherence of the country's development in the social, economic, environmental and spatial dimensions
Important are actions to improve the accessibility of these areas, supplement the missing infrastructure as a base for doing business and create good jobs, as well as to improve the environment, protect biodiversity as a basis for the development of sectors based on ecosystem services, as well as actions for improving the quality of life, which in the long run can inhibit depopulation.

Objective 2. Strengthening regional competitive advantages
In the context of territorial capital, natural capital is also important, which - in accordance with the concept of sustainable development - should be used in a way that minimizes the negative environmental effects of economic growth processes. Natural capital can also be a basis for the development of the region based on ecosystem services resulting from the natural resources of the region. Maintaining natural capital, including the quality of public goods such as air, water or biodiversity in an acceptable state from the point of view of legal requirements and social expectations, is a factor that positively affects investment and settlement attractiveness, and thus also competitiveness.

Slovakia

Examples of ES mainstreaming in policy and decision making:

Land use/Spatial planning
Not directly incorporated yet. It is closely associated with the Green Infrastructure concept that is linked to the NECONET (National Concept of Ecological Networks) and the Concept of Territorial Systems of Ecological Stability (ÚSES).

Environmental impact assessment (EIA) / Environmental damages valuation
No relevance yet, not mentioned in Act on Environmental Impact Assessment or in Act on Prevention and Remedy of Environmental Damage.

Incorporation into the national policies, strategies, laws
The term ecosystem services are reflected in some environmental policies e.g. Act on Nature and Landscape Protection and Act on Fisheries. From strategies there is a reflection on the concept of ES in the Greener Slovakia - Environmental Policy Strategy of the Slovak Republic until 2030; the updated National Biodiversity Strategy to 2020; Vision, foresight and strategy for the development of forestry in Slovakia.

9 https://www.gov.pl/web/fundusze-regiony/krajowa-strategia-rozwoju-regionalnego

ISBN: 978-3-903424-04-3