Chapter 1
Overview of the Ecosystem Services Concept

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Abstract The chapter provides a concise introduction into the issue of ecosystem services (ES), its research, and implementation. It starts with the definition, primary model, and a brief history of this concept. The ES approach is increasingly reflected and applied in the scientific field, but it does not yet have the necessary support in the economic and decision-making areas. The second part is devoted to the ES classification systems, which are used for the research, followed by an overview of basic assessment methods. The most used classification of ES includes provisioning, regulating and supporting, and cultural ES. Research methods are usually divided into biophysical, sociocultural, and economic (monetary). The most frequently used and recommended methods are briefly described. The next part characterizes the level of ES research and implementation in the European Union, which is a leader in this field. Significant progress was achieved in most EU Member States within the Mapping and Assessment of Ecosystems and their Services (MAES) process. The last part of the chapter provides the ES political background and research outputs in Slovakia. The implementation rate of the ES concept in the Slovak Republic is one of the lowest in the whole of the EU – and this is a real challenge for the future.

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P. Mederly, J. Černecký (eds.), *A Catalogue of Ecosystem Services in Slovakia*,
https://doi.org/10.1007/978-3-030-46508-7_1

1.1 Ecosystem Services Basics

1.1.1 Introduction to Ecosystem Services

Although the concept of ecosystem services or utility properties and functions of nature began to show up in scientific literature, social, and political debates already in the late 1960s and early 1970s, key research and a broader discussion on this issue can only be dated back to the late 1990s. In particular, ecosystem functions and services depend on the quality and quantity of natural resources (such as soil, air, and water) and biodiversity – referred to overall as natural capital. Therefore, it is necessary to assess the ecosystem services (hereinafter referred to as ES) in relation to the functions, processes, and structure of related ecosystems, that is, to the quality of the environment of a particular territory and the value of its natural capital.

By using natural resources, including ecosystem services and with other activities, people directly or indirectly affect the natural environment and the quality of its components, in both temporal and spatial framework – including short-, medium-, and long-term local, regional, and global scales. The interaction of nature and man is the basis for the concept of ecosystem services – the ES is thus a concept between natural, social, and economic sciences.

The ES concept focuses on comprehensive research of ecosystems, their functions, and the assessment of benefits which ecosystems can provide for the society. It is constructed on an interdisciplinary basis. The ES concept seeks to ensure the protection and efficient use of ecosystems and their services so that all ESs are harmoniously used and that one ES is not developed further to the detriment of others. Several methods have been developed for ES assessment, including monetary and non-monetary, participative, and biophysical. An important part of the concept is the involvement of various groups engaged in ES assessment and management (Izakovičová et al. 2017).

The main idea of the ES concept is therefore the usefulness and benefits of nature for the society and human well-being. Ecosystem services can be very easily defined as contributions of ecosystems (living systems) to human well-being. These services are final (end) as they present outputs of ecosystems (whether natural, semi-natural, or largely altered by human activity) which directly affect human well-being. Their basic attribute is that they retain a link to the related ecosystem functions, processes, and ecosystem structure itself, which co-creates them (Haines-Young and Potschin 2013).

1.1.2 Cascade Model of ES

A clear formulation of the ES concept is provided by the so-called cascade model (Haines-Young and Potschin 2018), which clearly defines the sequence of notions of ecosystem structure and processes – ecosystem functions – ecosystem services – benefits from ecosystem services – service values (see Fig. 1.1).

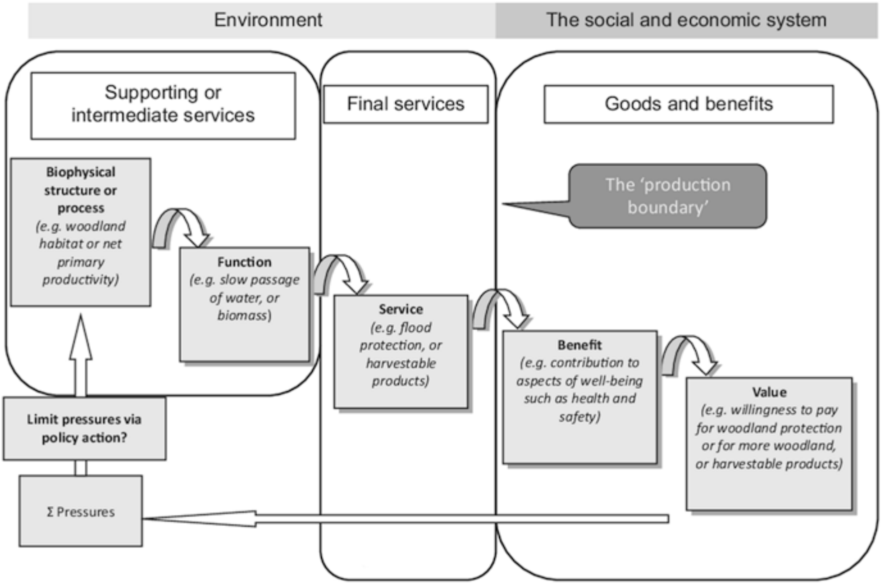

Fig. 1.1 Cascade model – from structure to functions, services, benefits, and values. (Source: Haines-Young and Potschin 2018)

The cascade model can be interpreted as follows:

– The ecosystems themselves, more precisely the geoecosystems, are the cornerstone and basic premise for the functioning of the ES. In the model, they are represented by a set of biophysical structures or processes which encompass the entire set of ecological components (e.g., matter, energy, and species), as well as key ecological processes (e.g., nutrient and energy cycles) taking place within the ecosystem. Obviously, only healthy ecosystems can provide a good quality ES – therefore, terms such as resilience, stability, and ecosystem integrity are accentuated.
– The next stage of the cascade is formed by ecosystem functions – these include the ecological components and processes that have the capacity to generate benefits used by people and thereby directly or indirectly support economic activities. According to Gómez-Baggethun et al. (2010), these represent a key link between ecology and economics.
– The central position of the cascade includes the ESs which, in a sense, represent the final outputs of the ecosystem – they are linked to ecosystem structures and processes, but at the same time, they are directly involved in generating benefits used by humans. Their existence is conditioned by the existence of demand and consumption of these services – without human use, they would not be considered ecosystem services.
– The final stage of the cascade consists of goods and benefits, representing the social and economic system. They are specific because they have a specific value

for humans – either monetary or non-monetary. The benefit can be understood as a concrete contribution of the ES to human well-being, with the value being its concrete valuation. It can be expressed differently, not only financially, because humans also attribute importance to the benefits based on moral, aesthetic, or spiritual values.

– With the use of ecosystem services as well as through the intermediary impacts on ecosystem functions and via other ways of influencing the landscape, humans put pressure on real geoecosystems, thereby causing adverse changes in their structure and functions and thus in further potential for their use. This feedback is shown in the model by an arrow which points away from the values back to the left side of the model.

1.1.3 A Brief History of Application of the ES Concept

The notion of ES was comprehensively explained for the first time in a publication Ehrlich and Ehrlich (1981) and has since been gradually applied, especially in scientific publications. Approximately since 2000, the establishment of the concept in the political agenda can be observed – for example through the so-called ecosystem approach, adopted in the year 2000 at the 5th Conference of the *Convention on Biological Diversity* in Nairobi, Kenya.

An ES summary vision and its basic classification, which has been used in the world literature, has been compiled by a large-scale project Millennium Ecosystem Assessment (MEA) in the period from 2001 to 2005 (project synthesis is presented in MEA 2005). The study of Costanza and Daly (1992), which estimated the average annual value of 17 selected ecosystem services at $33 trillion per year, which is approximately 1.5 times the global economy's GDP, has also been widely medialized. This value has been updated and refined to $125 trillion for 2011 (Costanza et al. 2014) – but with changes in landscape use and anthropogenic impacts since 1997, the ES value dropped by $20.2 trillion worldwide.

The economic dimension of the concept in 2010 was highlighted by the study The Economics of Ecosystems and Biodiversity (TEEB 2010) or by the wider TEEB initiative, which aims to *enhance the visibility of natural values*. Along with the increasing number of studies on monetary assessment of ecosystem services, the interest of decision-making and policymaking bodies has gradually begun to shift more towards the prospective creation of market-based instruments which could provide economic incentives for nature conservation.

At the global level, the ESs have also been established through the CBD. The Strategic Plan for Biodiversity 2011–2020 also includes the so-called *Aichi biodiversity targets*, two of which are particularly relevant for the ES (objectives 1 and 2, in more detail below). The establishment of an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012 has also helped to better integrate the ES concept into the policy agenda. IPBES creates a science and policy interface which enables scientific findings and analysis to be communicated towards the decision-making bodies and apply them also in the framework of international conventions. An example can be found in the Regional Assessment Report on Biodiversity and Ecosystem Services for Europe and Central Asia (IPBES 2018). Among the scientific and expert forums for research and promotion of the ES concept, it is appropriate to mention the Ecosystem Services Partnership (the largest international global network for ES research and application – available online: www.es-partnership.org) and the Natural Capital Project (a partnership between several universities and international organizations in the area of the development of ES assessment tools and their enforcement in decision-making – available online: www.naturalcapitalproject.org).

In addition to policy initiatives, the interest of the private sector in the ES concept has been growing in recent years. One such initiative is, for example, the Natural Capital Coalition, which brings together various stakeholders with a common vision to create a world where private companies protect and maintain the natural capital.

In their work, Costanza et al. (2017) describe the development of the ES concept in relative detail and very clearly at the same time. This article is highly recommended to those interested in this topic. They see the main progress in research and application of the ES concept in the following areas: the transition from definitions to classifications and ES assessment, the transition from integrated modelling to public participation and communication, and the development of institutions and innovations in the societal governance.

The fact that the ES concept is increasingly reflected and applied in the scientific field is also proven by the analysis of scientific and research publications on this issue in the Scopus scientific database (available online: www.scopus.com). By the end of 2000, approximately 150 articles and publications focused on the ES were published, compared to April 2017 when Costanza et al. mentioned approximately 17,000 titles containing the term ecosystem services in the title, abstract, or keywords. By the end of 2018, this number increased to 23,880 documents, and in the first 3 months of 2019, we saw an additional 1310 contributions (see Fig. 1.2).

This development can also be documented in the *Ecosystem Services* journal, which is the *flagship* of ES research. The journal was founded in 2012 by two prominent members of the scientific community of this topic (Rudolf de Groot and Leon Braat). In the first three-year period, there were 405 articles published in the journal, and in April 2019, this number increased to 880 articles altogether. In the first years, the journal published an average of 5–6 articles a month; in the year 2016, it was already 10–12 articles; and now it is more than 15 articles a month. However, it is only a fraction of what is published in all the world's research and scientific periodicals.

Despite the above, it is clear that the ES concept does not yet have the necessary support, especially in the economic field, nor in the area of important decision-making. At the end of the assessment study, Costanza et al. (2017) state the following:

> In particular, it points to the weakness of the mainstream economic approaches to valuation, growth, and development. The substantial contributions of ecosystem services to the sustainable wellbeing of humans and the rest of nature should be at the core of the fundamental change needed in economic theory and practice if we are to achieve a societal transformation to a sustainable and desirable future.

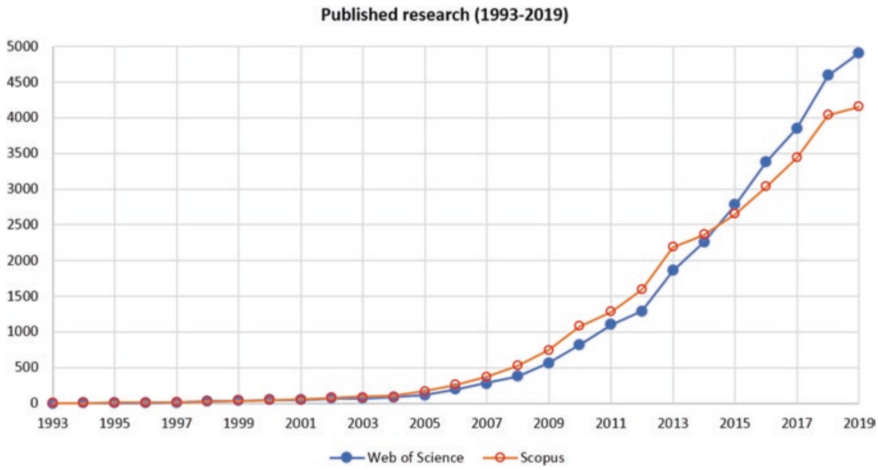

Fig. 1.2 Development of publications focusing on ecosystem services, included in the Web of Science and Scopus database

1.2 Ecosystem Services Classification

The basic classification of ecosystem services includes *provisioning services*, *regulating and supporting services*, *and cultural services*. There are a number of approaches to their more detailed classification, with the best-known being classification performed within the Millennium Ecosystem Assessment (MEA 2005) project, The Economics of Ecosystems and Biodiversity project classification (2010) and the Common International Classification of Ecosystem Services – CICES (Haines-Young and Potschin 2018). MEA 2005 is the basic classification used globally, especially before 2010, and CICES is the most detailed classification used for ES hierarchical classification and assessment.

Basic classification of ES according to CICES (Haines-Young and Potschin 2018) is the following:

- Provisioning services – this includes all material products and goods from ecosystems, providing nutrition, materials, and energy, especially *biomass for nutrition*, *drinking water and water for other non-drinking purposes*, *utility biomass*, *abiotic materials*, *and energy sources.*
- Regulating and supporting services – this includes the benefits from ecosystem functions regulating natural processes, as well as ecosystem functions and processes relevant to the healthy state of ecosystems and the provision of other services, in particular:

  Regulating services – regulation of waste, toxic substances, and other pollutants; regulation and mediation of flows (mass, liquid, and gaseous); regulation and protection of life cycles and habitats; and regulation and control of pests and diseases

Supporting services – in particular physical, chemical, and biological conditions: soil formation and composition, water cycle and water conditions, atmospheric composition and climate regulation, and other supporting processes

- Cultural services – this includes non-material benefits from ecosystems and biotic features of the landscape: *physical and experiential interactions*, *intellectual and representative interactions*, *spiritual and emblematic interactions*, *and other cultural outcomes*.

A more detailed description of the individual ES is provided in the main assessment part of the publication. A comparison of the ES basic classification systems is given in Table 1.1.

Table 1.1 Main classification systems of ecosystem services

ES group	Costanza et al. 1997	Category pursuant to MEA 2005	Category pursuant to TEEB 2010	Category pursuant to CICES – Haines-Young and 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	Genetic resources	Genetic sources of biotic origin
		Biochemicals and natural medicines	Medicinal resources	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

(continued)

Table 1.1 (continued)

ES group	Costanza et al. 1997	Category pursuant to MEA 2005	Category pursuant to TEEB 2010	Category pursuant to CICES – Haines-Young and Potschin 2018
Regulating and supporting services	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 and flood control)	Natural hazard regulation	Disturbance prevention or mediation	Regulation of air and liquid flows
	Water regulation (e.g., natural irrigation and drought prevention)	Water regulation	Regulation of water flows	Regulation of liquid flows
	Erosion control and 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)
	Refuges (nursery, migration habitats)	Biodiversity	Lifecycle maintenance (esp. nursery) Gene pool protection	Life cycle and habitats maintenance, gene pool protection
	Biological control	Regulation of pests and diseases	Biological control	Support of pest and disease control
	Nutrient cycling	Nutrient cycling and photosynthesis, primary production	x	x

(continued)

Table 1.1 (continued)

ES group	Costanza et al. 1997	Category pursuant to MEA 2005	Category pursuant to TEEB 2010	Category pursuant to CICES – Haines-Young and Potschin 2018
Cultural services	Recreation (incl. ecotourism and outdoor activities)	Recreation and ecotourism	Recreation and ecotourism	Physical and experiential interactions (recreation and ecotourism)
	Cultural (incl. aesthetic, artistic, spiritual, education, and science)	Aesthetic values	Aesthetic information	Experiential interactions
		Cultural diversity	Inspiration for culture, art, and design	Representative interactions (promotion, art)
		Spiritual and religious values	Spiritual experience	Spiritual and/or emblematic interactions (cultural heritage)
		Knowledge systems and educational values	Information for cognitive development	Intellectual interactions (willingness to protect nature, moral aspects)

Source: Costanza et al. (2017), modified

1.3 Basic Assessment Methods of Ecosystems Services

ES assessment is a complex and multidisciplinary issue, and when dealing with this issue, it is not appropriate to remain at the level of scientific methods. For example, Gómez-Baggethun et al. (2010) report that assessing ecosystems and their services should not be seen as a goal, but as a pragmatic tool pointed to the assessment of the true contribution of nature to human well-being and its incorporation into economic theory and practical decision-making. Jacobs et al. (2014) state that the ultimate objective of ES assessment is to contribute to a more sustainable and fair use of natural resources. Accordingly, Daily (2000) has proposed human well-being as a unit for ES assessment, with the aim of ES assessment being the improvement of the well-being of the whole society while respecting the principles of sustainability (ensuring the needs of the present generation without compromising the needs of future generations).

Majority of ES experts agree that a number of methods are appropriate for ES assessment – but in principle, it is possible to summarize them into three basic groups according to the main principle of assessment and provision of results –bio-physical methods, sociocultural (non-monetary) methods, and economic (monetary) methods. In addition, there are integrated methods which use multiple approaches and often combine multiple methods. From the point of view of the purpose of the assessment used, Costanza et al. (2017) recognize methods aimed at raising public awareness and interest, economic accounting, specific policy analysis, spatial development and land use planning, payments for ES, cost accounting, and general asset management.

Neugarten et al. (2018) provide an overview of ecosystem assessment tools based mainly on biophysical assessment and modelling (Table 1.2). At the same time, they created a *decision tree* for the selection of methods (Fig. 1.3).

The following text provides an overview and a brief description of the most frequently used and recommended methods of ES assessment – more specifically, the methods are presented in the characteristics of individual ES in the main part of this publication.

1.3.1 Biophysical/Natural Science Methods

Ecological (biophysical) assessment is usually the first step in ES assessment. It focuses in particular on assessment of the condition and functioning of ecosystems and their characteristics, from which the social and economic values are consequently derived. According to de Groot et al. (in Jacobs et al. 2014), the ecological value includes the ecosystem health with ecological indicators such as diversity or integrity. In the System of Environmental-Economic Accounting (SEEA; European Commission 2014), the value in biophysical units represents the quantification of the flow of assessed services where the ESs are expressed as material and energy flows.

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 (hydrological, climatic, erosion, production, etc.) are used to express the state, functions, and processes in ecosystems as well as the ES potential. 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 – Burkhard et al. 2009, 2014).

According to Gomez-Baggethun and De Groot et al. (2010), the main biophysical method includes the following:

- Ecological footprint – describes the spatial extent of the biologically productive area which the society uses for its consumption – inputs and outputs (similar are, e.g., carbon or water footprint)
- Land cover flow analysis – used to monitor changes in natural capital quality and soil multifunctionality
- Material flow analysis – monitors environmental inputs and outputs within the socio-economic system metabolism

Table 1.2 Overview of ecosystem services assessment tools

Tool name and acronym	Internet source	Citation
Tools written *step by step*		
Ecosystem Services Toolkit – EST	publications.gc.ca/site/eng/9.829253/publication.html	Value of Nature to Canadians Study Taskforce (2017)
Protected Areas Benefits Assessment Tool – PA-BAT	wwf.panda.org/our_work/biodiversity/protected_areas/arguments_for_protection/	Dudley and Stolton (2008); Ivanić et al. (2017)
Toolkit for Ecosystem Service Site-based Assessment v.2.0 – TESSA	tessa.tools	Peh et al. (2017)
Computer model-based tools		
ARtificial Intelligence for Ecosystem Services – ARIES	aries.integratedmodelling.org	Villa et al. (2009)
Co$ting Nature v.3 – C$N	www.policysupport.org/costingnature	Mulligan (2015)
Integrated Valuation of Ecosystem Services and Tradeoffs 3.4.2 – InVEST	www.naturalcapitalproject.org/invest/	Sharp et al. (2018)
Multiscale Integrated Models of Ecosystem Services – MIMES	www.afordablefutures.com	Boumans et al. (2015)
Social Values for Ecosystem Services – SolVES	solves.cr.usgs.gov	Sherrouse et al. (2011)
WaterWorld v.2 – WW	www.policysupport.org/waterworld	Mulligan (2013)

Source: Neugarten et al. (2018)

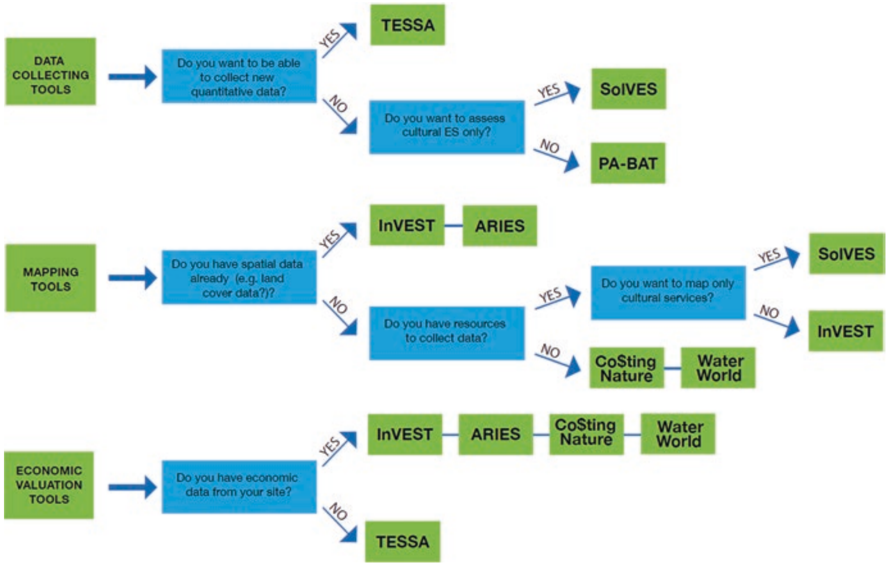

Fig. 1.3 Decision process (tree) for ES tool selection. (Source: Neugarten et al. 2018)

– Life cycle analysis – monitors the process of a certain activity or production cycle from its creation to its completion (liquidation, termination)
– Energy/exergy methods – aim to quantify the amount of energy that needs to be introduced during the performance of a given (e.g., economic) process

The best known (predominantly biophysical) models used for ES assessment include the following:

– InVEST: a set of spatial biophysical models for quantifying and assessing ES benefits created at Stanford University, suitable particularly for local and regional level (available online: www.naturalcapitalproject.org). Some models are also designed to describe the ES economic value.
– ESTIMAP: the spatial model used mainly on the continental scale but with several applications also on the national level. It enables the assessment of the impact of different land use change scenarios on ES provision. Eight analytical models focusing on different regulating ES (e.g., pollination, air quality regulation) are operational at EU level, but the module for assessment of recreational ES is most commonly used (Zulian et al. 2013, 2018).
– QuickScan: a comprehensive software spatial-statistical tool designed for participative decision-making by representatives of various stakeholder groups and subjects with the participation of experts (Verweij et al. 2016). The model can be used for different purposes and in different scales (available online: www.quickscan.pro).

1.3.2 Sociocultural Methods

There are a number of issues *outside the domain* of natural sciences which are related to the assessment of ecosystem services, including those from the social, cultural, and historical context of this issue. It is therefore logical to use *inclusive* assessment with the involvement of stakeholder group representatives (this term will also be used in other parts of the publication) and the related use of other than classical natural science methods.

Sociocultural assessment is understood either as a subset or as a synonym of the so-called non-monetary ES assessment which is focused on the *importance, preferences, needs, or requirements which people express in relation to nature* (de Groot et al. 2010; Chan et al. 2016; Castro et al. 2014). The number of studies using these methods for ES assessment is still growing, and so the sociocultural methods are becoming an accepted part of the ES concept, although they still do not have fully established methodological background (Gómez-Baggethun et al. 2014).

Sociocultural methods are mostly based on *qualitative data* – especially on value estimates or 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* which use, for example, the expression of relative significance instead of monetary or economic values. They are often based on collective and interactive procedures – for example 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.

Sociocultural assessment includes a wide range of methods, the most commonly used of which are the following (according to Santos-Martín et al. 2017):

- Preference assessment – consultation method for analysing the perception, recognising, and assessment of the demand or use of the ES.
- Time use methods – determining respondents' willingness to devote time to changing ES quality or quantity
- Photo-elicitation survey – exploring the value of a particular place in terms of ES provision based on respondents' perceptions and feelings
- Narrative methods – methods using description or specific story to express ecosystem/landscape value from an ES perspective
- Participatory mapping – ES assessment with participation and application of knowledge of various stakeholders of the society
- Scenario planning – creating possible future scenarios and assessing their relationship with ES utilization (usually with participatory methods)
- Deliberative methods – assessment and decision-making (including ES issue) through an open discussion of stakeholder representatives

1.3.3 Economic/Monetary Methods

Considering that most ESs are public goods (not directly part of the market), their economic value is usually not adequately reflected in market-based processes, and thus they are threatened by overuse or deterioration. One of the main goals of economic assessment is to avoid such a scenario by better reflecting the economic value of the ES into the decision-making processes.

In this context, it is especially the issue of assessment of the so-called externalities (such as the related effects and costs of ES use, which are not directly included in the ES price) and their incorporation into economic accounting and decision-making processes – this process is the domain of *environmental economics*. To this end, economists use mainly the concept of *total economic value*, which is composed of both use and non-use values. To capture these values, economics uses a variety of methods – primary methods or value transfer methods. For primary methods, *direct market methods* (in particular market prices and interactions) are used – if such information is not available, then parallel or hypothetical markets based on *preference surveys* are used. 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*.

Overview of used economic (especially monetary) methods of ES assessment:

– *Direct valuation methods:* in particular market price, avoided damage method, prevention cost, restoration cost, production function, spared government spending, and others – consist of a direct ES financial valuation
– *Revealed preference methods:* travel costs, hedonic pricing, opportunity costs – an estimate of the ES values through similar real functions or services in the landscape
– *Stated preference methods:* contingent valuation, choice experiments – an estimate of the ES value through the preferences (statements) of the respondents
– *Benefit/value transfer methods:* ES valuation in model territory based on research from existing primary assessment studies from other territories or political contexts

In conclusion, it needs to be pointed out that the attitudes on the ES monetary assessment vary. Although most scientists recognize its need (especially as a tool to raise awareness or to compare the cost of different alternatives to improve ES provision), some authors argue the usefulness of economic assessment. For example, according to Spangenberg and Settele (2010), the ES monetary assessment fails to capture the ES value in a broader sense, ignoring their social and ecological qualities perceived by ES beneficiaries at different levels. Norgaard (2000) states that current monetary assessment methods only help us see ES values from an unsustainable economic point of view and not from the *desirable* sustainable economic model. The ethical dimension of nature services assessment is also frequently discussed (e.g., Chan et al. 2016; Jax et al. 2013). Overall, there resonates 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.

1.3.4 Integrated Assessment of ES

Given the complexity of assessing the ES issues and the value pluralism associated with it (de Groot et al. 2002; Gómez-Baggethun and de Groot 2010; Jax et al. 2013), there is a consensus in the scientific community concerning the need to link different ES assessment methods and the development of the so-called *integrated assessment methods*. Significant progress has been made in the area of integrated ES assessment in recent years – in particular through scientific projects aimed at transferring research results to management and decision-making practice (OpenNESS and ESMERALDA projects – see below in Sect. 1.4).

An overview of various methods which can be used for the ES assessment and the interconnections between them is shown in Fig. 1.4 – it is a summary of the methods used in the OpenNESS project according to Barton and Harrison (2017). Obviously, interpreting the results achieved using a variety of different methods is not easy – the integrated methods should formalize and facilitate the process. For example, the framework for integrated assessment is also mentioned by Gómez-Baggethun and Barton (2013) – according to them, 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.

In general, integrated methods are used for the *overall assessment* of the final benefits of the ESs for human well-being or quality of life. They also help with the decision on priorities for the use of individual ESs, which are expressed in different units and different methods. For this purpose, the following are used, for instance:

- Multi-criteria decision analysis (MCDA) – a participatory tool used to link ecological, sociocultural, and economic contexts through an assessment and discussion framework involving various stakeholder groups (a specific policy framework), using modelling.
- Bayesian belief networks (BBN) – probabilistic models (charts) for decision-making in different probability conditions. They allow the gradual creation of a model decision network and assessing their likely consequences.
- State and transition models (STM) – expert modelling of the probable changes in the state of ecosystems, their properties, and their functions due to various decisions. They can be linked to spatial geographic information system (GIS) models.
- Scenario development – defining several possible directions for further development of a certain territory, based on verified assumptions about substantial trends and drivers. It is important to involve stakeholders in this process.
- Deliberative valuation – it is not a method but rather an assessment framework, based on a combination of multiple methods and techniques, involving research-

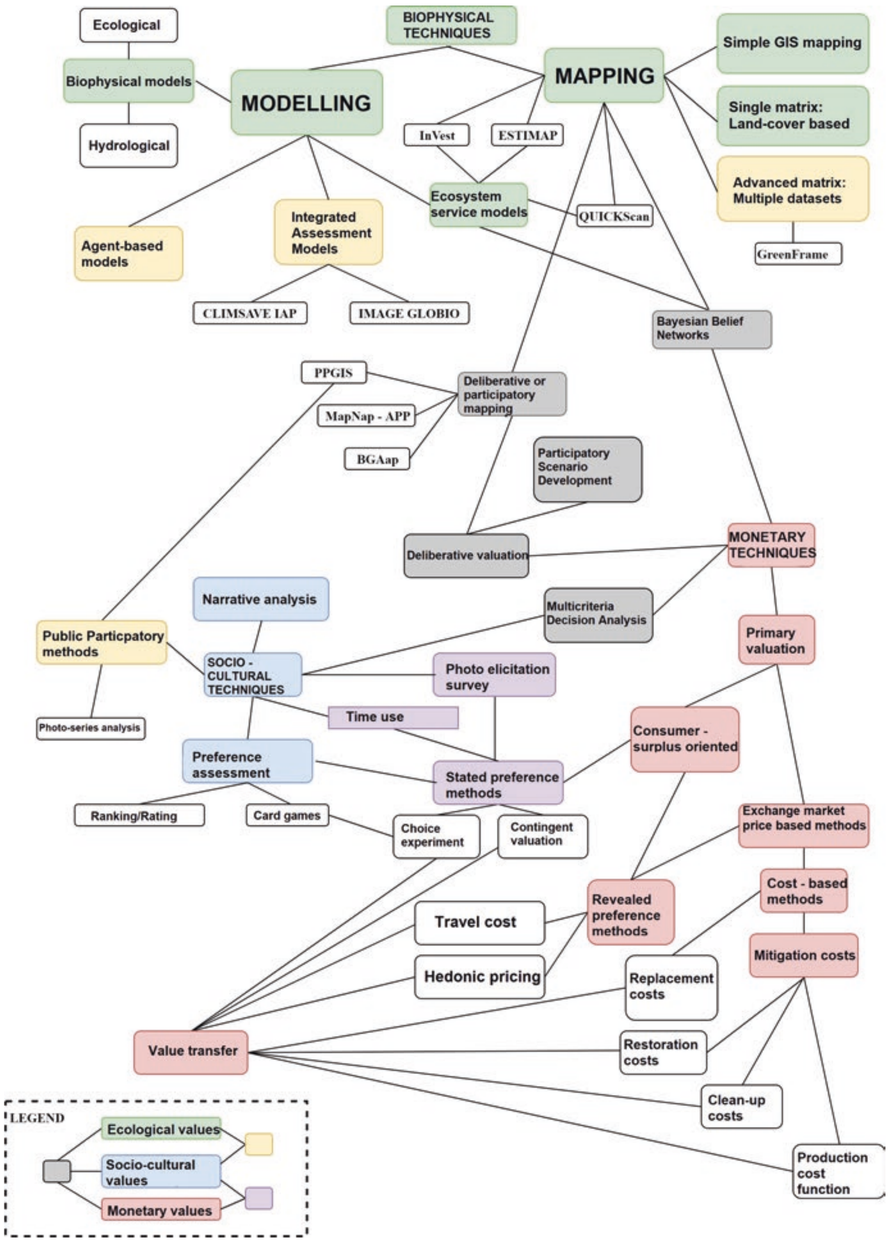

Fig. 1.4 Chart of methods used in ES assessment and relations between them. Groups of methods are coloured; examples of specific methods are given on a white background. (Source: Barton and Harrison (eds.) 2017, modified)

ers and representatives of different stakeholder groups. The result is achieved by mutual discussion and open dialogue, preferably by the consensus of a majority.

Several of these methods, or procedures, not only are *integration* but also can be described as combined – they also use the techniques of biophysical, sociocultural, and partly economic assessment.

Since the issue of integrated assessment is very complex, it cannot be summarized in a limited extent. Those interested in this area of research can find more information for further study in the work by Barton and Harrison (2017).

1.4 Process of Ecosystem Services Assessment in the European Union

1.4.1 Policy Context of ES Assessment

The EU became one of the leaders of the research and implementation of the ecosystem services concept. In particular, after 2010, the EU has adopted several important documents in the field of natural resources protection and biodiversity promotion – from the 1998 strategy through 2001 and 2006 action plans to the current EU biodiversity strategy 2020 adopted in 2011. The introduction of this strategy emphasizes the importance of biodiversity as part of natural capital in terms of ES provision and the overall standard of living (quality of life) of people. The strategy aims to reverse the loss of biodiversity and accelerate the EU's transition to a resource-efficient *green* economy.

The vision of EU biodiversity policy by 2050 is the protection, valuation, and adequate restoration of biodiversity and ecosystem services (natural capital) it provides. The main reason is the intrinsic value of biodiversity and its fundamental contribution to the standard of living and economic prosperity. The main goal by 2020 is to stop the loss of biodiversity and ES degradation within the EU and restore them to the fullest extent possible while increasing the EU's contribution to preventing global biodiversity loss.

The EU 2020 biodiversity strategy consists of 6 targets and 20 actions focused on halting biodiversity loss and the degradation of ecosystem services. ESs were included in target no. 2 Maintaining and enhancing ecosystems and their services, which specifies the following:

> By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems (European Commission 2011).

Special emphasis on ES has been transferred into action no. 5:

> Member States, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020 (European Commission 2011).

In order to support this goal, the European Commission has initiated the creation of an expert group on MAES (available online: www.biodiversity.europa.eu/mae). Within this group, much progress has been achieved in most EU Member States in the area of ES assessment. More support was provided by the EU-funded international scientific projects, in particular, OpenNESS (available online: www.openness-project.eu), aimed at operationalizing the concept of natural capital and ES; OPERAs (available online: www.operas-project.eu), focusing on how these concepts can be transferred from academia to practice; and ESMERALDA (available online: www.esmeralda-project.eu), which builds on both previous projects, with the goal to create a flexible methodology for ES assessment at European level as well as regional or local level.

A valuable output of the OpenNESS project includes 27 model studies at local and regional levels in 13 European and 4 non-European countries (for more information on outputs – Wijnja et al. 2016; Dick et al. 2018). An interesting tool could also be found in the Oppla platform (available online: www.oppla.eu), which is an open *marketplace* of knowledge about ES, natural capital, and nature-based solutions where experts from various fields – science, research and practice, public and private sectors, individuals, and small and large organizations – may find answers to related questions (Izakovičová et al. 2017).

1.4.2 National ES Assessments in Europe

National ES assessments in European countries are one of the main outcomes of the biodiversity protection strategy commitments and the functioning of the MAES working group. As part of the ESMERALDA project, a so-called *MAES barometer* has been prepared and is assessed. The barometer maps progress across individual countries (Fig. 1.5). According to this assessment, some countries have already achieved full implementation (not only the ecosystem and ES assessment but also

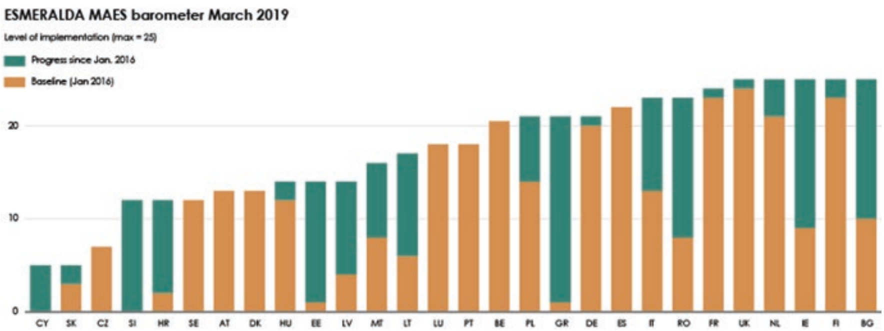

Fig. 1.5 ESMERALDA MAES barometer: EU Member States' progress in the assessment and implementation of the ES concept in the period 01/2016–03/2019. (Source: Biodiversity Information System for Europe (https://biodiversity.europa.eu/maes))

their integration in national policies) – the countries include the United Kingdom, the Netherlands, Ireland, Finland, and Bulgaria. Other countries are significantly approaching this objective (Italy, Romania, France). For the period since 2015, Greece, Ireland, Bulgaria, Romania, Estonia, and Slovenia have made the largest progress. The overall level of implementation (valid on March 2019) was assessed at 70% – unfortunately, Slovakia only reaches 20% and is at the very end of the ranking together with Cyprus.

The unflattering position of the SR is a consequence of the halting of the MAES process practically in the very beginning and the absence of financial resources to ensure a national ES assessment.

Table 1.3 provides an overview of national ES assessments with available information according to literature analysis and work by Schröter et al. (2016). In addition to the specified countries, several countries do not have national assessments available and published in English, or in progress of preparation (Bulgaria, Hungary, Italy, France, Greece). In addition to EU countries, Norway, Russia, and Israel are included in the table, for which background studies were available.

Table 1.3 Overview of national assessments of ES and the number of assessed ES by main groups

Country	ES total	Provisioning ES	Regulating and supporting ES	Cultural ES	Citation
Czech Republic (CZ)	18	7	5 / 4	2	Frélichová et al. (2014), Vačkář et al. (2018)
Denmark (DK)	11	3	1 / 2	5	Turner et al. (2014)
Finland (FI)	28	10	8 / 4	6	Jäppinen and Heliölä (2015)
Flanders (BE)	16	5	6 / 4	1	Stevens et al. (2015)
Netherlands (NL)	19	5	5 / 5	4	CBS (2015), PBL Netherlands (2019)
Ireland (IE)	28	9	5 / 6	8	Parker et al. (2016)
Lithuania (LT)	31	14	6 / 5	6	Depellegrin et al. (2016)
Luxembourg (LU)	13	4	4 / 4	1	Becerra-Jurado et al. (2016)
Germany (DE)	18	5	5 / 5	3	Rabe et al. (2016), Albert et al. (2016), Grunewald et al. (2016)
Romania (RO)	12	4	3 / 2	3	NEPA. (2017)
Russia (RU)	19	4	6 / 4	5	Bukvareva et al. (2017)
Spain (SP)	22	7	4 / 4	7	Santos-Martín et al. (2016)
Great Britain (UK)	26	12	4 / 5	5	UK NEA (2011)
Portugal (PT)	6	3	0 / 3	4	Schröter et al. (2016)
Norway (NO)	26	7	5 / 5	9	Schröter et al. (2016)
Israel (IS)	3*	0	0 / 3	1	Lotan et al. (2018)
Italy (IT)	5*	0	2 / 2	1	Giarratano et al. (2018)

The numbers in the cells indicate the number of assessed ES
*Assessments of only some ES available

The analysis of the studies shows some generalizations which can also be used for the process of preparing the ES national assessment in Slovakia. Here are the main facts:

– The number of ES for assessment in individual countries varies significantly but is on average 15–20 ES. The lowest number (3–6 ES) is reported by IS, IT, and PT; by contrast, the largest number (26–28 ES) is reported by NO, UK, FI, and IE.
– The emphasis on ES representation by main groups varies – some countries have over-represented provisioning ES (FI, LT, GB), other cultural ES (DK, IR, NO, 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, RU) used simpler land use maps or Corine Land Cover maps.
– Most countries use other indicators for the assessment of the ES – the natural environment properties database is standard, and it is further used for the selection of indicators, the creation of maps in the GIS, and the possible use of models. The most sophisticated indicator system is used by FI, LU, IE, UK, BE, and NL.
– ES assessment methods vary significantly across countries. Simple methods include mainly the use of the so-called assessment matrix (ES matrix – Burkhard et al. 2009, 2014) – this was used as the main method in, for example, national studies of LI and RU.
– More complex procedures in the form of ES mapping, ES indicators, and statistical data evaluation were, for example, presented in studies of BE, NL, UK, RO, and SP.
– Biophysical models have been used for the ES part in different countries – DK, FI, DE, IE, IT, and LU.
– The economic valuation of the ES in the form of the benefit transfer method was used by CZ, IT, UK, FI, and 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 capacity issues but also the demand and current ES flow issues and compare them in different ways. The most common include statistical evaluations of relationships between these categories for administrative units – regions (e.g., DK, DE).

1.5 Ecosystem Services Assessment in the Slovak Republic

1.5.1 Policy Process of ES Assessment

As is clear from the previous text, the implementation rate of the ES concept in the SR is one of the lowest in the whole of EU. However, this is mainly due to political factors, not a lack of expertise or necessary data. Unfortunately, in the previous period, there was not enough *political will* to ensure the assessment process, even though this process is required by the approved documents. The assessment of the current state of application of the ES concept in Slovakia at the political level (planning and decision-making at the national, regional, and local level) is part of the study by Bezák et al. (2017), which, in addition to analysing the current situation, also provides the basis for better implementation of the ES concept.

In 2012, following the adoption of the European strategy and tasks defined by the strategy, the SR prepared the Updated National Strategy for Biodiversity Protection for 2012–2020. The strategy was adopted by the Government Decree no. 12/2014 (MoE SR 2014). The aim is to create a policy framework to halt the loss of biodiversity and to accelerate the transition of the SR as an EU member country to the *green* economy, which uses natural genetic resources in accordance with the Europe 2020 Strategy. The *key objective* of the strategy is to halt the loss of biodiversity and the degradation of ecosystems and their services in the SR by 2020, to restore biodiversity and ecosystems to an appropriate extent, and to increase our contribution to preventing global biodiversity loss.

The vision set by the SR in this document is as follows:

> Natural Capital of the SR – biodiversity, ES and related goods are sufficiently protected by 2050, regularly assessed, wisely used and, where appropriate, restored due to their intrinsic values and for their significant contribution to the welfare and economic prosperity of the Slovak Republic. Adopted measures and policies at the national level prevent the adverse changes which the loss of natural capital would cause.

The strategy includes nine objectives, which are largely based on European objectives. Each of them focuses on a specific issue, with Objectives 1–3 being established for the protection and restoration of biodiversity and related ES. In particular, Objective 3 is important from an ES perspective:

> Ensure the maintenance and strengthening of ecosystems and their services by 2020 through the establishment of green infrastructure and the restoration of at least 15% of degraded ecosystems.

The following measures are important in particular for the identification, assessment, and subsequent protection of ecosystems and their services:

– Improve knowledge of ecosystems and services provided through mapping and assessing the status of ecosystems and their services in the SR
– Prepare a system of assessment and economic valuation of ES and goods and propose a comprehensive system of payments for ES use, taking into account existing systems and mechanisms

However, the achievement of this ambitious objective and the measures outlined above is unrealistic within the given timeframe by 2020 – therefore, the objectives will have to be revised or deadlines moved.

Following the national strategy for biodiversity, the ES concept was also transformed into the Environmental Policy Strategy of SR 2030 entitled Greener Slovakia (approved by the Slovak Government in February 2019). One of the measures is to assess and sustainably use the ES. In relation to ES, the environmental strategy states the following:

> By 2030, all ESs will be taken into account equally and shall be implemented within the national accounting system. The ESs will be assessed and quantified and taken into account when considering investments and policies as well as in environmental impact assessments. The establishment of a comprehensive ES assessment system and sustainable use of ESs will be supported and the possibilities for monetization will be considered. Payments for ESs will create sufficient incentives to maintain them.

These measures will also be developed in the Nature and Landscape Protection Framework by 2030.

In 2014, an expert working group MAES 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 SNC SR were 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 ecosystem 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 MoE SR 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 online: 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 community interest (66 habitat types and 196 species), which is an important database necessary for the assessment of many ES aspects. As part of the monitoring since 2013 under the professional guidance of SNC SR, comprehensive monitoring is conducted on more than 10,000 permanent monitoring sites. It is the largest field data collection in the history of Slovakia, which has so far involved more than 400 experts. The first stage of monitoring consisted of field collection, processing, and evaluation of data on the status of individual habitats and species of European importance. The results of this project and further information are available in publications by Šefferová Stanová and Galvánková (2015) and Janák et al. (2015). At the same time, the Comprehensive Information and Monitoring System (CIMS; available online: www.biomonitoring.sk) was established, which aggregates the occurrence data on habitats and species in Slovakia provided by experts and the general public. In the current programming period, the Monitoring II project is approved, and SNC SR is preparing two larger projects with nationwide coverage. The first project is focused on management measures in non-forest habitats and the second on nature-based forest management in protected areas.

Another possibility and opportunity for improving the state of knowledge and implementation of management measures in the field of biodiversity protection and the ES is the Operational Programme Quality of Environment (OP QE), which is a programme document of the SR for drawing assistance from the EU Structural Funds and the Cohesion Fund in the 2014–2020 programme period. In terms of ES assessment, it is important to develop projects under priority axis 1 Sustainable use of natural resources through the development of environmental infrastructure, especially in investment priority 2.2 Biodiversity and soil protection and restoration and ES support, including NATURA 2000 and green infrastructure network. This priority offers opportunities to finance activities and measures for the conservation and improvement of habitats or ecosystems and thus directly supports the provision of ES in Slovakia. However, the support from the operational programme is limited by the duration of the programme period, and therefore, it is necessary to introduce systematic financing for support, restoration, and conservation of habitats in Slovakia by the MoE SR. The next step should be to involve small owners – local stakeholders – in the restoration of biodiversity and support them financially, for example through Envirofond.

The above-mentioned processes implemented by MoE SR (especially SNC SR) are a basic prerequisite for an adequate ES assessment. Notwithstanding, much more accurate and diverse data would be needed for a comprehensive ES assessment, but these are not currently being collected and are not supposed to be collected in the near future. Essentially, basic data sources lack quality and quantity, because data is often outdated, inaccurate, or incomplete. Despite the unfavourable situation, SNC SR is actively preparing a monograph in this area, which will, upon completion, present a national ES assessment from the perspective of an ecosystem approach based on the above-mentioned data sources.

1.5.2 Expert Level of ES Assessment

Although the ES concept is not as politically well established in Slovakia as in other European countries, its application has been gradually increasing in recent years, especially in the *expert field,* for example, in the valuation of functions and services of nature in protected areas, assessment of forest functions, agricultural soils assessment, assessment of historical agricultural landscape structures, and others.

The issue of ES research and assessment in the SR is currently investigated as part of *the research tasks and scientific projects of various workplaces*, with partial results and case studies being published (active workplaces in this area include mainly the Institute of Landscape Ecology of SAS, National Forest Centre, and National Agricultural and Food Centre). This also applies to research conducted by Slovak universities, which is fragmented into research projects and tasks of individual entities (especially Comenius University in Bratislava, Slovak University of Technology in Bratislava, Constantine the Philosopher University in Nitra, Slovak University of Agriculture in Nitra, Technical University in Zvolen, Matej Bel University in Banská Bystrica). Most of the existing spatial and database materials and partly the research capacities are concentrated in two research organizations within the MoE (Slovak Environmental Agency and State Nature Conservation). Research coordination and joint projects are rare, so the exchange of experience and presentation at various professional and scientific events is more implemented.

PhD research at some universities and research organizations is also focused on the education and preparation of ES specialists (11 dissertations with the ES topic were prepared in the SR in the period from 2014 to 2018, of which 5 were prepared at Constantine the Philosopher University in Nitra and 3 at the Slovak University of Agriculture in Nitra). The ES issues are also addressed in the final thesis of students of the above-mentioned universities (in the same period, approximately 75 bachelor and master theses focused on the ES assessment in general or in a particular territory – most at the Slovak University of Agriculture in Nitra, Matej Bel University in Banská Bystrica, Technical University in Zvolen, and Slovak University of Technology in Bratislava).

Some of the *first research publications* comprehensively assessing the non-production functions of forest ecosystems and vegetation in Slovakia generally include Papánek (1978), Midriak et al. (1981), and Jurko (1990), with Eliáš (1983, 2010) also focusing on this issue for a long period of time.

The ES concept is relatively best elaborated for forestry and nature conservation areas. The topic of forest ES and their assessment is mainly addressed by the researchers of the National Forest Centre and Technical University in Zvolen (e.g., Čaboun et al. 2008; Kovalčík and Tutka 2008; Čaboun et al. 2010, 2014; Konôpka 2010, 2012; Sarvašová and Šálka 2012; Šálka and Dobšinská 2013; Sarvašová et al. 2014; Štěrbová 2017; Šálka et al. 2017). In terms of theory, this topic was elaborated by, for example, Vološčuk (2013); also, the publication Schneider et al. (2016) could be useful for the Slovak studies. From the ES assessments of protected areas, it is possible to mention several publications – assessment of the Tatranský národný park (Fűzyová et al. 2009; Brezovská and Holécy 2009; Švajda 2009; Fleischer et al. 2017), National Park (NP) Slovenský raj (Getzner 2009), NP Veľká Fatra (Považan et al. 2014a), Nízkotatranský NP (Špulerová et al. 2016) and NP Muránska Planina (Považan et al. 2015). More generally, the ES of protected areas was mainly the topic of Považan et al. (2014b).

In the field of soil science and agriculture, attention was initially given to soil production functions (the concept is summarized, for example, in Džatko 2002). Especially after 2000, researchers began to put more attention on the complex of non-production soil functions (e.g., Hronec et al. 2005; Bujnovský et al. 2009; Tutka et al. 2009; Bujnovský 2011). Among the more recent studies, we can mention especially the articles of Vilček (2011, 2014), Vilček and Koco (2018), Kanianska (2014), Kanianska et al. (2016), Makovníková et al. (2016, 2017), and

Kizeková et al. (2016, 2018). The leader in this field is NPPC – Soil Science and Conservation Research Institute and Matej Bel University in Banská Bystrica.

Hydrological ES of Slovakia research is being developed within the Water Research Institute (Bujnovský 2018) and Slovak Agricultural University in Nitra (Jurík et al. 2017).

The assessment of the ES of *historical structures of the agricultural landscape* is mainly addressed by the Institute of Landscape Ecology of SAS (e.g., Špulerová 2006; Špulerová et al. 2014, 2017, 2018; Lieskovský et al. 2015). The assessment of the functions and services of vegetation in the residential environment is addressed by, for example, Supuka et al. 1991, 2000, Reháčková and Pauditšová 2006, and Turanovičová and Rózová 2017.

Participatory mapping and socio-economic assessment of ES have been addressed by, foe example, Bezák and Bezáková (2014), Kluvánková-Oravská and Chobotová (2010), Kluvánková-Oravská et al. (2013), and Kluvánková and Brnkaľáková (2017).

Of the more extensive ES assessment studies in specific model territories, it is worth to mention the case study of the OpenNESS EU project, which was conducted in the period from 2013 to 2016 at two institutions (Institute of Landscape Ecology SAS and Regioplan Nitra). In addition to analysing the current state of application of the ES concept in Slovakia (Bezák et al. 2017), the study also focused on the elaboration and direct implementation of several methods of ES assessment on the example of the model area of Trnava and its functional urban area (Mederly et al. 2017). Based on all project outputs, a proposal for appropriate landscape and spatial planning procedures has been developed, particularly with regard to the integration of the ES concept into the planning and decision-making process (Izakovičová et al. 2017).

1.5.3 Background for the ES Catalogue

Finally, as a starting point for the ES assessment in Slovakia, it is appropriate to quote the conclusions from the article by Izakovičová et al. 2017, which summarizes the results of the OpenNESS case study in the Trnava model territory:

> The ES concept is relatively unknown in Slovak terms, as evidenced by the results of the conducted research. Given the prevailing sectoral approach to the planning process in Slovakia and the poor application of integrated policies or strategies, the implementation of the ES concept is quite limited. The ES are not reflected in national strategic documents or laws which would be binding for the local implementation of spatial policies. The public interests represented by the ES are suppressed by local, mostly individual preferences. The ES concept, which represents an integrated approach to landscape assessment with a focus on participatory methods, has a great potential to streamline spatial planning in Slovakia. When considering the effective implementation of the ES concept, the following will be necessary:
>
> – implement the ES concept into the environmental policy and legislation, i.e. to change the legislation of spatial planning and nature and landscape protection, and subsequently modify landscape documentation methodologies;

- implement the integrated principles and participative methods of the ES concept in spatial-planning processes and reflect the ES concept in sectoral plans while harmonizing the objectives of sectoral policies;
- develop a national ES strategy in Slovakia and develop a national, regional and local ES assessment methodology;
- set up stakeholders at different spatial levels to support the implementation of the ES concept and overcome gaps, by the top-down approach – from national strategies to local implementation;
- focus on the mandatory incorporation of the ES concept, in particular in local strategies, which are mandatory as part of EU funding applications (e.g., PESD);
- ensure effective education, training and dissemination.

References

Albert, C., Bonn, A., Burkhard, B., Daube, S., Dietrich, K., Engels, B., Frommer, J., Götzl, M., Grêt-Regamey, A., Job-Hoben, B., Koellner, T., Marzelli, S., Moning, C., Müller, F., Rabe, S. E., Ring, I., Schwaiger, E., Schweppe-Kraft, B., & Wüstemann, H. (2016). Towards a national set of ecosystem service indicators: Insights from Germany. *Ecological Indicators, 61*, 38–48.

Barton, D. N., & Harrison, P. (Eds.). (2017). *Integrated valuation of ecosystem services. Guidelines and experiences*. EU FP7 OpenNESS Project Deliverable, European Commission FP7. https://oppla.eu/sites/default/files/uploads/openness-d3344integratedassessmentvaluationofesfinal2.pdf. Accessed 4 Apr 2019.

Becerra-Jurado, G., Philipsen, C., & Kleeschulte, S. (2016). *Mapping and assessing ecosystems and their services in Luxembourg – Assessment results*. Luxembourg: Le Gouvernment du Grand -Duché de Luxemburg. https://doi.org/10.13140/rg.2.1.4924.5841.

Bezák, P., & Bezáková, M. (2014). Landscape capacity for ecosystem services provision based on expert knowledge and public perception (case study from the North West Slovakia). *Ekologia Bratislava, 33*(4), 344–353. https://doi.org/10.2478/eko-2014-0031.

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

Boumans, R., Roman, J., Altman, I., & Kaufman, L. (2015). The Multiscale Integrated Model of Ecosystem Services (MIMES): Simulating the interactions of coupled human and natural systems. *Ecosystem Services, 12*, 30–41. https://doi.org/10.1016/j.ecoser.2015.01.004.

Brezovská, K., & Holécy, J. (2009). Ocenenie rekreačnej funkcie lesov Vysokých Tatier metódou cestovných nákladov. *Acta Facultatis Forestalis Zvolen, LI*(1), 151–162. https://lf.tuzvo.sk/sites/default/files/aff_09_suppl_1.pdf. Accessed 4 Apr 2019.

Bujnovský, R. (2011). Hodnota poľnohospodárskej pôdy a jej ekologických funkcií. *Životné prostredie, 45*(1), 35–37. http://147.213.211.222/sites/default/files/2011_1_035_037_bujnovsky.pdf

Bujnovský, R. (2018). Estimation of benefits from the actual use of inland water ecosystem services in the Slovak Republic. *Ekológia, 37*(3), 201–218. https://doi.org/10.2478/eko-2018-0017.

Bujnovský, R., Balkovič, J., Barančíková, G., Makovníková, J., & Vilček, J. (2009). *Hodnotenie a oceňovanie ekologických funkcií poľnohospodárskych pôd Slovenska*. Slovakia: VÚPOP.

Bukvareva, T., et al. (2017). Supplied, demanded and consumed ecosystem services: Prospects for national assessment in Russia. *Ecological Indicators, 78*(1), 351–360. https://doi.org/10.1016/j.ecolind.2017.03.034.

Burkhard, B., Kroll, F., Muller, F., & Windhorst, W. (2009). Landscapes' capacities to provide ecosystem services – A concept for land-cover based assessments. *Landscape Online, 15*, 1–22. https://doi.org/10.3097/LO.200915.

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), 1–32. https://doi.org/10.3097/LO.201434.

Čaboun, V., Moravčík, M., & Tutka, J. (2008). *Výskum, klasifikácia a uplatňovanie funkcií lesov v krajine. Lesy a lesníctvo – riziká, výzvy, riešenia*. Slovakia: National Forest Centre.

Čaboun, V., Tutka, J., Moravčík, M., Kovalčík, M., Sarvašová, Z., Schwarz, M., & Zemko, M. (2010). *Uplatňovanie funkcií lesa v krajine*. Slovakia: National Forest Centre.

Čaboun, V., Kovalčík, M., & Sarvašová, Z. (2014). Concept of the integrative aspects of the forest ecosystem services with case study on recreation services assessment in Slovakia. *Ecological Processes, 15*(3), 1–6. https://doi.org/10.1186/s13717-014-0015-8.

Castro, A. J., Verburg, P. H., Martín-López, B., Garcia-Llorente, M., Cabello, J., Vaughn, C. C., & López, E. (2014). Ecosystem service trade-offs from supply to social demand: A landscape-scale spatial analysis. *Landscape and Urban Planning, 132*, 102–110. https://doi.org/10.1016/j.landurbplan.2014.08.009.

CBS et al. (2015). *Ecosystem goods and services in the Netherlands*. https://www.clo.nl/en/indicators/en1572-ecosystem-goods-and-services-in-the-netherlands. Accessed 2 Mar 2019.

Černecký, J., Gajdoš, P., Špulerová, J., Halada, Ľ., Mederly, P., Ulrych, L., Ďuricová, V., Švajda, J., Černecká, Ľ., Andráš, P., & Rybanič, R. (2020). Ecosystems in Slovakia. *Journal of Maps, 16*, 28–35. https://doi.org/10.1080/17445647.2019.1689858.

Chan, K., Balvanera, P., Benessaiah, K., et al. (2016). Why protect nature? Rethinking values and the environment. *PNAS, 113*, 1462–1465. https://doi.org/10.1073/pnas.152502113.

Costanza, R., & Daly, H. (1992). Natural capital and sustainable development. *Conservation Biology, 6*, 37–46.

Costanza, R., dArge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., Oneill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature, 387*(6630), 253–260.

Costanza, R., De Groot, R., Sutton, P. C., 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. https://doi.org/10.1016/j.ecoser.2017.09.008.

Daily, G. (2000). The value of nature and the nature of value. *Science, 289*(5478), 395–396.

De Groot, R. S., Wilson, M. A., & Boumans, R. M. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics, 41*(3), 393–408.

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, 7*, 260–272.

Depellegrin, D., Pereira, P., Misiunė, I., & Egarter-Vigl, L. (2016). Mapping ecosystem services potential in Lithuania. *International Journal of Sustainable Development & World Ecology, 23*(5), 441–455. https://doi.org/10.1080/13504509.2016.1146176.

Dick, J., Turkelboom, F., Woods, H., et al. (2018). Stakeholders' perspectives on the operationalisation of the ecosystem service concept: Results from 27 case studies. *Ecosystem Services, 29*, 552–565. https://doi.org/10.1016/j.ecoser.2017.09.015.

Dudley, N., & Stolton, S. (2008). *The protected areas benefits assessment tool: A methodology*. Gland: WWF International. Available at: d2ouvy59p0dg6k.cloudfront.net/ downloads/pa_bat_web_1355739158.pdf. Accessed 13 Apr 2019.

Džatko, M. (2002). *Hodnotenie produkčného potenciálu poľnohospodárskych pôd a pôdno-ekologických regiónov Slovenska*. Slovakia: Research Institute of Soil Science and Soil Protection.

Ehrlich, P. R., & Ehrlich, A. H. (1981). *Extinction: The causes and consequences of the disappearance of species*. New York: Random House.

Eliáš, P. (1983). Ecological and social functions of vegetation. *Ekológia, 2*, 93–104.

Eliáš, P. (2010). Od funkcií vegetácie k ekosystémovým službám. *Životné prostredie, 44*(2), 59–64.

European Commission (2011). *European Commission COM/2011/0244*. Communication from the commission to the European parliament, the Council, the Economic and Social Sommittee and the Sommittee of the regions.

European Commission. (2014). *System of environmental-economic accounting 2012 experimental ecosystem accounting*. New York: European Commission Organisation for Economic Co-operation.

Fleischer, P., Pichler, V., Fleischer, P., Holko, L., et al. (2017). Forest ecosystem services affected by natural disturbances, climate and land-use changes in the Tatra Mountains. *Climate Research, 73*(1–2), 57–71. https://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.

Fűzyová, Ľ., Lániková, D., & Novorolský, M. (2009). Economic valuation of Tatras national park and regional environmental policy. *Polish Journal of Environmental Studies, 18*(5), 811–818.

Getzner, M. (2009). *Economic and cultural values related to protected areas. Part A: Valuation of ecosystem services in Tatra (PL) and Slovensky Raj (SK) national parks*. Final report. http://www.minzp.sk/files/sekcia-ochranyprirodyakrajiny/ps-543/final-report-part-b-pl-sk_getzner_201003.pdf. Accessed 04 April 2019.

Giarratano, M. C., et al. (2018). *Comitato Capitale Naturale*. Roma: Secondo Rapporto sullo Stato del Capitale Naturale in Italia. https://www.minambiente.it/comunicati/il-secondo-rapporto-sullo-stato-del-capitale-naturale-italia. Accessed 6 Apr 2019.

Gómez-Baggethun, E., & Barton, D. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics, 86*, 235–245. ISSN 0921-8009.

Gómez-Baggethun, E., & De Groot, R. (2010). Chapter 5: Natural capital and ecosystem services: The ecological foundation of human society. In R. M. Harrison & R. E. Hester (Eds.), *Ecosystem services* (pp. 105–121). https://doi.org/10.1039/9781849731058-00105.

Gómez-Baggethun, E., De Groot, R., Lomas, P. L., & Montes, C. (2010). The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecological Economics, 69*(6), 1209–1218. https://doi.org/10.1016/j.ecolecon.2009.11.007.

Gómez-Baggethun, E., et al. (2014). *State-of-the-art report on integrated valuation of ecosystem services*. EU FP7 OpenNESS project deliverable 4.1., European Commission FP7. http://www.openness-project.eu/sites/default/files/Deliverable%204%201_Integrated-Valuation-Of-Ecosystem-Services.pdf. Accessed 6 Apr 2019.

Grunewald, K., Herold, H., Marzelli, S., Meinell, G., Richter, B., Sybre, R. U., & Walz, U. (2016). Concept of national indicators for ecosystem services in Germany further development, types of classes and sheet of indicators. *In Naturschutz und Landschaftsplanung, 48*, 141–152.

Haines-Young, R., & Potschin, M. (2013). *CICES V4.3-Revised report prepared following consultation on CICES Version 4, August–December 2012*. Nottingham: Centre for Environmental Management, University of Nottingham. https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf. Accessed 6 Apr 2019.

Haines-Young, R., & Potschin, R. M. (2018). *Common International Classification of Ecosystem Services (CICES) V5.1 and guidance on the application of the revised structure*. Nottingham: Barton in Fabis. https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf. Accessed 2 Apr 2019.

Hronec, O., Bedrna, Z., & Vilček, J. (2005). *Environmentálna pedológia*. Slovakia: Slovak University of Agriculture in Nitra.

IPBES. (2018). *Summary for policymakers of the regional assessment report on biodiversity and ecosystem services for Europe and Central Asia of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. https://www.ipbes.net/assessment-reports/eca. Accessed 6 Apr 2019.

Ivanić, K.-Z., Štefan, A., Porej, D., & Stolton, S. (2017). Using a participatory assessment of ecosystem services in the Dinaric Arc of Europe to support protected area management. *Parks, 23*, 61–74. https://doi.org/10.2305/IUCN.CH.2017.PARKS-23-1K-ZI.en.

Izakovičová, Z., Bezák, P., Mederly, P., & Špulerová, J. (2017). Uplatňovanie konceptu ekosystémových služieb v plánovacej a riadiacej praxi v Slovenskej republike – výsledky projektu OpenNESS na prípadovej štúdii Trnava. *Životné prostredie, 51*(4), 198–204.

Jacobs, S., Dendoncker, N., & Keune, H. (2014). *Ecosystem services: Global issues, local practices*. Boston: Elsevier.

Janák, M., Černecký, J., & Saxa, A. (Eds.). (2015). *Monitoring of animal species of Community interest in the Slovak Republic, Results and assessment in the period of 2013–2015*. Banská Bystrica: State nature conservancy of the Slovak Republic.

Jäppinen, J. P., & Heliölä, J. (Eds.). (2015). *Towards a sustainable and genuinely green economy. The value and social significance of ecosystem services in Finland (TEEB for Finland). Synthesis and roadmap*. Helsinki: The Finnish Ministry of Environment, Helsinki.

Jax, K., Barton, D. N., Chan, K. M. A., De Groot, R., Doyle, U., Eser, U., Görg, C. H., Gómez-Baggethun, E., Griewald, J., Haber, W., Haines-Young, R., Heink, U., Jahn, T., Joosten, H., Kerschbaumer, L., Korn, H., Luck, G. W., Matzdorf, B., & Wichmann, S. (2013). Ecosystem services and ethics. *Ecological Economics, 93*, 260–268. https://doi.org/10.1016/j.ecolecon.2013.06.008.

Jurík, Ľ., Halászová, K., & Sedmáková, M. (2017). Ekosystémové služby zdrojov vody pre krajinu. *Životné prostredie, 51*(4), 221–226.

Jurko, A. (1990). *Ekologické a socio-ekonomické hodnotenie vegetácie*. Bratislava: Píroda.

Kanianska, R. (2014). *Ekosystémové služby a ich oceňovanie. In Stav a trendy integrovaného manažmentu životného prostredia*. Slovakia, Zvolen: Technical University of Zvolen.

Kanianska, R., Jaďuďová, J., Makovníková, J., Kizeková, M., & Tomaškin, J. (2016). *Ekosystémové služby*. Banská Bystrica: Belianum.

Kizeková, M., Čunderlík, J., Dugátová, Z., Makovníková, J., Kanianska, R., Jaďuďová, J., Jančová, Ľ., & Pálka, B. (2016). *Agroekosystémové služby a súčasný stav trávnych porastov v Slovenskej republike*. Slovakia/Banská Bystrica: NPPC VÚTPHP Banská Bystrica, NPPC SSCRI Bratislava, UMB Banská Bystrica.

Kizeková, M., Čunderlík, J., Dugátová, Z., Jančová, Ľ., Kanianska, R., & Makovníková, J. (2018). *Klasifikácia ekosystémových služieb trávnych porastov a ich hodnotenie*. http://www.agroporadenstvo.sk/index.php?start&t=rastlinna-vyroba-rastlinna-vyroba&t2=&article=1118. Accessed 4 Apr 2019.

Kluvánková, T., & Brnkaľáková, S. (2017). Globálne problémy a lokálne riešenia v udržateľnom manažmente ekosystémových služieb a krajiny. *Životné prostredie, 51*(4), 195–197.

Kluvánková-Oravská, T., & Chobotová, V. (2010). Inštitúcie a ekosystémové služby v demokratickej a trhovej spoločnosti. *Životné prostredie, 44*(2), 84–88.

Kluvánková-Oravská, T., Ditmarová, Ľ., & Blaženec, M. (2013). *Ecosystem services: Interdisciplinary research challenges*. Paper presented at ecosystem services: Adaptive EU policies for future EU regions, Slovak Academy of Sciences, Bratislava, 30 September–1 October 2013.

Konôpka, J. (2010). Od reprodukcie k multifunkčnému využívaniu lesných ekosystémov. *Lesnícky časopis – Forestry Journal, 56*(1), 81–92.

Konôpka, J. (2012). Manažment hydrických funkcií lesov. *Lesnícky časopis – Forestry Journal, 58*(2), 129–135.

Kovalčík, M., & Tutka, J. (2008). *Hodnotenie rekreačnej funkcie lesov SR preferenčnými metódami – výsledky testovacej štúdie*. Paper presented at Aktuálne otázky ekonomiky LH SR, National Forest Centre, Zvolen, 2008.

Lieskovský, J., Bezák, P., Špulerová, J., Lieskovský, T., Koleda, P., Dobrovodská, M., Buergi, M., & Gimmi, U. (2015). The abandonment of traditional agricultural landscape in Slovakia – Analysis of extent and driving forces. *Journal of Rural Studies, 37*, 75–84. https://doi.org/10.1016/j.jrurstud.2014.12.007.

Lotan, A., Kost, R., Mandelik, Y., Peled, Y., Chakuki, D., Shamir, S. Z., & Ram, Y. (2018). National scale mapping of ecosystem services in Israel – Genetic resources, pollination and cultural services. *One Ecosystem, 3*, e25494. https://doi.org/10.3897/oneeco.3.e25494.

Makovníková, J., Kobza, J., Pálka, B., Mališ, J., Kanianska, R., & Kizeková, M. (2016). An approach to mapping the potential of cultural agroecosystem services. *Soil and Water Research, 11*(1), 44–52. https://doi.org/10.17221/109/2015-SWR.

Makovníková, J., Pálka, B., Širáň, M., Kanianska, R., Kizeková, M., & Jaďuďová, J. (2017). *Modelovanie a hodnotenie agroekosystémových služieb*. Banská Bystrica: Matej Bel University.

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.

Midriak, R., et al. (1981). *Diferencované obhospodarovanie lesa podľa integrovaných funkcií* (Lesnícke štúdie 31). Zvolen: VÚLH & Bratislava: Príroda.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Wetlands and water synthesis*. Washington, DC: World Resources Institute.

MoE SR. (2014). *Aktualizovaná národná stratégia ochrany biodiverzity do roku 2020*. http://www.minzp.sk/sekcie/temy-oblasti/ochrana-prirody-krajiny/medzinarodne-dohovory/dohovor-biodiverzite/aktualizovana-narodna-strategia-ochrany-biodiverzity-do-roku-2020/. Accessed 6 Apr 2019.

Mulligan, M. (2013). WaterWorld: A self-parameterising, physically based model for application in data-poor but problem-rich environments globally. *Hydrology Research, 44*, 748. https://doi.org/10.2166/nh.2012.217.

Mulligan, M. (2015) Trading off agriculture with nature's other benefits, spatially In Zolin, C. A and Rodrigues, R., de, A. R. (eds) Impact of climate change on water resources in agriculture. CRC Press. ISBN 9781498706148.

NEPA. (2017). *Assessment of ecosystems and ecosystem Services in Romania*. Romania: NEPA, NINA, ROSA, WWF Romania.

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: IUCN.

Norgaard, R. B. (2000). Ecological economics. *BioScience, 50*(4), 291. https://doi.org/10.1641/0006-3568(2000)050[0291:EE]2.3.CO;2.

Papánek, F. (1978). *Teória a prax funkčne integrovaného lesného hospodárstva*. Bratislava: Príroda.

Parker, N., Naumann, E.-K., Medcalf, K., Haines-Young, R., Potschin, M., Kretsch, C., Parker, J., & Burkhard, B. (2016). *Irish wildlife manuals, national ecosystem and ecosystem service mapping pilot for a suite of prioritised services – Appendices*. Ireland: National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs.

Peh, K. S.-H., Balmford, A. P., Bradbury, R. B., Brown, C., Butchart, S. H. M., Hughes, F. M. R., MacDonald, M. A., Stattersfield, A. J., Thomas, D. H. L., Trevelyan, R. J., Walpole, M., & Merriman, J. C. (2017). *Toolkit for Ecosystem Service Site-based Assessment (TESSA), version 2.0*. Cambridge.

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.

Považan, R., Getzner, M., & Kadlečík, J. (2014b). Hodnotenie ekosystémových služieb v chránených územiach Karpát so zameraním na Slovensko – Príručka pre rýchle hodnotenie. *Quaestiones rerum naturalium, 1*(2), 7–44.
Považan, R., Getzner, M., & Švajda, J. (2015). On the valuation of ecosystem services in Muránska Planina National Park (Slovakia). *Eco. Mont. Journal on Protected Mountain Areas Research and Management, 7*(2), 61–69. https://doi.org/10.1553/eco.mont-7-2s61.
Rabe, S.-E., Koellner, T., Marzelli, S., & Schumacher, P. (2016). Gret-Regamey, A. (2016). National ecosystem services mapping at multiple scales – The German exemplar. *Ecological Indicators, 70*, 357–372. https://doi.org/10.1016/j.ecolind.2016.05.043.
Reháčková, T., & Pauditšová, E. (2006). *Vegetácia v urbánnom prostredí*. Bratislava: Cicero.
Šálka, J., & Dobšinská, Z. (2013). *Policy analysis for assuring forest ecosystem externalities*. Zvolen: Technical University in Zvolen.
Šálka, J., Dobšinská, Z., & Štěrbová, M. (2017). *Analýza verejnej politiky na zabezpečenie ekosystémových služieb lesa*. Zvolen: Technical University in Zvolen.
Santos-Martín, F., García Llorente, M., Quintas-Soriano, C., Zorrilla-Miras, P., Martín-López, B., Loureiro, M., Benayas, J., & Montes, M. (2016). *Spanish National Ecosystem Assessment: Socio-economic valuation of ecosystem services in Spain.Synthesis of the key findings*. Madrid: Biodiversity Foundation of the Spanish Ministry of Agriculture, Food and Environment.
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 B. Burkhard & J. Maes (Eds.), *Mapping ecosystem services* (pp. 104–114). Sofia: Pensoft Publishers.
Sarvašová, Z., & Šálka, J. (2012). *Integrácia úžitkov verejnoprospešných funkcií do trhového mechanizmu – teórie a zahraničné skúsenosti*. Zvolen: Technical University in Zvolen.
Sarvašová, Z., Kovalčík, M., Dobšinská, Z., Šálka, J., & Jarský, V. (2014). Ecosystem services – Examples of their valuation methods in Czech Republic and Slovakia. *Change and Adaptation in Socio-Ecological Systems, 1*(1). https://doi.org/10.2478/cass-2014-0008.
Schneider, J., Holušová, K., & Karber, V. (2016). *Proceedings from the role of forest functions within ecosystem services international scientific conference* (p. 2016). Brno: Mendel University in Brno.
Schröter, M., Albert, C. H., Marques, A., Tobon, W., Lavorel, S., Maes, J., Brown, C., Klotz, S., & Bonn, A. (2016). National Ecosystem Assessments in Europe: A review. *BioScience, 66*(10), 813–828. https://doi.org/10.1093/biosci/biw101.
Šefferová Stanová, V., & Galvánková, J. (Eds.). (2015). *Monitoring of plants and habitats of community interest in the Slovak Republic, results and assessment in the period of 2013–2015*. Banská Bystrica: State Nature Conservancy of the Slovak Republic.
Sharp, R., Tallis, H.T., Ricketts, T., Guerry, A.D., Wood, S.A., Chaplin-Kramer, R., Nelson, E., Ennaanay, D., Wolny, S., Olwero, N., Vigerstol, K., Pennington, D., Mendoza, G., Aukema, J., Foster, J., Forrest, J., Cameron, D., Arkema, K., Lonsdorf, E., Kennedy, C., Verutes, G., Kim, C.K., Guannel, G., Papenfus, M., Toft, J., Marsik, M., Bernhardt, J., Griffin, R., Glowinski, K., Chaumont, N., Perelman, A., Lacayo, M. Mandle, L., Hamel, P., Vogl, A.L., Rogers, L., Bierbower, W., Denu, D., & Douglass, J. (2018). *InVEST Version 3.4.4 user's guide*. The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund. https://naturalcapitalproject.stanford.edu/. Accessed 10 Apr 2019.
Sherrouse, B. C., Clement, J. M., & Semmens, D. J. (2011). A GIS application for assessing, mapping, and quantifying the social values of ecosystem services. *Applied Geography, 31*, 748–760. https://doi.org/10.1016/j.apgeog.2010.08.002.
Spangenberg, J. H., & Settele, J. (2010). Precisely incorrect? Monetising the value of ecosystem services. *Ecological Complexity, 7*(3), 327–337. https://doi.org/10.1016/j.ecocom.2010.04.007.
Špulerová, J. (2006). Funkcie nelesnej drevinovej vegetácie v krajine. *Životné prostredie, 40*(1), 37–40.

Špulerová, J., Dobrovodská, M., Štefunková, D., Bača, A., & Lieskovský, J. (2014). *Biodiversity of traditional agricultural landscapes in Slovakia and their threats. Biocultural Landscapes*. Dordrecht: Springer.
Špulerová, J., Hrnčiarová, T., Piscová, V., Vlachovičová, M., Kalivoda, H., Kanka, R., Dobrovodská, M., Kenderessy, P., Miklósová, V., Drábová, M., & Belčáková, I. (2016). Sustainable tourism development in a selected area of the Low Tatras National Park – landscape planning versus urban planning. *Carpathian Journal of Earth and Environmental Sciences, 11*(2), 485–496.
Špulerová, J., Štefunková, D., Dobrovodská, M., et al. (2017). *Historické štruktúry poľnohospodárskej krajiny Slovenska*. Bratislava: VEDA.
Špulerová, J., Petrovič, F., Mederly, P., Mojses, M., & Izakovičová, Z. (2018). Contribution of traditional farming to ecosystem services provision: Case studies from Slovakia. *Land, 7*(2), 74. https://doi.org/10.3390/land7020074.
Štěrbová, M. (2017). Prístupy a metódy hodnotenia ekosystémových služieb lesa. *Životné prostredie, 51*(4), 213–220.
Stevens, M., Demolder, H., Jacobs, S., Michels, H., Schneiders, A., Simoens, I., Spanhove, T., Van Gossum, P., Van Reeth, W., & Peymen, J. (2015). *Flanders regional ecosystem assessment – State and trends synthesis report*. https://pureportal.inbo.be/portal/files/9004761/Stevens_etal_2015_FlandersRegionalEcosystemAssessment_State_Trends.pdf. Accessed 10 Apr 2019.
Supuka, J., et al. (1991). *Ekologické princípy tvorby a ochrany zelene*. Bratislava: Veda.
Supuka, J., Jančura, P., Pavlík, J., Kattoš, K., & Marenčák, M. (2000). *Ekológia urbanizovaného prostredia*. Zvolen: Technical University in Zvolen.
Švajda, J. (2009). Contribution for improvement of visitor monitoring in the Tatra National Park. *Eco. Mont-Journal on Protected Mountain Areas Research, 1*, 13–18. https://doi.org/10.1553/ecomont2s13.
TEEB – The Economics of the Ecosystem and Biodiversity. (2010). *Mainstreaming the economics of nature. A synthesis of the approach, conclusions and recommendations of TEEB*. Geneva: United Nations Environment Programme.
Turanovičová, M., & Rózová, Z. (2017). Metodické východiská hodnotenia kultúrnych ekosystémových služieb v urbanizovanom prostredí. *Životné prostredie, 51*(4), 232–239.
Turner, K. G., Vestergaard Odgaard, M., Bøcher, P. K., Dalgaard, T., & Svenning, J. C. H. (2014). Bundling ecosystem services in Denmark: Trade-offs and synergies in a cultural landscape. *Landscape and Urban Planning, 125*, 89–104. https://doi.org/10.1016/j.landurbplan.2014.02.007.
Tutka, J., Vilček, J., & Kovalčík, M. (2009). Oceňovanie verejnoprospešných funkcií lesných a poľnohospodárskych ekosystémov a služieb odvetví. In *Abstracts of Aktuálne otázky ekonomiky lesného hospodárstva Slovenskej republiky*. Technical University in Zvolen.
UK NEA. (2011). *The UK National Ecosystem Assessment: Synthesis of the key findings*. Cambridge: UNEP-WCMC.
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.
Value of Nature to Canadians Study Taskforce. (2017). *Completing and using ecosystem service assessment for decision-making: An interdisciplinary toolkit for managers and analysts*. Ottawa: Federal, Provincial, and Territorial Governments of Canada. https://biodivcanada.chm-cbd.net/documents/ecosystem-services-toolkit?lang=En& n=B443A05E-1.Accessed 10 Apr 2019.
Verweij, P., Janssen, S., Braat, L., Van Eupen, M., Pérez Soba, M., Winograd, M., De Winter, W., & Cormont, A. (2016). QUICKScan as a quick and participatory methodology for problem identification and scoping in policy processes. *Environmental Science and Policy, 66*, 47–61. https://doi.org/10.1016/j.envsci.2016.07.010.
Vilček, J. (2011). Potenciály a parametre kvality poľnohospodárskych pôd Slovenska. *Geografický časopis, 63*(2), 133–154.

Vilček, J. (2014). Mapovanie a hodnotenie environmentálnych funkcií poľnohospodárskych pôd Slovenska. *Geografický časopis, 66*(3), 287–304.
Vilček, J., & Koco, Š. (2018). Integrated index of agricultural soil quality in Slovakia. *Journal of Maps*, 14(2), 68–76 (2018). https://doi.org/10.1080/17445647.2018.1428233.
Villa, F., Ceroni, M., Bagstad, K., Johnson, G., & Krivov, S. (2009). *ARIES (Artificial Intelligence for Ecosystem Services): A new tool for ecosystem services assessment, planning, and valuation*. Burlington: Ecoinformatics Collaboratory, Gund Institute for Ecological Economics, University of Vermont. www.ariesonline.org/docs/Villa%20et%20al.%20 2009.Pdf. Accessed 10 Apr 2019.
Vološčuk, I. (2013). *Teoretické princípy ekologických procesov, funkcií a služieb ekosystémov*. Banská Bystrica: Belianum.
Wijnja, H., Van Uden, G., & Delbaere, B. (Eds.). (2016). *Ecosystem Services in operation: Case studies*. European Commission FP7, OpenNESS Project. https://issuu.com/ecnc.org/docs/openness_casestudies_brochure. Accessed 20 Mar 2019.
Zulian, G., et al. (2013). *ESTIMAP: Ecosystem services mapping at European scale*. Belgium: Institute for Environment and Sustainability, Joint Research Centre, European Commission.
Zulian, G., Stange, E., Woods, H., Carvalho, L., Dick, J., Andrews, C. H., Baró, F., Vizcaino, P., Barton, D. N., Nowel, M., Rush, G. M., Autunes, P., Fernandes, J., Ferraz, D., Ferreira Dos Santos, R., Aszalós, R., Aranay, I., Crúcz, B., Priess, J. A., Hoyer, C. H., Bürger-Patricio, G., Lapola, D., Mederly, P., Halabuk, A., Bezák, P., Kopperoinen, L., & Viinikka, A. (2018). Practical application of spatial ecosystem service models to aid decision support. *Ecosystem Services, 29*(C), 465–480. https://doi.org/10.1016/j.ecoser.2017.11.005.