Chapter 2
Methodology of the National ES Assessment

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Abstract Chapter provides a brief overview of the methodology of pilot ES assessment in Slovakia. For the assessment process, in total 41 map inputs were used, in raster format with the pixel size 25 m. The most important data are the land cover map, the ecosystems map, protected areas, forestry data, digital elevation model, and soil data. The resulting landscape capacity maps present selected ES in the 0–100 relative scale, in a uniform standardized pixel format of 1 km resolution. Background data contain about 49,000 pixels with individual ES values and thus represent a basic dataset which is possible to use for further evaluation of the relationships and factors which affect ES provision.

The main aim of the publication is to provide a pilot assessment of all ES, which were selected for the territory of Slovakia based on current ecosystem and ES assessment process in Europe and the MAES process in Slovakia (5 provisioning, 10 regulating/supporting, and 3 cultural ES). As mentioned in Chap. 1, the issue of ES assessment is extremely complex and involves several aspects. Moreover, this process is still only in its beginnings within Slovakia and is not well elaborated.

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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_2

Therefore, references from various available sources, in particular scientific reviews and articles, were used for the characterization of individual ES.

To improve the levels of knowledge and as an introduction to the next stage of the detailed and applied ES assessment in Slovakia, we consider it appropriate and useful to draw up a clear assessment of the main ES which we have tried to establish in this publication. We have developed the *coordinated procedure for expressing the landscape's relative capacity to provide each ES*, based mainly on biophysical (environmental) spatially expressed data. The result of the assessment is a relative scale of 0–100, where 0 means the minimum and 100 the maximum suitability of the area for the provision of the given ES within the whole territory of Slovakia (Mederly et al. 2019). The values can then be classified into a simple suitability scale, e.g., minimum to low–below average–average–above-average–high to very high capacity of the landscape to provide ES.

Background map documents and database information were prepared in a unified form to assess the landscape's capacity to provide ES. In particular, we relied on relevant data available in the spatial and information datasets of organizations involved in the compilation of the publication (Constantine the Philosopher University in Nitra, ILE SAS, and SNC SR), in some cases from the available sources of environmental institutions (SEA and SHMÚ – Slovak Hydrometeorological Institute). In total, 41 map layers were used directly for the ES evaluation (see Table 2.1), which were compiled into additional tailored assessment layers via reclassification or computational algorithms. Subsequently, the resulting capacity maps of individual ES were prepared. Key layers which were used for a larger number of ES included: a map of the current landscape structure and its interpretation, a map of ecosystems and the selected derived features, basic data on Slovakia's forests, data on protected areas, a digital elevation model, and soil properties data. The detail and applicability of these documents fit a scale of 1:10000 to 1:25000, which is highly above standard for national-level assessment. Supplementary background material was aimed at expressing important climate and hydrological data, where the accuracy is at a scale of approximately 1:50000, which is also sufficient for the national level. For cultural ES, less accurate documents from the Landscape atlas of the Slovak Republic were used – in order to ensure a more accurate assessment of the ES, a task remains to incorporate the information, especially at the level of individual municipalities, from state statistical surveys.

The standardization of the background layers consisted of converting all input maps into a uniform shape – a raster format with a pixel size of 25 m. All calculations were performed in this resolution, and also a landscape capacity map was generated to provide the given ES in different arithmetic values (generally from 0 to N points), based on the respective calculation algorithm different for each ES. For better standardization of results, their better display ability, and preparation for further statistical analysis, the capacity values were then recalculated for grid of 1 km – resulting value for pixel 1 × 1 km was calculated as an arithmetic average of values from 1600 original pixels 25 × 25 m. These values were then converted to a 0–100 scale according to a simple transformation algorithm, where 0 = lowest achieved value and 100 = highest achieved value for a given ES. *The resulting ES maps for*

Table 2.1 List of map layers used for assessment of ecosystem services in Slovakia

Content (theme) of the map layer	Source of data	Accuracy	Prov.	Reg.	Cult.
Digital elevation model – slope and other parameters	Database of UKF	1:25,000	2	2	2
Morphological-positional type of relief	Database of ILE SAS	1:25,000	*	1	2
Hydrogeological regionalization	Database of ILE SAS	1:50,000	1	*	*
Average annual temperature	SR Climate Atlas	1:50,000	*	1	*
Rainfall intensity (max 1-day totals)	SR Climate Atlas	1:50,000	*	1	*
Moisture balance indicator	SR Climate Atlas	1:50,000	*	1	*
Average. annual amount of solar radiation	SR Climate Atlas	1:50,000	*	1	*
Territorial climate classification	SR Climate Atlas	1:50,000	2	*	*
Hydrological basins (watersheds)	Slovak Water Mng. Map	1:50,000	*	1	*
Watercourses and water bodies	Slovak Water Mng. Map	1:50,000	1	*	*
Significant watercourses	Slovak Water Mng. Map	1:50,000	1	*	2
Water resources used	Slovak Water Mng. Map	1:50,000	1	*	*
Water resources protection zones	Slovak Water Mng. Map	1:50,000	1	*	*
Water reservoirs	Slovak Water Mng. Map	1:50,000	1	*	*
Basins of watercourses used for drinking purposes	Slovak Water Mng. Map	1:50,000	1	*	*
Natural medicinal resources protection zones	Slovak Water Mng. Map	1:50,000	1	*	1
Protected water management areas	Slovak Water Mng. Map	1:50,000	1	*	*
Average. groundwater depth	Database of ILE SAS	1:25,000	2	*	*
Soil subtype	SSCRI, ILE SAS	1:25,000	2	2	*
Soil texture	Database of ILE SAS	1:25,000	2	2	*
Soil depth	Database of ILE SAS	1:25,000	2	1	*
Current landscape structure/land use	ZB GIS, Corine Land Cover	1:25,000	3	3	3
Spatial diversity of landscape structure	Database of UKF	1:25,000	*	2	*
Classification and use of forest spatial units	NLC + SNC SR	1:10,000	2	*	2
Forest types	NLC + SNC SR	1:10,000	*	3	*
Forest age classes	NLC + SNC SR	1:10,000	1	3	1
Significant ecosystems (habitats)	SNC SR	1:25,000	*	2	*
The naturalness of ecosystems	Database of UKF	1:25,000	*	2	*
State of ecosystems	SNC SR	1:25,000	*	1	*
Categorization of protected areas	SNC SR	1:25,000	*	1	2

(continued)

Table 2.1 (continued)

Content (theme) of the map layer	Source of data	Accuracy	Prov.	Reg.	Cult.
Natural conservation significance of a territory	Database of UKF	1:25,000	*	1	2
Leaf area index (LAI)	Copernicus Global Land S.	1:50,000	*	2	*
Photosynthetically active radiation (FAPAR)	Copernicus Global Land S.	1:50,000	*	1	*
Normalized difference vegetation index (NDVI)	Copernicus Global Land S.	1:50,000	*	1	*
Potential for geothermal energy	SR Landscape Atlas	1:100,000>	*	*	1
Fishing and hunting areas	SR Landscape Atlas	1:100,000>	1	*	*
Areas of traditional (historical) land use	SR Landscape Atlas	1:100,000>	*	*	3
Significant natural sites	SR Landscape Atlas	1:100,000>	*	*	2
Historical parks and gardens	SR Landscape Atlas	1:100,000>	*	*	2
Cultural and historical attractions and monuments	SR Landscape Atlas	1:100,000>	*	*	2
Recreation and tourism objects	SR Landscape Atlas	1:100,000>	*	*	1

3 – most important layers for ES assessment, 2 – important layers for ES assessment, 1 – complementary layers for ES assessment; Prov. - Provisioning ES, Reg. - Regulatory & Supporting ES, Cult. - Cultural ES

the territory of Slovakia contain about 49,000 pixels with individual values for each ES – they represent a basic statistical set (or a point field) with which further work can be performed and assessment of the interactions and factors affecting the provision of the ES can be made.

Since the distribution of the majority of the resulting ES capacity values was significantly asymmetric and did not meet the preconditions for a statistically normal distribution, before the final transformation of the maps into the 0–100 scale, we proceeded to the modification – cutting the data file by so-called outliers at 2% of the minimum and maximum values. *The graphical presentation of maps* in the publication is unified – maps show the relative capacity of a landscape to provide a given ES in a 5-degree legend divided by the frequency of occurrence (i.e., every 20% percentile of occurrence is represented by 1 shade of a given color scale).

The resulting capacity of the landscape is not expressed in biophysical or monetary values, but in a relative scale (it represents % of maximum capacity, the value of suitability of the area, etc.). The big advantage is that these values can be further processed on the basis of known data from relevant research and studies. Minimum and maximum values can be replaced by specific biophysical units or monetary values based on advanced research or value/benefit transfer method from known ES valuation studies. It is this path that could be seen as a promising for the future assessment of the capacity of Slovakia's landscape to provide ES.

As part of the ES description, we also assess two factors of the spatial distribution of the ES in Slovakia – the relationship between the main types of landscape

and ecosystems which provide the given ES; and the importance of the ES in terms of nature and landscape protection in Slovakia.

The main types of landscape and ecosystems providing the given ES are described based on the comparison of the spatial distribution of individual landscape types/main ecosystems with the achieved value of the landscape capacity. Most ES maintain a *logic* of the correlation between the degree of naturalness of a given landscape/ecosystem type and its ES provisioning capacity, but this is not always the case (e.g., for some provisioning services).

The importance of the given ES from the point of view of nature and landscape protection in Slovakia is assessed (both verbally and graphically) by comparison of the achieved capacity of the landscape with the degree of nature conservation significance of an area in the SR (I.–V.). *The nature conservation significance* is a special indicator used also for the processing of some ES maps, which expresses the synthesis of various existing categories of nature and landscape protection – from the national system of protected areas of the SR, through the European system NATURA 2000, biosphere reserves Man and Biosphere Programme (MAB), and the United Nations Educational, Scientific and Cultural Organization (UNESCO) natural heritage sites, to Ramsar Sites in Slovakia. Based on the overlap of individual categories of nature and landscape protection, we have compiled a more detailed 9-stage and simpler 5-stage classification of the nature conservation significance of Slovakia's territory (categories I–V), where I. represents an area without any protection and V. is an area with at least three overlapping categories of protection at the same time. These categories do not, therefore, represent degrees of protection 1–5 as per the Act on Nature and Landscape Protection of the SR – e.g., the area of protection level 5 without any other categories of protection represents the nature conservation significance degree III. The relationship between the categories of nature conservation significance and the landscape's capacity to provide ES was expressed in a graph and a simple correlation for each ES.

The *comprehensive* ES comparison according to their basic groups, the final assessment of the achieved results, their relation to nature conservation significant areas, and proposals for the further continuation of the ES assessment process in Slovakia are present in Chap. 6 of the publication.

Reference

Mederly, P., Černecký, J. (eds.) et al. (2019). Katalóg ekosystémových služieb Slovenska. Banská Bystrica: State Nature Conservancy of the Slovak Republic, Constantine the Philosopher University in Nitra, Institute of Landscape Ecology SAS.