Chapter 6
Synthesis of Ecosystem Services Assessment in Slovakia

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Abstract This chapter provides comprehensive findings for the three basic groups of ES. Five provisioning ES are essential for Slovakia – agricultural crops; timber and fibre; drinking water; freshwater and fish; and game and wildfood. Regulatory ES represent the regulation of natural processes – erosion and natural hazards mitigation; runoff and flood protection; local and global climate regulation; and air and water quality regulation. Supporting ES enable the appropriate course of natural functions and processes – as biodiversity promotion; pollination; pest and disease control; or soil formation. Cultural ES are the intangible benefits of nature for people, such as recreation and tourism; landscape aesthetics; and natural and cultural heritage. As a synthesis, the overall landscape capacity for ES provision is expressed, as an average of the main ES groups. Regarding landscape types, the high value of the ES capacity is documented for mountains and sub-mountain areas, while the low capacity is typical for lowlands and open basin areas. Also, the relationships between land use and ES are evaluated. Results confirm the generally accepted fact that forest ecosystems are the most important for the ES provision (mainly decidu-

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ous forests), and urbanized areas (mainly industrial and technical infrastructure) are the least important. Finally, the crucial importance of nature and landscape protection was confirmed – not only for the healthy state of ecosystems but also for the fulfilment of their functions and services.

6.1 Provisioning Ecosystems Services

Provisioning ES are one of the main ES groups, most likely perceived and directly appreciated by most people. On the basis of the different classification systems (see Table 1.1 in Chap. 1), this includes material products and goods from ecosystems, providing nutrition, materials and energy, especially *biomass for food*, *drinking water and water for other purposes* and *biomass for use*, *abiotic materials and substances* and *energy sources*. For the pilot ES assessment, based on the opinion of MAES process experts representing the different ES assessment institutions in Slovakia, we selected five ES, including agricultural and forest biomass, drinking water and freshwater and complimentary food sources from different types of ecosystems.

P1 biomass – Agricultural crops are mainly based on the production capacity of soils and climatic-hydrological conditions. The spatial distribution of the landscape's capacity to provide this ES is therefore significantly different from that of most other provisioning ES. This ES is actually used in the agricultural production process; it is one of the *most visible*, and in terms of assessment of ES, it is the best developed. The problem is that with the intensive use of this ES, the use most of all the other ES is largely suppressed (even excluded). Especially agriculture and its practices directly affecting more than half of Slovakia's territory are extremely important not only for the use of this ES but also for the possibility of maintaining and providing other production- and most non-production ES.

P2 biomass – Timber and fiber are sometimes simplified as a complement to the previous ES because it is actually used mainly in the form of forestry. However, this is not so clear because agricultural ecosystems and other types of landscape are also involved to some extent in the provision of this ES. However, it is clear that forestry is the main factor in using and restoring this potential. Unlike agriculture with an annual and seasonal utility cycle, wood biomass benefits are mostly associated with decades-long periods – and this is a *major problem in using this ES*. Woody plants as its carrier also play a key role in providing other provisioning and, in particular, regulatory and supporting ES. *A one-time benefit from this ES* (most often through the logging of forests or small woods) can cause a *loss of benefit* in terms of the amount of other ES for decades. This is a fact which is completely neglected in sectoral landscape management in order to maximize immediate benefit.

P3 drinking water and *P4 freshwater* are closely related ES which are sometimes understood and assessed as one entity. Drinking water is crucial for the survival of humans and animals; freshwater is particularly important in terms of human economic activities, living conditions excluded and the overall condition of ecosystems. The capacity of the landscape to provide these ES depends mainly on the abiotic conditions and processes (in particular rainfall-runoff properties, precipitation balance, hydrogeological properties); ecosystem status and the overall quality of the environment are also important, especially for drinking water. The spatial projection of the landscape potential for these ES is different from the other ES, which is caused by the above facts. The landscape capacity for drinking water is concentrated in larger units with the protection of surface and underground resources; the capacity for freshwater is associated mainly with hydrogeological units with a positive balance of rainfall-runoff regime. Wider river valleys and floodplains with accumulation of quaternary gravels are of particular importance (Žitný ostrov area is of European significance in this respect). It should also be mentioned that other functions and services are sometimes restricted by the use of this ES – especially in the case of building hydropower, large water reservoirs, but also in excess of water abstraction.

P5 fish and game/wildfood depend mainly on the predominant land use, quality of the environment and, in the case of game animals, also on the regulatory intervention of humans. To a large extent, it is linked to ES P2 and dominates in lower and medium-altitude mountain ranges, but lowland and basin areas also have some potential, especially their submountain parts and areas near to larger watercourses and water bodies. The use of this ES does not fundamentally affect the benefits of other ES – it is less conflicting in this respect.

Various methods are used for the assessment of provisioning ES, including mainly the biophysical and economic ones. Capacity is expressed, e.g. with modelling of related ecosystem functions, processes and production capability, with the common use of spatial GIS models. Real use and demand for ES are also expressed through monetary methods, as provisioning ES are mostly part of the markets.

With regard to the overall spatial projection of the capacity of the landscape of Slovakia to provide provisioning ES Fig. 6.1), *the highest values are achieved by small discontinuous areas within some mountain ranges* (especially Strážovské vrchy, Veľká Fatra; partly Nízke Tatry, Malé Karpaty, Považský Inovec, Slovenský

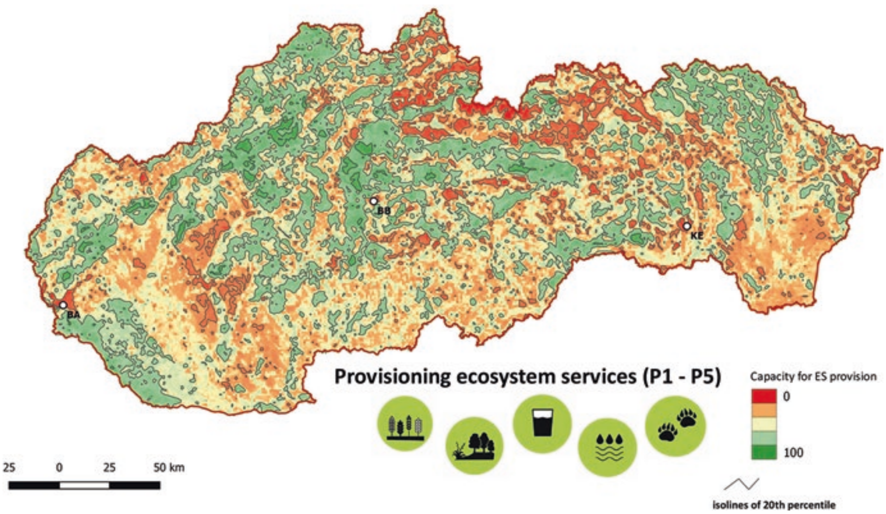

Fig. 6.1 The total capacity of the landscape to provide provisioning ES

kras). In addition to most of the lower and middle mountain ranges, high values are also achieved by sub-mountain areas and some parts of lowlands and basins. The specific area is the Podunajsko and the Žitný ostrov, which also have a high potential in terms of provisioning ES, given by their importance in terms of providing drinking and freshwater. The landscape's lowest capacity to provide provisioning ES is typical for urbanized and densely populated areas, as well as for lesser-productive and non-forested parts of lowlands and higher river basins. The Tatry region and the highest parts of the other high mountain ranges have a specific position with very little capacity for provisioning ES.

By using provisioning ES, there occurs an *abstraction* of matter and energy from the ecosystems providing the given ES. Therefore, it is very important to know their recovery capacity in terms of the time of recovery of the necessary production functions of ecosystems. Some ES are used practically constantly and have a continuous recovery ability (e.g. water), others are seasonal (agricultural and forest crops), and the timber biomass has a significantly longer recovery cycle. Another related issue is that while the use of some provisioning ES is not in principle threatening to other ES (partly water, game, wild berries), the use of agricultural crops and forest biomass largely limits the possibilities of using other ES – thus causing the so-called trade-offs (limits, conflicts of interests) not only from the point of view of some provisioning but also most of the regulatory and cultural ES.

The landscape capacity for provisioning ES as a whole compared to other groups of ES is least related to biodiversity, nature and landscape protection. The variance between the average value for the whole territory of Slovakia and the values achieved for the five basic categories significance of the territory of Slovakia in terms of nature and landscape protection is the smallest of all ES groups (Fig. 6.2). It can be

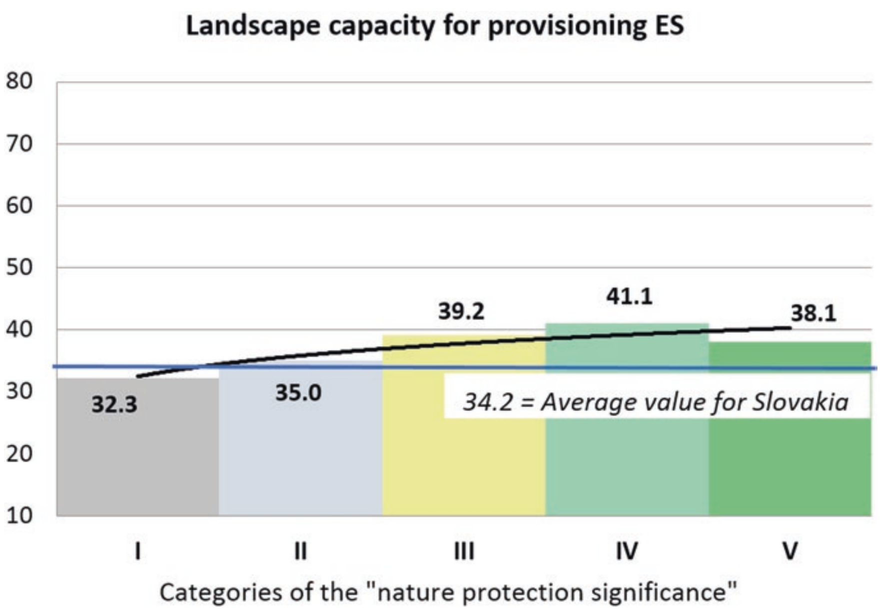

Fig. 6.2 The relationship between provisioning ecosystem services and the significance of the territory of Slovakia in terms of nature and landscape protection

said that between categories III. and V., the degree of significance of the territory, there is virtually no difference in terms of capacity to provide provisioning ES. The lowest capacity is associated with a territory which is the least important in terms of nature and landscape protection, which is due to the fact that most provisioning ES is related to ecosystems with a higher proportion of forests and natural vegetation (except for P1 biomass production). However, even here the value is only insignificantly lower (by 2%) compared to the national average, which shows the relative balance within the territory.

6.2 Regulatory Ecosystems Services and Supporting Ecosystems Functions

Regulatory ES represent the benefits of regulating processes in ecosystems, especially their abiotic components; at the same time, they contribute to improving air quality (R1), water quality (R2), and also to regulation of threatening processes such as erosion and other natural hazards (R3), floods (R4) or climate risks and extremes (R5). These ES are all closely related. Deposition of pollutants from the atmosphere in the soil and vegetation can significantly reduce their concentration in other environmental components (water, air) and thus reduce the adverse effects on human health and contribute to the provision of other ES (e.g. cultural, such as recreation, provisioning – provision of drinking/freshwater). The range of regulatory effects in pollutant deposition depends on many environmental factors, e.g. in case of air quality regulation, also from air turbulence, habitat type and duration of foliage.

Regulatory ES have a significant impact on the regulation of natural processes – erosion and natural hazards, runoff and flood protection as well as climate regulation. These landscape processes are related to land use, geological bedrock properties and slope inclination, the rainfall-runoff regime in basins as well as the protective effect of vegetation. The spatial structure of the vegetation and its properties plays an important role in soil protection and slope stabilization, water retention and climate regulation.

Terrestrial ecosystems play an important role in regulatory ES. The main media facilitating the proper functioning of water and air quality regulation include vegetation, soil and soil biota and wetland ecosystems (the metabolic activity of plants and microorganisms). Ecosystems contribute to improving the quality of individual environmental components (air, water, soil). Forests and other wooded areas are the most important ecosystems for air quality regulation, climate change and erosion control and other processes. A very good anti-erosion effect of vegetation is provided also by permanent grassland areas. For regulation of the effects of slope processes, the wooded parts of hills, highlands and mountainous areas are the most important. Riparian and non-forest vegetation are also important in the regulation of runoff conditions. It is the spatial extent and quality of urban vegetation that is important for climate regulation, as there is the greatest demand for this ES in urban areas.

Biophysical methods (or combined with economic methods) are used in particular to assess these ES. Suitable indicators for air quality regulation include atmospheric gas flow, atmosphere/air purification capacity and pollutant content/level in the atmosphere, dry deposition rate (potential), air pollutant removal (real production) and human exposure (demand). For the assessment of water quality regulation, the indicators include land use, hydrogeological properties, soil quality as well as vegetation properties – its spatial structure (coverage, biomass volume), naturalness, diversity and nutrient cycle.

A wide range of models is being used to assess the ES erosion and natural hazard regulation, runoff mitigation and flood risks regulation. Used indicators include land use, relief, the occurrence of real processes (landslides and erosion), soil parameters (depth, texture, retention capacity), state of aquatic ecosystems as well as the vegetation properties (its distribution, coverage and spatial structure). Modelling tools are also used to assess global climate regulation. The issue of erosion and other slope processes as well as the modelling of flood risk is very well developed and known for the territory of Slovakia, unlike the assessment of other ES. When considering the economic methods, it is possible to use, for example, the contingent valuation methods, cost savings or replacement costs for the air quality regulation or climate regulation.

A separate group of the ES is formed by the so-called supporting (ecological) functions and services. The most important ES include the following: (R7) biodiversity promotion; (R8) lifecycle maintenance/pollination; (R9) pest and disease control; and (R10) maintenance of soil formation and composition. However, there are many other ES which are important, e.g. decomposition function to maintain ecological stability and other services which are ignored in most assessments.

As is the case with typical regulatory ES, nature and nature-based habitats have the greatest capacity to provide supporting ES, due to their functions and ability to participate in ecological processes such as primary production, photosynthesis, reproductive capacity, pollination, nutrient cycle, soil formation and fertility maintenance. Plants, animals but also invisible fungi and microbes, which form a network of interconnections, structures and functions and are also influenced by the abiotic environment, contribute to the provision of ES. Also important are the soils which perform a number of basic functions in the landscape, such as nutrient cycle, water regulation, habitat and biodiversity protection, filtering and buffering as well as habitat stability itself. That is why the relationship between the landscape's capacity to provide these ES and the significance of the territory of Slovakia in terms of nature and landscape protection is clearly positive (Fig. 6.3).

Supporting ES have a significant impact on the provision of other ES as well as on the provision of natural functions and processes, so in some classifications (e.g. MEA 2005), they are referred to as a separate group. The potential of providing these ES is largely dependent on the ecosystem types, their status and the land use in the immediate and distant surroundings. Fertile and healthy soil is needed for habitat sustainability and food production. A landscape with a high proportion of habitats in a favourable state is much more stable, but if one wants to use some of the benefits of the landscape to achieve ecological stability, it is necessary to look

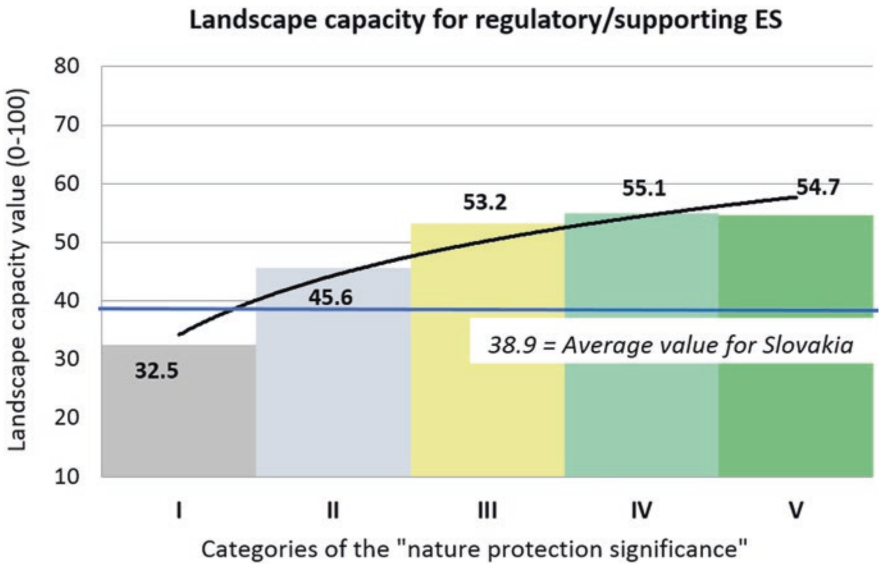

Fig. 6.3 The relationship between regulatory and supporting ecosystem services and the significance of the territory of Slovakia in terms of nature and landscape protection

for and find a carrying capacity for various anthropogenic activities so as to avoid irreversible disturbance of their recovery rate.

In the case of supporting ES, it is sometimes difficult to distinguish between the potential and the actual flows/contributions of the ecosystems to the provision of the given ES. Therefore selected biophysical service flow indicators are most often used to assess their capacity, by which they contribute to preventing or minimizing any damages if the flows of services and processes in ecosystems were disrupted. The correlation between these ES has also been reflected in a number of joint indicators for their assessment.

Biodiversity promotion is focused mainly on the conservation of biodiversity, its favourable habitat status as well as the protection of rare and endangered species, and these characteristics are most commonly used as indicators for assessing this ES.

Lifecycle maintenance/pollination is essential for maintaining and promoting the biodiversity of most wild plants, as well as for the fertility and stability of crop production dependent on pollination. For this ES, the key indicators include the habitat possibilities for nesting of pollinators as well as flower sources (the type of ecosystems and their species composition).

Natural and seminatural as well as anthropogenic ecosystems are characterized by the ability to provide *pests and diseases control* through genetic variations of plants and animals. The performance of this service can be expressed by the number and effectiveness of pest control species.

The monetary value of selected ES is most often mentioned for pollination because it is easiest one to express on the basis of farmers' sales for the most economically important species, or by the value of produced honey and so on. In case of biodiversity protection, the social value of protected species and habitats of national or European importance, including priority habitats, is established by Nature and Landscape Protection Act (National Council of the Slovak Republic 2002). To express the monetary value of pest and disease control, the following methods were introduced: preventive cost methods (value derived from research of costs to prevent or reduce environmental risk) or a production approach assessment based on indirect loss values which could be caused by pests and diseases on agricultural production.

The flow of supporting ES is also influenced by environmental stress factors, in the form of direct spatial loss of ecosystems, poor/disturbed ecosystem status or the intensity and way of use of surrounding areas. The effectiveness of environmental ES can be enhanced by supporting the proper management of landscape diversity or aiming at increasing the share of ecologically important elements.

The overall capacity of the landscape to provide regulatory and supporting ES is shown in Fig. 6.4. It was expressed as the average value achieved for all ten ES which create this group. The spatial projection expresses the above-mentioned main factors and the context of the provision of these ES. The high value of the landscape capacity is evident in the case of mostly forested mountain and foothill areas, and the low capacity is evident for lowland and basin areas with the predominant arable land. The most important natural regions providing regulatory and supporting ES include the Malé Karpaty, Biele Karpaty, Považský Inovec, Strážovské vrchy, Tríbeč, Vtáčnik, Štiavnické vrchy, Malá Fatra, Veľká Fatra, part of Slovenské Rudohorie, Slovenský kras, Čergov, Slanské vrchy and Východné Karpaty regions.

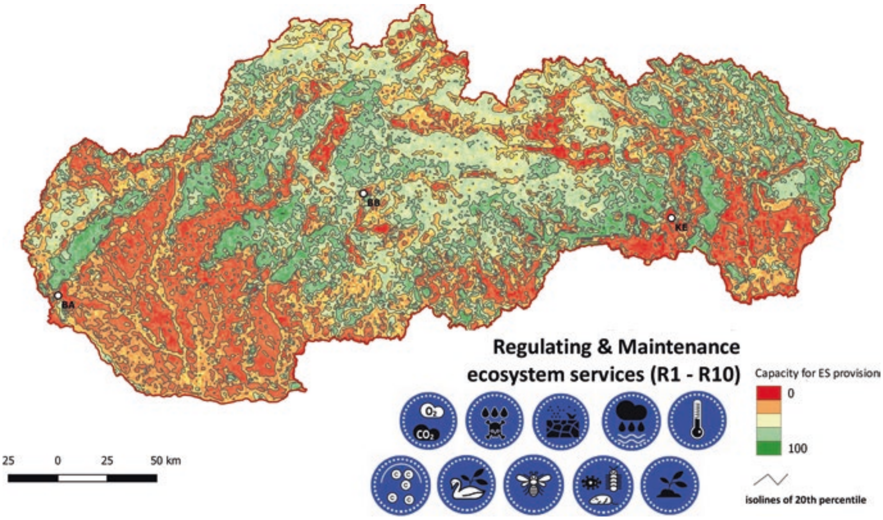

Fig. 6.4 The total capacity of the landscape to provide regulatory and supporting ES

Other mountain ranges and sub-mountain areas are characterized by medium to relatively high landscape capacity. From the lowland and basin areas, the Borská nížina, the peripheral parts of the higher intra-mountain basins, Latorica and Podunajsko areas are the most important in terms of provision of this group of ES.

6.3 Cultural Ecosystems Services

The Millennium Ecosystem Assessment (MEA 2005) defined cultural ES as the intangible benefits which people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, exploration, ability to distinguish values, recreation and aesthetic experiences. These include educational values because the ecosystems, their components and elements, as well as cultural landscapes, form the basis for both formal and informal education, edification and promoting the environmental and cultural-historical awareness as well as shaping the attitudes of the population towards their environment. Inspiration is also beneficial, and not only in art, folklore, but also in the landscape and also the perception of the genius loci. Last but not least, this all presents opportunities for scientific discoveries, research, knowledge and then education and training based on the traditional knowledge of the environment. All the ES and especially the cultural ones often have the character of public goods. This includes conditions of non-exclusion (which means that people cannot be denied ES benefits) and noncompetitive consumption (which means that ES benefits to one person do not reduce their availability to others) (Vačkář et al. 2014).

The cultural ES group includes different ES depending on the classification used (see Table 1.1 in Chap. 1). The most common ones, according to MEA (2005), include the following: recreation and tourism; aesthetic values; cultural diversity; spiritual and religious values; and cognitive and educational values. Three ES were selected for the pilot assessment of cultural ES in Slovakia – recreation and tourism; landscape aesthetics; and natural and cultural heritage.

The general feature of cultural ES is their intangibility and subjectivity. The subjective factors play an important role in the choice of the use of cultural ES. The preference for different services depends largely on the preference of individual residents and visitors, from their values, as well as their social status. The use of intellectual services, especially research and education, is significantly determined by education and employment. These services are preferably used by researchers, educators, nature conservationists, etc., who carry out research activities in individual territories. However, educational services are used by a wider group. In addition to research and teaching staff, they are also used by nature conservationists but also by amateurs interested in knowing the secrets of the landscape, its components and elements. A special group of using cultural ES, especially cultural diversity, includes artists who find inspiration for different types of art in the landscape and its ecosystems. People who find spiritual experiences in the landscape and its ecosystems also form a specific group. Mostly the use of these ES is also conditioned by the occurrence of sacred buildings in the given area (chapels, crosses, churches and other places of worship).

The most commonly used group of the cultural ES includes the services providing physical and experiential interactions, enabling the development of recreation and tourism. These require the presence of special types of ecosystems (especially water and forest ecosystems, agroecosystems as well as urban ecosystems) or special types of landscapes (valuable natural or cultural-historical landscape types). The type of ecosystem often determines the form of recreation and tourism. For example, aquatic ecosystems are most often used for water sports and swimming, with mountain ecosystems being used especially for the development of winter sports – downhill and cross-country skiing, etc., but also for the summer tourism – hiking, forest berries collection and so on. Agro-ecosystems play a primary role in tourism development, and urban ecosystems are dominant in the field of exploration tourism – learning about the cultural and historical values of the landscape. The development of recreation and tourism is also associated with the presence of certain natural resources. The occurrence of mineral and healing waters is tied to the development of the spa industry. A supportive factor for the use of cultural ES is also the socio-economic infrastructure – accommodation, catering facilities, parking lots, educational trails, observation points, cross-country trails, ski resorts, etc. The accessibility of the site and its promotion also play a significant role.

From the point of view of the use of cultural ES, all types of ecosystems and types of the landscape have a certain value, as each of them is specific and requires detailed examination as well as the presentation (research, education-training services, etc.). The most attractive and most desirable include the natural types of ecosystems – sites of protected areas, NATURA 2000 sites, sites with important habitats and others. But they also include cultural and historical landscape features – UNESCO World Natural and Cultural Heritage sites, heritage reserves and zones, traditional landscaping and the like. That is why the positive relationship between the landscape's capacity to provide the ES and significance of the territory in terms of nature and landscape protection is most evident from all ES groups (Fig. 6.5).

However, the real use of many cultural ES is often limited by the need to protect nature, biodiversity and landscape stability as well as the need to protect natural resources (water resources, highest quality soils, forests with special functions and the like). Often this is the source of conflicts between nature protection and various entities benefiting from the use of cultural ES (landowners, operators of accommodation and recreational facilities, etc.). The use of cultural ecosystems is also limited by the effects of stress factors such as environmental contamination (polluted air and water, damaged forest ecosystems, etc.), noise, radiation, localization of inadequate buildings and objects in the landscape and the like.

Due to their intangibility and a high degree of subjectivity, it is relatively difficult to measure, monitor, model and value most of the cultural ES (Schröter et al. 2019). Sociocultural methods are most commonly used to assess them, using participatory methods, such as stakeholder participation workshops, questionnaires, personnel interviews, etc. The main objective of these methods is to identify opinions, demands and attitudes of people in relation to the use of ecosystems (de Groot et al. 2010).

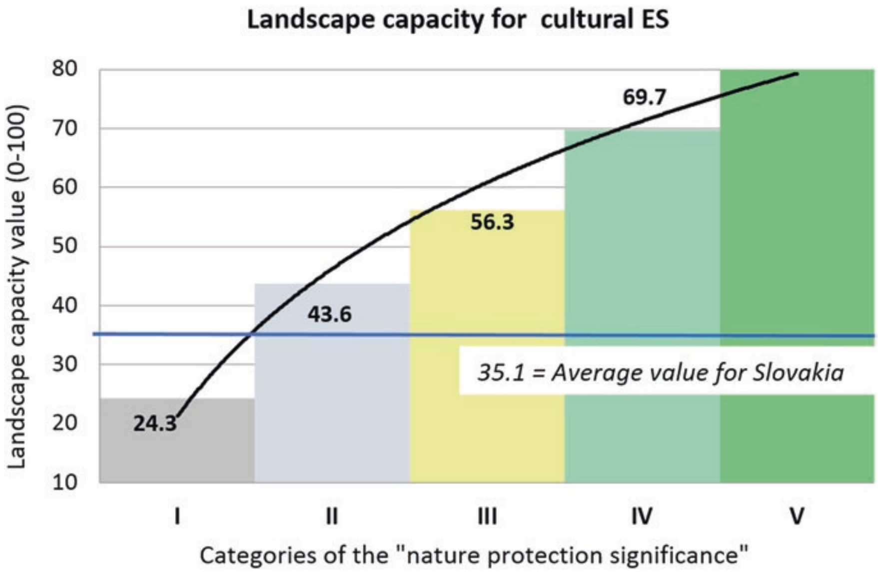

Fig. 6.5 The relationship between cultural ES and the significance of the territory of Slovakia in terms of nature and landscape protection

Photo-series analysis, online map surveys and mobile phone applications are also often used. In the context of the economic assessment of cultural ES, contingent valuation is most often used, which consist in the direct determination of people's willingness to pay or accept compensation for the ES change in a hypothetical market (Farber et al. 2006), e.g. willingness to pay for entrances to protected areas, for revitalization of ecosystems and degraded land, travel costs methods (real consumer costs associated with accommodation, meals, transportation, entrance fees) and so on. The so-called matrix method (Burkhard et al. 2014) and other mapping methods based on the use of GIS and modelling (e.g. ESTIMAP method – Zulian et al. 2013, 2018) are also used.

Various statistical methods are also used for the assessment of the real use of cultural ES (e.g. number of overnight stays, number of tickets sold, number of hunting and fishing permits, number of sports equipment rented, etc.). Groups of cultural ES providing experiential interactions, inspiration for culture and art, spiritual experiences as well as information for exploration are poorly measurable or almost unmeasurable due to the high proportion of subjectivity – or, e.g. the number of created works (literary, art, scientific, etc.) can be used as an indicator.

The landscape's overall capacity to provide cultural ES is shown in Fig. 6.6 and expressed as the average for the three assessed ES, which constitute this group. It should be noted that all three assessed ES are relatively closely related to each other, and their spatial projection is very similar. Therefore, there is no surprise among the territories with the highest capacity for provision of cultural ES – mainly the high mountains of the Carpathians (especially the Vysoké and Západné Tatry) and also

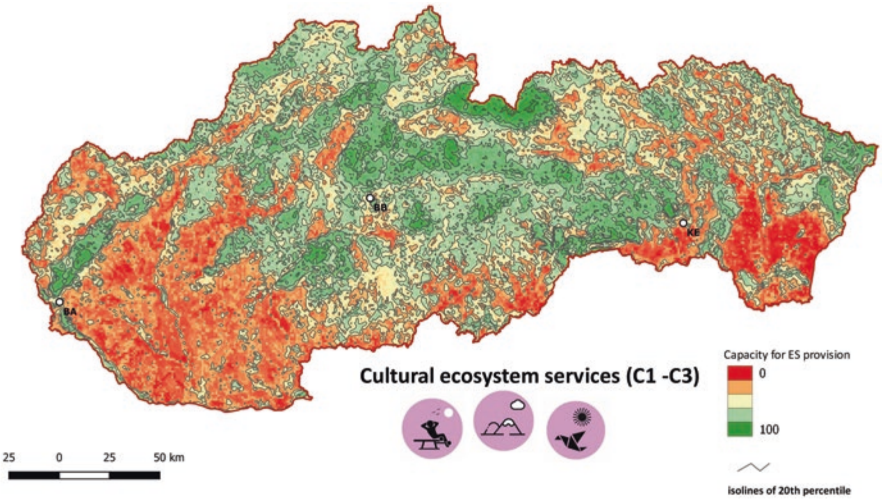

Fig. 6.6 The total capacity of the landscape to provide cultural ES

the areas of Poloniny, the Slovenský raj, Muránska planina, Slovenský kras, Poľana, Štiavnické vrchy and Malé Karpaty. Most of the other mountainous and submountain areas, the Podunajsko and Latorica areas, have medium to high capacity levels. On the contrary, low values are achieved by most of the lowlands and central parts of the intra-mountain basins, with the lowest value being typical for large open lowland and basin highlands.

6.4 Summary Assessment

The main objective of the publication *Catalogue of Ecosystem Services of Slovakia* is to introduce and assess the main ES important for the territory of Slovakia. Of course, staying only at individual ES level without the assessment of groups and the ES as a whole would be insufficient. That is why we decided to prepare a map of the landscape's overall capacity to provide the ES, which represents the synthesis of the first stage of research.

In similar calculations of aggregate indices, the main issue is always to determine the weight (importance) of individual input indicators. In case of the landscape's overall capacity to provide the ES, we have decided to solve this problem relatively simply, but in our opinion in a sufficiently representative and *fair* manner – the weight of provisioning ES as a whole represents 25%, as well as the weight of cultural ES, and finally the weight of regulatory and supporting ES represents 50% of total value. The resulting value was thus calculated as the sum of the capacity values for each ES group multiplied by the given weight. The theoretical value of the capacity ranges from 0 to 100, where 0 means no capacity and 100 the maximum possible landscape capacity for ES provision.

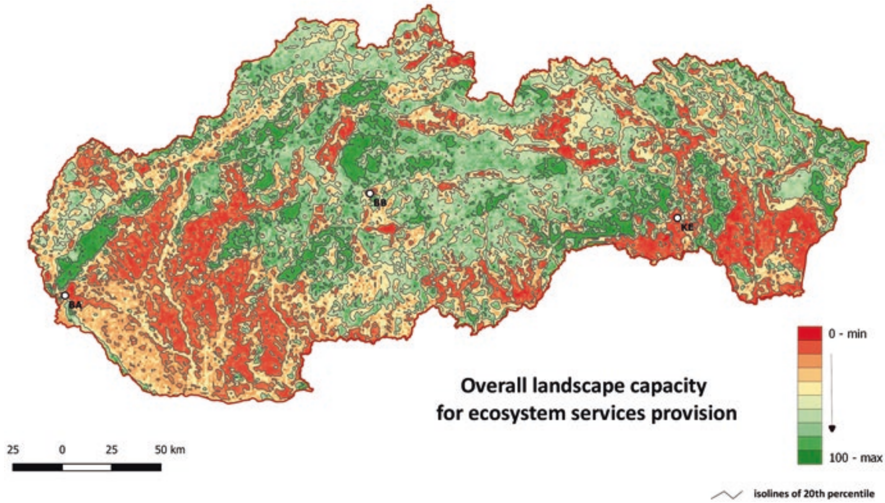

Fig. 6.7 The total capacity of the landscape to provide ecosystem services

The spatial projection of the total landscape capacity is shown in Fig. 6.7. The most important areas of Slovakia from the point of view of ES provision can be quite clearly identified from the map – these include mainly the lower and middle mountain ranges of Slovakia (the largest areas of high landscape capacity are, e.g. in the regions Veľká Fatra, Malá Fatra, Strážovské vrchy, Malé Karpaty, Tríbeč, Vtáčnik, Štiavnické vrchy, Poľana, Starohorské vrchy, Slovenský raj, Muránska planina, Slovenský kras, Slanské vrchy and Bukovské vrchy). On the contrary, the lowest capacity of the landscape is typical for larger areas of lowlands and basins of Slovakia (Chvojnická pahorkatina, Podunajská nížina, Juhoslovenská kotlina, Košická kotlina, Východoslovenská nížina), of the smaller intra-mountain basins, these include Turčianska kotlina, Oravská kotlina, Hornádska kotlina and Žiarska kotlina.

As ecosystem functions and related services are substantially based on the natural structure of the territory, it also seems useful to assess the main natural units in terms of their ES capacity. The main natural regions of Slovakia are well represented by geomorphological units (GM). Table 6.1 shows the average capacity values of these units for the provision of ES – both the total values and the values for the ES main groups. Colour highlighting of values in table cells expresses the division of units based on so-called 20 percentile (every 20% of the total number of GM units is represented by a different colour – the best 20% is highlighted in dark green and the worst 20% in orange). The total values are shown in Fig. 6.8.

Based on these values, it is possible to consider the Spišsko-gemerský kras (Slovenský raj a Muránska planina), Veľká Fatra, Malá Fatra, Slovenský kras, Bukovské vrchy, Starohorské vrchy, Strážovské vrchy, Čergov, Malé Karpaty and Slanské vrchy as the *ten most important GM in Slovakia*. In general, almost all GM from the top 20 of the most important show *high and very high capacity values for*

Table 6.1 Average values of the landscape's capacity to provide ES for geomorphological units in Slovakia

Number	Geomorphological unit	Geomorphological region	km^2	TOT_ES	PROV_ES	REG_ES	CULT_ES
1	Spišsko-gemerský kras	Slovenské Rudohorie	364	58.56	46.87	58.73	69.91
2	Veľká Fatra	Fatransko-tatranská oblasť	786	57.59	46.87	57.56	68.36
3	Malá Fatra	Fatransko-tatranská oblasť	550	56.23	42.41	58.72	65.09
4	Slovenský kras	Slovenské Rudohorie	496	54.81	43.52	55.52	64.70
5	Bukovské vrchy	Poloniny	378	54.80	29.57	61.55	66.58
6	Starohorské vrchy	Fatransko-tatranská oblasť	177	54.54	45.12	55.63	61.77
7	Strážovské vrchy	Fatransko-tatranská oblasť	960	54.44	48.91	57.95	52.96
8	Čergov	Východné Beskydy	310	54.32	38.85	60.41	57.61
9	Malé Karpaty	Fatransko-tatranská oblasť	848	54.03	43.24	56.83	59.24
10	Slanské vrchy	Matransko-slanská oblasť	525	53.01	39.06	60.75	51.44
11	Tribeč	Fatransko-tatranská oblasť	506	52.97	41.97	59.43	51.05
12	Burda	Matransko-slanská oblasť	28	52.96	39.53	57.74	56.69
13	Moravsko-sliezske Beskydy	Západné Beskydy	24	52.90	56.35	48.79	57.81
14	Poľana	Slovenské stredohorie	181	52.83	35.39	53.60	68.73
15	Vtáčnik	Slovenské stredohorie	365	52.62	37.79	59.69	53.32
16	Nízke Tatry	Fatransko-tatranská oblasť	1268	52.55	40.68	51.12	67.29
17	Vihorlatské vrchy	Vihorlatsko-gutinská oblasť	382	52.35	36.53	59.45	54.07
18	Štiavnické vrchy	Slovenské stredohorie	871	52.29	37.45	56.01	59.69
19	Čierna hora	Slovenské Rudohorie	264	52.11	38.34	57.48	55.12
20	Volovské vrchy	Slovenské Rudohorie	1352	51.94	33.86	56.37	61.17
21	Tatry	Fatransko-tatranská oblasť	543	51.87	28.72	44.97	88.97
22	Pohronský Inovec	Slovenské stredohorie	153	51.59	39.92	59.24	47.98
23	Považský Inovec	Fatransko-tatranská oblasť	465	50.25	41.54	57.72	44.04

(continued)

Table 6.1 (continued)

Number	Geomorphological unit	Geomorphological region	km^2	TOT_ ES	PROV_ ES	REG_ ES	CULT_ ES
24	Súľovské vrchy	Fatransko-tatranská oblasť	194	50.15	48.86	51.95	47.84
25	Busov	Nízke Beskydy	99	49.51	45.51	55.06	42.37
26	Chočské vrchy	Fatransko-tatranská oblasť	117	49.49	42.41	49.70	56.15
27	Stolické vrchy	Slovenské Rudohorie	603	47.60	31.61	54.67	49.46
28	Kremnické vrchy	Slovenské stredohorie	485	47.21	42.53	51.09	44.14
29	Oravské Beskydy	Stredné Beskydy	139	46.88	39.48	46.32	55.40
30	Laborecká vrchovina	Nízke Beskydy	1158	46.83	34.86	54.52	43.44
31	Javorníky	Slovensko-morav. Karpaty	867	46.60	41.70	48.35	47.99
32	Branisko	Fatransko-tatranská oblasť	84	46.43	33.84	52.46	46.95
33	Žiar	Fatransko-tatranská oblasť	146	46.40	42.55	51.33	40.39
34	Veporské vrchy	Slovenské Rudohorie	898	46.05	34.53	49.45	50.75
35	Javorie	Slovenské stredohorie	229	45.90	37.84	50.50	44.74
36	Kysucké Beskydy	Stredné Beskydy	168	45.20	37.01	46.10	51.62
37	Oravská Magura	Stredné Beskydy	173	45.04	35.50	48.00	48.67
38	Biele Karpaty	Slovensko-morav. Karpaty	681	43.94	33.57	48.49	45.20
39	Kysucká vrchovina	Stredné Beskydy	418	43.78	36.24	45.30	48.28
40	Kozie chrbty	Fatransko-tatranská oblasť	170	43.63	44.15	43.72	42.92
41	Ostrôžky	Slovenské stredohorie	259	42.84	32.53	50.59	37.64
42	Turzovská vrchovina	Západné Beskydy	223	42.79	48.05	39.72	43.66
43	Podtatranská brázda	Podhôľno-magurská oblasť	89	41.86	32.16	40.41	54.45
44	Revúcka vrchovina	Slovenské Rudohorie	949	41.80	30.81	48.70	38.98
45	Ľubovnianska vrchovina	Východné Beskydy	189	40.72	30.70	47.38	37.31
46	Cerová vrchovina	Matransko-slanská oblasť	500	39.78	30.93	47.02	34.26
47	Spišská Magura	Podhôľno-magurská oblasť	344	38.53	27.61	41.48	43.52
48	Levočské vrchy	Podhôľno-magurská oblasť	644	38.52	29.13	42.81	39.32

(continued)

Table 6.1 (continued)

Number	Geomorphological unit	Geomorphological region	km²	TOT_ES	PROV_ES	REG_ES	CULT_ES
49	Skorušinské vrchy	Podhôľno-magurská oblasť	192	38.19	34.83	40.63	36.68
50	Bachureň	Podhôľno-magurská oblasť	130	37.93	32.81	43.06	32.79
51	Krupinská planina	Slovenské stredohorie	856	37.84	33.66	42.79	32.12
52	Zemplínske vrchy	Matransko-slanská oblasť	109	37.11	33.93	41.52	31.46
53	Ondavská vrchovina	Nízke Beskydy	1807	37.00	38.23	41.16	27.45
54	Bodvianska pahorkatina	Lučensko-košická zníženina	155	36.65	36.18	40.59	29.57
55	Pieniny	Východné Beskydy	53	36.38	22.11	41.14	41.78
56	Horehronské podolie	Fatransko-tatranská oblasť	316	35.22	30.73	35.79	38.58
57	Podbeskydská vrchovina	Stredné Beskydy	235	34.63	28.79	35.30	39.13
58	Borská nížina	Záhorská nížina	1162	34.52	36.18	38.26	25.40
59	Šarišská vrchovina	Podhôľno-magurská oblasť	274	33.19	28.38	37.23	29.93
60	Beskydské predhorie	Nízke Beskydy	671	32.30	27.71	37.50	26.55
61	Jablunovské medzihorie	Západné Beskydy	53	32.03	29.75	34.77	28.85
62	Dolnomoravský úval	Juhomoravská panva	97	31.32	39.87	31.49	22.44
63	Zvolenská kotlina	Slovenské stredohorie	625	31.23	31.64	31.58	30.12
64	Oravská vrchovina	Stredné Beskydy	284	31.06	19.25	36.16	32.68
65	Rožňavská kotlina	Slovenské Rudohorie	67	29.51	30.92	28.44	30.25
66	Hornonitrianska kotlina	Fatransko-tatranská oblasť	400	29.45	33.86	30.25	23.45
67	Myjavská pahorkatina	Slovensko-morav. Karpaty	365	29.14	29.55	30.25	26.50
68	Považské podolie	Slovensko-morav. Karpaty	561	28.96	37.67	28.43	21.31
69	Žilinská kotlina	Fatransko-tatranská oblasť	271	28.63	31.85	27.65	27.37
70	Podtatranská kotlina	Fatransko-tatranská oblasť	1197	28.01	25.29	26.57	33.61
71	Podbeskydská brázda	Stredné Beskydy	132	26.13	25.01	24.87	29.78
72	Spišsko-šarišské medzihorie	Podhôľno-magurská oblasť	513	25.99	24.03	28.25	23.41

(continued)

Table 6.1 (continued)

Number	Geomorphological unit	Geomorphological region	km^2	TOT_ ES	PROV_ ES	REG_ ES	CULT_ ES
73	Pliešovská kotlina	Slovenské stredohorie	100	25.88	34.11	24.45	20.53
74	Juhoslovenská kotlina	Lučensko-košická zníženina	1805	25.88	29.91	27.81	18.07
75	Žiarska kotlina	Slovenské stredohorie	128	25.09	28.11	26.43	19.38
76	Oravská kotlina	Podhôľno-magurská oblasť	216	24.71	21.35	24.70	28.14
77	Východoslovenská pahorkatina	Východoslovenská nížina	718	24.23	28.40	25.31	17.94
78	Podunajská rovina	Podunajská nížina	3458	23.92	36.68	22.57	13.88
79	Košická kotlina	Lučensko-košická zníženina	1141	23.84	28.07	24.45	18.43
80	Turčianska kotlina	Fatransko-tatranská oblasť	436	23.84	30.17	22.36	20.44
81	Hornádska kotlina	Fatransko-tatranská oblasť	462	23.00	26.43	21.82	21.93
82	Chvojnícka pahorkatina	Záhorská nížina	353	22.94	30.58	22.85	15.49
83	Podunajská pahorkatina	Podunajská nížina	6355	21.83	29.37	21.92	14.13
84	Východoslovenská rovina	Východoslovenská nížina	1716	19.65	27.49	20.52	10.07
Slovak Republic			49.035	36.80	34.20	38.90	35.10

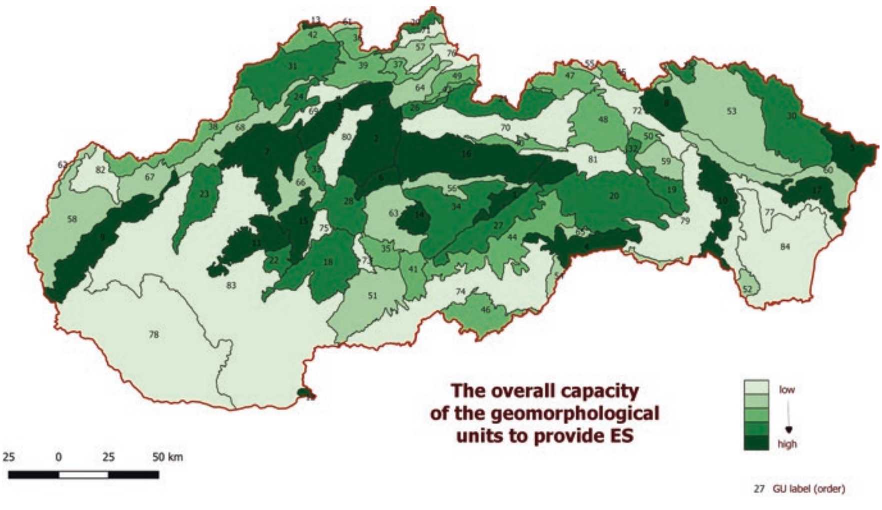

Fig. 6.8 The total capacity of the landscape to provide ES for geomorphological units of Slovakia

all ES groups (with the exception of Bukovské vrchy, Poľana and Volovské vrchy, which have only average provisioning ES capacity).

On the contrary, the least significant GM in Slovakia in terms of capacity to provide the ES can be considered the areas of Východoslovenská rovina, Podunajská pahorkatina, Chvojnícka pahorkatina, Hornádska kotlina, Turčianska kotlina, Košická kotlina, Podunajská rovina, Východoslovenská pahorkatina and Oravská kotlina a Žiarska kotlina. These units, together with other predominantly intra-mountain basin areas, have very low capacity for regulatory and cultural ES and predominantly low capacity for provisioning ES. The exception is the GM of Podunajská rovina with a high value for provisioning ES (mainly due to high capacity for ES P1, P3 and P4).

An interesting indicator of the balance of GM in terms of ES provisioning capacity is also the difference between the most favourable and least favourable value, which is the lowest in the case of Súľovské vrchy, Kozie chrbty (with mostly high value of the landscape's capacity), Zvolenská kotlina and Rožňavská kotlina (with low landscape capacity). On the contrary, the largest difference is present in case of GM units of Bukovské vrchy, Poľana, Nízke Tatry, Volovské vrchy and especially the Tatra Mountains – in all cases the most favourable values are achieved for the cultural ES and least favourable for the provisioning ES.

Figure 6.9 shows the relationship between landscape structure and its capacity to provide ES. As the land use has directly entered the computational algorithms for most ES, such an assessment is merely a summary of how individual categories of

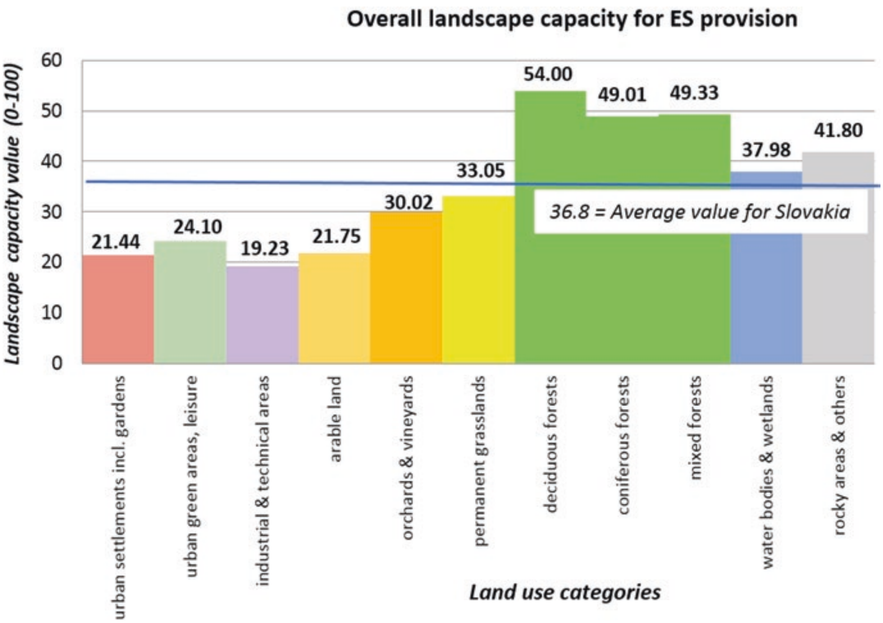

Fig. 6.9 The total capacity of the landscape to provide ES for the main categories of land use

the landscape structure contribute to ES provision. Statistical results confirm the generally accepted fact that forest ecosystems are the most important type of ecosystems in terms of ES provision and urbanized areas are the least important.

The most important category of landscape structure in terms of ES provision in Slovakia is the *deciduous forests* with the highest value of the landscape's capacity (it has 54 points, which means 1.5 times the average value of the whole territory of Slovakia). *Mixed and coniferous forests* are also among the most important categories. The second group of significance with values above the national average includes two types of landscape structure: *rocks and screes* and *water areas and wetlands*. While the first type is particularly significant due to the very high value for cultural ES and achieves a very small spatial extent, hydric ecosystems are quite significant from the point of view of all three ES groups, but most for the regulatory ES.

Grassland (meadows and pastures) and *permanent agricultural crops* (orchards and vineyards) have an average significance in terms of ES provision in Slovakia. Their capacity to provide individual ES groups is relatively balanced.

Other major categories of the landscape structure – arable land and urbanized areas – have low to very low significance in terms of ES provision in Slovakia. *Arable land* has a higher capacity for provisioning services; *residential vegetation*, *sports and recreational areas* provide relatively balanced, albeit lower potential for all major ES groups. The lowest overall significance in terms of capacity for the provision of ES comes from *residential buildings* and, in particular, *industrial and technical areas*.

The assessment of the landscape's capacity to provide ES is only the first step of a comprehensive ES assessment. As reported by Burkhard et al. (2014), in the ES assessment, it is necessary to distinguish three basic aspects – from the landscape's potential to provide the ES (supply, capacity) through the requirements for their provision in a particular territory (demand) to their real use and balance (ES flow).

Landscape capacity refers to the usable potential of natural resources and ecosystem functions. It creates the so-called ES supply, which according to Burkhard et al. (2014) is based on potentials and additional inputs. These inputs are related to the economy and represent social, human, financial and production investment assets (Costanza and Daly 1992). The ES flow is realized between ES supply and consumption, reflecting the real amount of man-made goods and ecosystem services in a particular territory (in the form of a vector from production sites to consumption points), thus generating the final benefit from ES to humans. This flow is directed from the natural environment to human society and determined by the so-called *ES demand* in a particular territory and over a period of time (Burkhard et al. 2014).

ES supply, demand and flow together create a dynamic process of creating and using the ES which moves from natural ecosystems to human society – a simplified scheme of this process is shown in Fig. 6.10.

Only when all the basic aspects of ES provision and use in Slovakia are known and assessed, we can state that there is a *comprehensive ES assessment in Slovakia*. The present publication is therefore only one of the necessary parts of such an

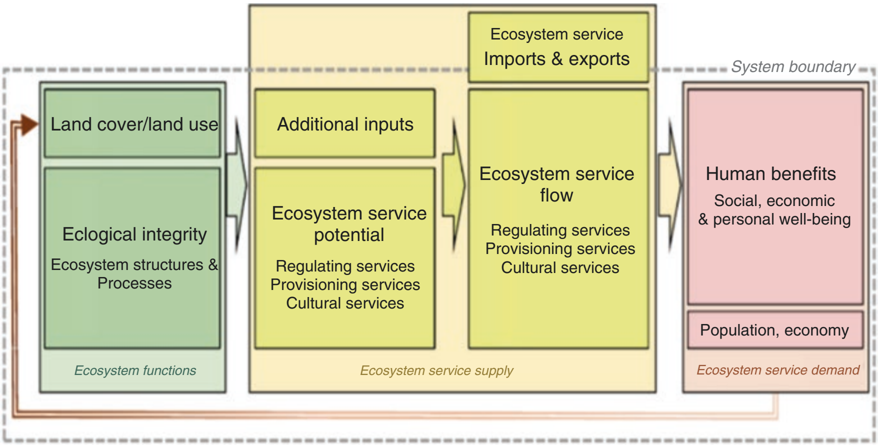

Fig. 6.10 The ecosystem services cycle in the landscape and society – conceptual model. (Source: Burkhard et al. 2014)

assessment. The individual ES chapters also provide appropriate data sources for assessing the demand and use of these ES, but only theoretically – the specific methodologies will depend on the data actually available. However, this process goes well beyond the environmental sector and will require much better synergies from other sectors – in particular, the availability of selected data sources. It, therefore, remains a challenge for the coming future.

6.5 The Importance of Ecosystem Services for Nature and Landscape Protection in Slovakia

The welfare in EU countries is supported by its natural capital, which includes ecosystems providing basic goods and services to people. Publications on the economic benefits of the NATURA 2000 network (2013) show that NATURA 2000 plays a key role in protecting and strengthening the EU's natural capital. NATURA 2000 network has an important role to play in addressing the challenges in relation to climate change by mitigating the changes and impacts. It also includes carbon-rich habitats, brings socioeconomic benefits such as maintaining the water cycle and its quality, preserves natural pollinators, preserves landscape values and promotes tourism and recreation and the like. According to this study, the benefits flowing from NATURA 2000 are on the order of 200–300 billion EUR per year. NATURA 2000 network can be seen as a key element of green infrastructure in an open landscape, involved or directly providing a number of ecosystem services which are threatened by the degradation of natural habitats. Investing in NATURA 2000 management and recovery measures and strong legal protection can increase the provision of these services.

We have tried to document the significance of the ES in terms of nature and landscape protection (or the relationship between these two aspects of land use and management) by comparing the landscape's capacity to provide the ES and the so-called significance of the territory in terms of nature and landscape protection (for more details see Chap. 2). The achieved results (presented and commented in the subchapters of this publication) show a clear correlation between these two indices in the case of the majority of the ES, which is particularly evident in the case of cultural ES and most regulatory ES (except for R4 and R10).

Nature protection plays an indispensable role, particularly in the provision of regulatory/supporting and cultural ES. The greatest capacity to provide regulatory and supporting ES comes from natural and seminatural ecosystems, which are also most significant in terms of NaLP – the most obvious positive correlation has been documented for ES R1, R3, R7 and R9. Also in the case of cultural ES, the natural ecosystems and significant cultural and historical landscape features are the most attractive – a very clear positive correlation with the significance of the territory in terms of nature and landscape protection was recorded for all three ES (C1–C3).

A slightly different picture applies to the provisioning ES, for which the landscape's capacity to provide ES as a whole is least related to nature protection. Actually, in the case of ES P1, we recorded a negative correlation and in the case of ES P2 a neutral relationship. However, as a whole, also here is a slightly positive relationship between these two indices.

The relationship between the overall capacities of the landscape to provide the ES (see Fig. 6.7) and the significance of the territory in terms of nature and landscape protection (degrees 1–5) is shown in Fig. 6.11. A positive correlation is more

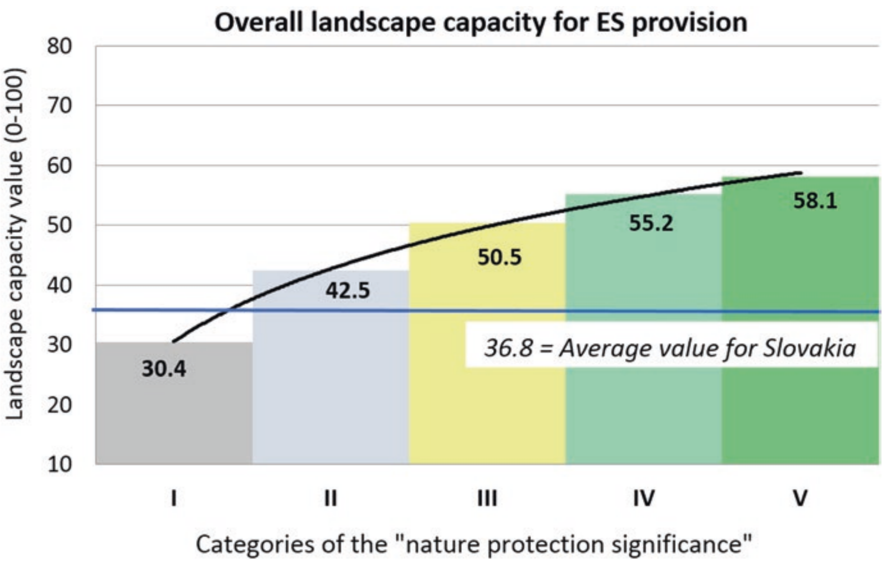

Fig. 6.11 The overall relationship between the landscape capacity to provide ES and the significance of the territory of Slovakia in terms of nature and landscape protection

than evident – the value of the landscape's capacity increases with the significance of the territory in terms of NaLP, which applies to all categories of significance. This fact emphasizes the key importance of nature and landscape protection not only for the healthy state of ecosystems but also for the fulfilment of their functions and services that are directly or indirectly used by humans.

The ES concept *fundamentally changes the view of nature protection functions and tasks*. While the approaches to date have focused mainly on the subjects of protection (and thus habitats, species and biodiversity), the ES concept brings a different view of the mission and role of protected areas, especially through the protection of processes and related ecosystem functions. Thus, the ES concept requires a change in the traditional *protection paradigm* – the most important ES producers are natural ecosystems and habitats – even those which are relatively widespread. The rarity and the level of endangering of the habitats in this concept are diminishing, and the existence and presence of habitats in places where there is a demand for the relevant ES play the most important role. The accessibility of the ES then also plays an important role, with the ES best being accessible in the largest possible area with benefits of ES provided to as many people as possible – ideally as close as possible to the demand sites (i.e. the occurrence of the largest number of residents or visitors in a particular territory).

Only time will tell, whether this approach is correct and whether it is realistic and useful to change the long-term nature and landscape protection *strategy*. However, it is clear that it is more than necessary to invest resources in the preservation and improvement of protected areas in Slovakia. The assessment clearly showed that the protected nature areas provide most of the natural services and benefits which a man uses directly or indirectly – most of the ES are associated with those parts of Slovakia where protected areas are most represented.

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