POTENTIAL OF CULTURAL AGROECOSYSTEM SERVICES. THE CASE OF SLOVAKIA

Makovníková Jarmila[1], Pálka Boris[1], Orságová Katarína[2], Širáň Miloš[1], Kanianska Radoslava[3], Kizeková Miriam[4]

[1]National Agricultural and Food Centre, Soil Science and Conservation Research Institute Bratislava, Regional Station Banská Bystrica, Slovakia

[2]Matej Bel University Banská Bystrica, Slovakia

[3]Matej Bel University Banská Bystrica, Faculty of Natural Sciences, Department of Environment, Slovakia

[4]National Agricultural and Food Centre, Grassland and Mountain Agriculture Research Institute Banská Bystrica, Slovakia

Abstract

Service-providing ecosystems are denoted as natural capital. On the basis of this, it could be perceived the linkage between economy and ecological dimensions. Concept of agroecosystem service combines environmental and socio-economic approach to the analysis and evaluation of natural capital. Multi-criteria approach to spatial quantification of ecosystem services related to socio-economic indicators which are districts as statistics territorial units, allows explicitly assess potential of ecosystems of agricultural land to provide agroecosystem services and adapt the land management under the local conditions. Applying the mapping of agroecosystem services potential appropriately can help to show the possibilities of regional sustainable land use management as well as trade-offs between diferent ecosystem services. For analysis and evaluation of potential of agroecosystem services in Slovakia, we have created a mapping unit combining four input layers: slope topography, climate units, soil texture and usage of land. Agroecosystems of arable land are predominantly of very low (50.7 %) to low potential (15.7%) of natural conditions for recreation. In Slovakia 53.82% of the area of used permanent grasslands has high and very high potential of natural conditions for outdoor recreation. Potential of natural conditions for recreation is higher only in some districts with a higher proportion of area of grassland agroecosystems and protected areas NATURA 2000. Prešov region has a higher potential of natural conditions for recreation comparing with the districts of western and southern Slovakia.

Key words: *ecosystem services, model of cultural services, hiking, cycling, cross-country skiing*

1. INTRODUCTION

Service-providing ecosystems are denoted as natural capital (Costanza and Daly, 1992). On the basis of this, it could be perceived the linkage between economy and ecological dimensions. To achieve this in sustainable way, natural capital has to be related to other forms of capital, such as production capital, human capital and social or cultural capital. The concept of ecosystem services represents a bridge between ecological and economical approaches and helps to create a transdisciplinary ecological economy. Ecosystem services (the provisioning, regulating and cultural one) are basically determined by the interaction between ecological and social systems, because only those ecosystem processes contributing to the satisfaction of human needs are defined as ecosystem services (Birghofer et al., 2015). The concept of ecosystem services brings a new comprehensive view on the issue of effective use of natural goods not only from the point of view of production but mainly from the point of view of services provided by ecosystems (Makovníková et al., 2017, Kanianska et al., 2016). Traditionally, agroecosystems have been considered primarily as sources of provisioning services, but more recently their contributions to other types of ecosystem services have been recognized (MEA, 2005, Burghard et al., 2014), such as regulating and cultural services. Because the provision of ecosystem services depends on biophysical conditions, land use and climatic changes (Burghard et al., 2012), the supply and demand of services may differ geographically. Research on mapping ecosystem

services has grown substantially in the past decade (Maes et al., 2011). Information based on mapping and modeling exercises has been used to analyse the spetial distribution of multiple ecosystem services at local, regional (Chan et al, 2012) and global (Naidoo et al., 2008) or spatial scale (Maes et al., 2011). As defined by Dominati (2010), cultural ecosystem services are one of the three main service categories. Cultural ecosystem services are defined as "non-material benefits people obtain from ecosystems (MAE, 2005). From the group of cultural services is the most commonly mapped recreation service, because it is relatively simple to quantify. Recreation and tourism is one of the six categories of cultural ecosystem services recognized by the Millenium Ecosystem Assessment. However, cultural services cannot be treated independently and depend on supply and regulating services as well as on supporting processes. The methods mapping recreation and tourism ecosystem services involve very location- specific proxies for recreation and tourism (Naidoo et al., 2011) for example number of cyclists (Willemen et al., 2008), landscape naturalness and attractiveness (Maes et al., 2011), number of walkers.

The work presented in this paper aims at potential for outdoor recreation as an example of cultural agroecosystem services (recreational activities tied to the natural resources).

2. MATERIALS AND METHODS

All agro-ecosystems are considered to be potential providers of these services. Agroecosystems also have the potential for providing cultural ecosystem services, particularly recreational activities linked to natural resources, such as hiking, biking, cross-country skiing. Recreation potential was evaluated through agroecosystem landscape components that have a specific link with summer, winter and year-round recreation. The capacity of ecosystems to provide recreational services depends on the particular uniqueness of the site, its accessibility and the surrounding infrastructure. In the analysis of the suitability of the area in terms of recreational usage, the altitude, inclination, drainage, precipitation, temperature (climate) and their distance to the roads were taken as basis. A point rating system was created for individual evaluation criteria and sub-criteria (Table 1A, B, C).

Assessment factors	Sub-criteria	Suitability degree (point value)
Altitude in (m a s.l.)	< 600	1
	600–1200	3
	>1200	2
In close the proximity to Marked trails, nature trails		4
Distance to the roads	< 100 m	1
	100–200 m	2
	200–500 m	3
	> 500 m	4

Table 1A. The assessment factors and subcriteria for hiking

Assessment factors	Sub-criteria	Suitability degree (point value)
Inclination in (°)	0–2	1
	2–5	2
	> 5	3
In close proximity to Marked trails		4
Distance to the roads	< 100 m	1
	100–200 m	2
	200–500 m	3
	> 500 m	4

Table 1B. The assessment factors and subcriteria for biking

Assessment factors	Sub-criteria	Suitability degree (point value)
Inclination in (°)	0–2	1
	2–5	2
	> 5	3
In close proximity to Marked trails		4
Climate region	VW	1
	W	2
	MW	3
	MC	4

Table 1C. The assessment factors and subcriteria for cross-country skiing

The recreational potential for all these activities was calculated as sum of individual recreational activities potential without added points (Natura 2000) which were added only to the final sum in order to prevent multiple evaluations of additional factors The categories of agroecosystem to provide outdoor recreational activity (sum are as follows:1- very low relevant capacity (lower than 6.00 points), 2 – low potential (6.01 – 9.00 points), 3 – medium potential (9.01 – 12.00 points), 4 – high potential (12.01 – 15.00 points), 5 – very high potential (more than 15.00 points).

For spatial quantifying of agroecosystem services of used agricultural land in Slovakia, we have created a mapping unit combining four input layers: slope topography, soil texture and usage of land in four climatic regions (Makovníková et al., 2017).

3. RESULTS AND DISCUSSION

Agroecosystems have the potential to provide cultural ecosystem services (Paracchini et al., 2014, Joyce and Sutton, 2009), especially recreational activities linked to natural resources, such as hiking, cycling, cross-country skiing. Our model designed to analyze and evaluate the natural conditions for recreation in agricultural areas is based on an analysis of the suitability of natural conditions for summer, winter and year-round recreation and is complemented by territorial quantification of NATURA 2000 areas.

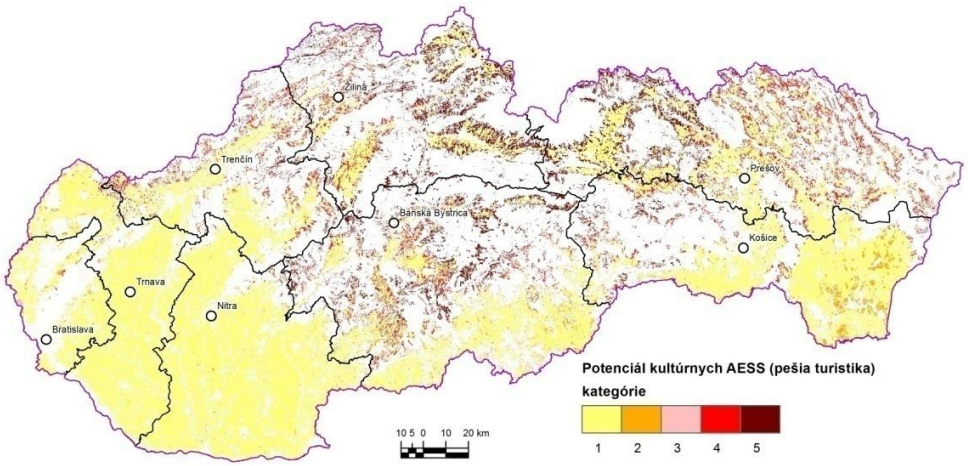


Figure 1. The potential of natural conditions for hiking in Slovakia

The low category of potential (Figure 1) includes 56.83% of agricultural land use, a low category of 9.26%, a medium potential of 0.82%, a high potential of 22.56% and a very high potential for hiking 10.54% in Slovakia.

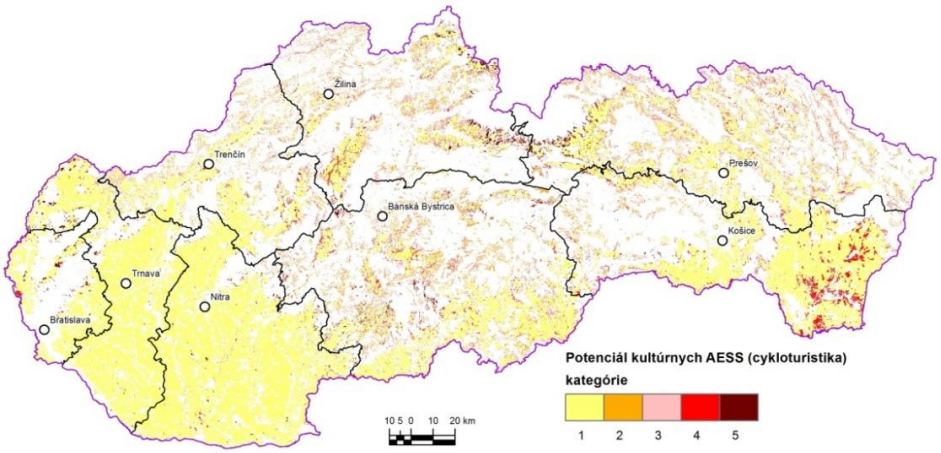


Figure 2. The potential of natural conditions for cycling in Slovakia

The low category of potential for cycling (Figure 2) includes 44.31% of agricultural land use, a low potential of 12.90%, a medium potential of 19.74%, a high potential of 11.23%, and a very high potential for cycling 11.82% in Slovakia.

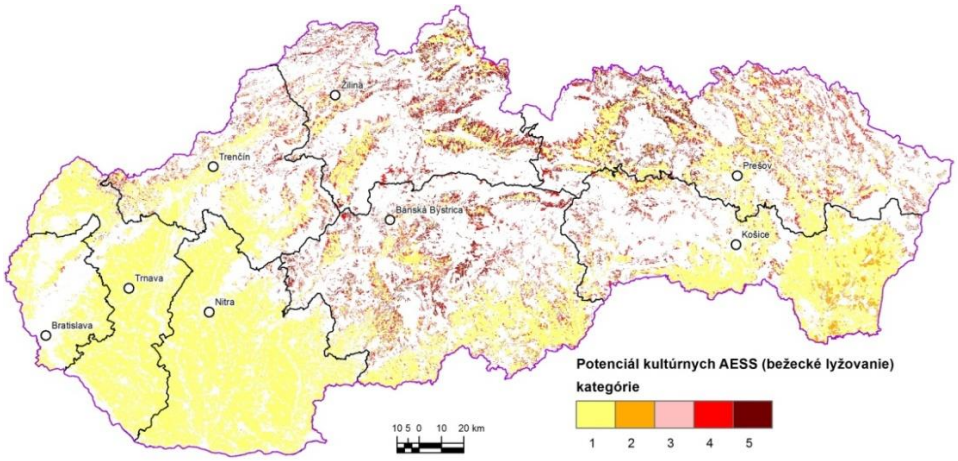


Figure 3. The potential of natural conditions for cross-country skiing in Slovakia

The low category of potential occupies an area of 34.84% of the land used for agricultural land, a low potential of 21.24%, a medium potential of 12.77%, a high potential of 24.87% and a very high potential for cross-country skiing of 6.28% in Slovakia.

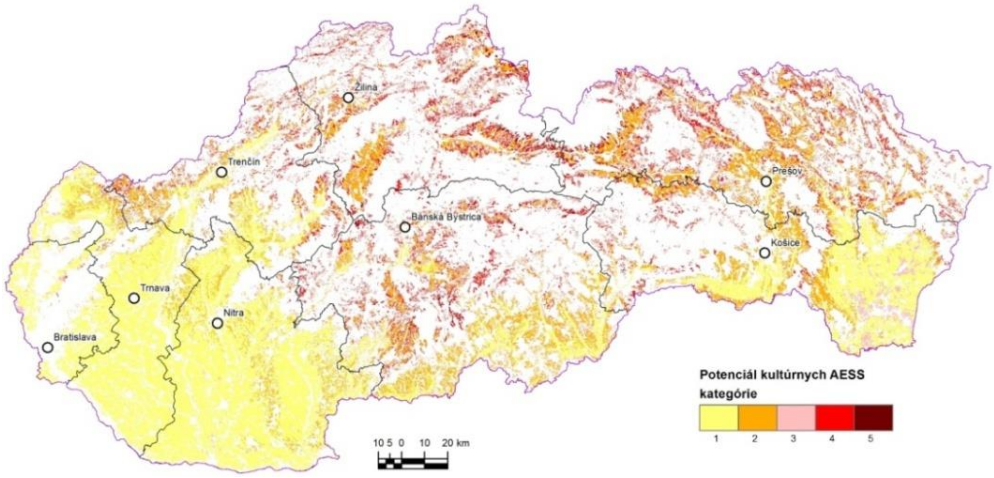


Figure 4. The potential of natural conditions for recreation in Slovakia

Potential	in % of total area of agricultural land	in % of total area of arable land	in % of total area of grassland
very low potential	50,70	64,44	6,69
low potential	15,69	16,32	13,71
medium potential	19,48	17,51	25,77
high potential	12,94	1,71	48,82
very high potential	1,19	0,02	5,01

Table 2. The categories of the potential of cultural ecosystem services in % of total area of agricultural land

The potential of agroecosystem for cultural agroecosystem services is shown in Figure 4. Agroecosystems of arable land are (Table 2) predominantly of very low to low potential of natural conditions for recreation. The majority of the total area of Slovakia belongs to the low and very low category of potential of natural conditions for recreation (66.4% of all agroecosystems). In Slovakia 53.82% of the area of used permanent grasslands has high and very high potential of natural conditions for outdoor recreation. Contrary to ecosystems of arable land, grassland agroecosystems are located close to protected Natura 2000 sites in areas with higher sloppiness and at higher altitude. The results of percentage distribution of the various categories of potential of climate regulations are significantly influenced by the ecosystems of arable land due to the high share of area of these ecosystems on the total area of agricultural land.

Concept of agroecosystem service combines environmental and socio-economic approach to the analysis and evaluation of natural capital. Multi-criteria approach to spatial quantification of ecosystem services related to socio-economic indicators which are districts as statistics territorial units (NUTS, LAU, LŠÚJ1, Decree 438/2004), allows explicitly assess potential of ecosystems of agricultural land to provide agroecosystem services and adapt the land management under the local conditions. The Figure 5 and Figure 6 also shown an assessment of potential of agroecosystem services in regions and districts of Slovakia.

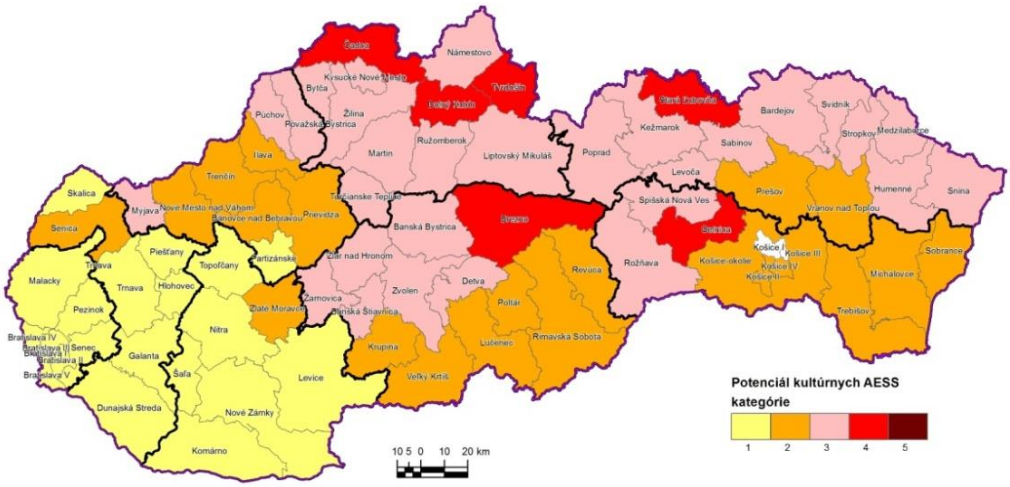


Figure 5. The potential of natural conditions for recreation in districts of Slovakia

Potential of natural conditions for recreation is higher only in some districts with a higher proportion of area of grassland agroecosystems and protected areas NATURA 2000. In the Trenčín region it is Považská Bystrica district, in Banská Bystrica region it is Brezno district, Banská Bystrica district, Banská Štiavnica district and Zvolen district. Eight districts of the Žilina region has more than 40% share in the category of high and very high potential of natural conditions for recreation. The highest potential is in the districts Čadca, Tvrdošin, Kysucké Nové Mesto, Liptovský Mikuláš, Ruzomberok, Dolny Kubin, Námestovo and Žilina with the share of 61.35%, 57.43%, 55.07%, 53.73%, 51.68%, 51.56%, 45.33% and 42.03%, respectively.

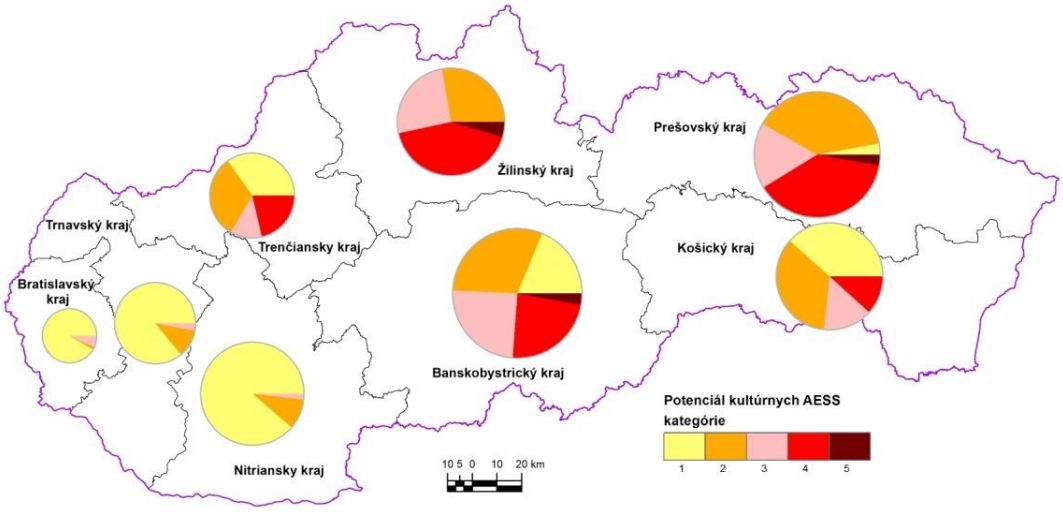


Figure 6. The potential of natural conditions for recreation in regions of Slovakia

Similarly to Žilina region, Prešov region has a higher potential of natural conditions for recreation comparing with the districts of western and southern Slovakia. Districts where an area of agroecosystems in higher than 40 % belonging to the category of high and very high potential of natural conditions for recreation are Medzilaborce district (71.52%), Stará Ľubovna district (51.98%), Svidník district (51.72%), Stropkov district (49.83%), Poprad district (47.22 %) and Snina district (42.96 %).

4. CONCLUSIONS

Agroecosystems of arable land are predominantly of very low to low potential of natural conditions for recreation. Only permanent grasslands has high and very high potential of natural conditions for outdoor recreation. The capacities of grasslands to supply cultural agroecosystem services can significantly contribute to the economic stability and prosperity of a particular region, using these soils with low production potential, primary for the recreational purposes, thereby preventing degradation and loss of agricultural soil.

ACKNOWLEDGEMENTS

The authors acknowledge the Slovak Research and Development Agency for the financial support via contract No. APVV-0098-12 Analysis, modelling and evaluation of agroecosystem services.

REFERENCES

1. Birghofer, K., Diehl, E., Andersson, J., Ekroos, J., Früh-Müller, A., Machnikowski, F., Mader, V. L., Nilsson, L., Sasaki, K., Rundlöf, M., Wolters, V., Smith, H. G. 2015,“ Ecosystem services—current challenges and opportunities for ecological research“, *Front. Ecol. Evol*., 12, January 2015 http://dx.doi.org/10.3389/fevo.2014.00087.
2. Burkhard, B., Kroll, F., Nedkov, S. & F. Müller 2012,“ Mapping supply, demand and budgets of ecosystem services', *Ecological Indicators*, 21, pp. 17-29.
3. Burkhard, B, Kandziorai, M., S. & F. Müller 2014, „Ecosystem Service Potentials, Flows and Demands - Concepts for Spatial Localisation, Indication and Quantification“, *Official Journal of the International Association for Landscape Ecology* - Regional Chapter Germany (IALE-D),viewed 21 february 2015, <http://dx.doi.org/10.3097/LO.201434>

4. Chan, K., Satterfield, T., Goldstein, J. 2012, "Rethinking ecosystem services to better address and navigate cultural values", *Ecological Economics* 74, 8–18.
5. Costanza, R., and Daly, H.E. 1992, "Natural capital and sustainable development" *Conserv. Biol.* 6 (1), 37-463.
6. N.D. Crossman, B. Burkhard, S. Nedkov, L. Willemen, K. Petz, I. Palomo, E.G. Drakou, B. Martín-Lopez, T. McPhearson, K. Boyanova, R. Alkemade, B. Egoh, M.B. Bunbar & J. Maes 2013, „A blueprint for mapping and modelling ecosystem services", *Ecosystem services*, 4, pp.4-14.
7. Daily G. C.(ed.) 1997, *Nature's services: societal dependence on natural ecosystems*, Washington, DC: Island Press.
8. Dominati, E., Patterson, M. & Mackay, A 2010, 'A framework for classifying and quantifying the natural capital and ecosystem services of soils', *Ecological Economics* 69, pp.1858-1868
9. Džatko, M. 2002, *Evaluation of production potential of agricultural soils and soil-ecological regions of Slovakia*, Bratislava : VÚPOP, 2002, 88 s. ISBN 80-85361-94-9.
10. Felipe-Lucia, M.R., F.A. Comin, & E. M. Bennett 2014, ' Interactions among ecosystem services across land uses in a floodplain agroecosystem', *Ecology and Society* 19(1): 20, viewed 21 february 2015,

    <http://dx.doi.org/10.5751/ES-06249-190120>
11. Fisher, B., R.K. Turner & P. Morling 2009, ' Defining and classifying ecosystem services for decision making', *Ecological Economics*, 2009. 68(3), pp. 643-653
12. Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, PE&RS, Vol. 77(9):858-864.
13. Joyce, K., S. Sutton, S. 2009, „A method for automatic generation of the recreation opportunity spectrum in New Zealand", *Appl. Geogr*., 29 (3), pp. 409–418
14. Kanianska, R., Jaďuďová, J., Makovníková, J., Kizeková, M. 2016,"Assessment of Relationships between Earthworms and Soil Abiotic and Biotic Factors as a Tool in Sustainable Agricultural", *Sustainability*, roč. 8, č. 9, 06.
15. Lavorel, S., Grigulis, K. 2012, „ How fundamental plant functional trait relationships scale-up to trade-offs and synergies in ecosystem services", *J. Ecol*., 100, 128–140
16. Maes, J., Paracchini, M.L. & Zulian, G. 2011, *A European assessment of the provision of ecosystem services,* JRC Scientific and Technical reports, Luxembourg: Publications Office of the European Union
17. MEA 2005, 'Millenium ecosystem assessment', *In* Ecosystems and human well-being: biodiversity synthesis. Washington, DC*:* World Resources Institute.
18. Makovníková, J., Barančíková, G., and Pálka, B. 2007, 'Approach to the asseeement of transport risk of inorganic contamination on the immobilisation capability of soil', *Plant Soil Envir*., vol. 53, pp. 365-373
19. Makovníková J., Pálka B.,Širáň, M., Kanianska R., Kizeková M., Jaďuďová, J. 2017, *Modeling and evaluation agroecosystem services.* (Modelovanie a hodnotenie agroekosystémových služieb). Belianum. Vydavateľstvo Univerzity Mateja Bela v Banskej Bystrici, 2017, 150 s., ISBN 978-80-557-1242-0.
20. Milcu, A. Ioana, J. Hanspach, D. Abson, & J. Fischer 2013, 'Cultural ecosystem services: a literature review and prospects for future research', *Ecology and Society* 18(3):44. viewed 21 february 2015, <http://dx.doi.org/10.5751/ES-05790-180344>

21. Naidoo, R., Balmford, A., Costanza, R., Fisher, B., Green, R. E., Lehner, B., Malcolm, T. H., Ricketts, T. H. 2008, „Global mapping of ecosystem services and conservation priorities“, *Proceedings of the National Academy of Sciences of the USA* 105:9495-9500.

22. Naidoo, R., Stuart-Hill, G., Weaver, L. C., Tagg, J., Davis, A. 2011, „ Effect of diversity of large wildlife species on financial benefits to local communities in northwest Namibia“, *Environmental and Resource Economics*, 48:321–335.

23. Nedkov, S. & B. Burkhard 2012, ' Flood regulating ecosystem services - Mapping supply and demand, in the Etropole municipality, Bulgaria', *Ecological Indicators* 21, pp.67-79.

24. Paracchini, M.L., Zulian, G., Kopperoinen, L., Maes, J., Schägner, J.P., Termansen, M., Zandersen, M., Perez-Soba, M., Scholefield, P.A., Bidoglio G. 2014, „ Mapping cultural ecosystem services: a framework to assess the potential for outdoor recreation across the EU“, *Ecol. Indic*., 45 (2014), pp. 371–385

25. Pert, P.L., Butler, J.R., Brodie, J.E., Bruce, C., Honzak, M., Kroon, F.J., Metcalfe, D.,Mitchell, D. & Wong, G. 2010, ' A catchment-based approach to mapping hydro-logical ecosystem services using riparian habitat: a case study from the Wet Tropics, Australia', *Ecol. Complex*. 7, pp. 378–388.

26. Power A.G. 2010, ' Ecosystem services and agriculture: tradeoffs and synergies', *Phil. Trans. R. Soc.* 65, pp. 2959–2971

27. Regionalisation of Tourism in the Slovak Republic 2005, Ministry of Economy, Department of Tourism FO ART, s. r. o. 2005.

28. 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.

29. Sherrouse, B. C., and Semmens, D.J., 2012, *Social values for ecosystem services (SolVES): Documentation and user manual, version 2.0:* U.S. Geological Survey Open-File Report 2012–1023, 55 p.

30. Vačkár, D., Frélochová, J., Lorencová, E., Pártl, A., Harmáčková, Z. and Loučková, B. 2013, *'Methodological framework for integrated assessment of ecosystem services in Czech Republic'*, Academie ved ČR.

31. Vihervaara, P.; Kumpula, T.; Tanskanen, A. and B. Burkhard 2010, 'Ecosystem services - A tool for sustainable management of human-environment systems. Case study Finnish Forest Lapland', *Ecological Complexity* 7/3, pp. 410-420.

32. Willemen, L., Verburg, P. H., Hein, L., van Mensvoort, M. E. F., 2008. *Spatial characterization of landscape functions. Landscape and Urban Planning* 88, 34–43.

33. Zhang, W., Ricketts, T.H., Kremen, C., Carney, K. & Swinton, S.M. 2007, ' Ecosystem services and disservices to agriculture', *Ecological Economics* 64, pp. 253-260.