Original scientific article
Received: July 27 2022;
Received in revised form: -
Accepted: November 26 2022;
Available online: July 13 2023.

UDC: 338.48:[007:912]:004](497.16)
doi: 10.5937/zrgfub2371005V

GEOECOLOGICAL EVALUATION OF NATURAL POTENTIALS OF ŠAVNIK (MONTENEGRO) FOR THE PURPOSES OF RECREATIONAL TOURISM USING V-WERT METHOD IN GIS ENVIRONMENT

Filip Vujović[1]*, Gojko Nikolić**, Tamara Đurđevac***, Eldin Brđanin****

* Master's student, University of Montenegro, Faculty of Philosophy, Department of Geography, Nikšić, Montenegro
** Associate Professor, University of Montenegro, Faculty of Philosophy, Department of Geography, Nikšić, Montenegro
*** PhD student, University of Novi Sad, Tourism and Hotel Management, Department of Geography, Novi Sad, Serbia
**** PhD student, University of Belgrade, Faculty of Geography, Belgrade, Serbia

Abstract: The geoecological assessment of the natural potentials of the Montenegrin municipality of Šavnik for the purposes of recreational tourism is carried out in this work using the quantitative diversity method (V-Wert method). The main criteria used in this evaluation method are natural elements (forests, water areas, relief, climate) and land cover. For the evaluation, the whole procedure was implemented in the environment GIS (Geographic Information Systems) using the software QGIS 3.14. The evaluation results show that unfavorable areas occupy 247 km^2 (39%), conditionally favorable 185 km^2 (30%), favorable 141 km^2 (22%) and very favorable 54 km^2 (9%). Despite the significant natural potential, which is partially recognized by this method with certain advantages and disadvantages, recreational tourism and all forms of tourism are underdeveloped in the municipality.

Keywords: tourism, quantitative diversity method, V-Wert method, GIS, geoecological assessment, recreational tourism.

Introduction

Geoecology, i.e. landscape ecology, is an applied science of the landscape (as a living and working space for humans and other organisms), the aim of which

[1] vujovicfilip@hotmail.com (corresponding author)

is to define the ecologically optimal spatial organization of the use and protection of the landscape (Troll, 1939; Miklos, 1994). Geoecology offers a range of theories, models, and experiences in the study of landscapes (Pecelj et al., 2015). The multidisciplinary approach to modern spatial planning has rightly generated increased interest in its geoecological aspect, especially in professional studies and analyzes, making this subject area a research field in its own right. Geoecological content has long been systematically represented and modeled in this field through various forms of geoecological mapping (Nikolić, 2016).

One of the practical geoecological methods suitable for planning optimal spatial management is geoecological assessment. Geoecological assessment is the process of evaluating whether and to what extent a space or some of its geocomponents correspond to a certain type of use (Crnogorac & Spahić, 2012). Through geoecological assessment, it is possible not only to determine the suitability of space for a particular type of use, but also to identify illogicalities in the use of space by comparing the results with the current type of use (Čirjak & Mamut, 2017).

As a relatively independent element of the natural environment, landscape assessment is a rather difficult task. Landscape can be considered as a prerequisite for the nature of influence of all other natural components in space, and as such it affects the qualitative characteristics of the surface and surface part of the lithosphere, climatic conditions, soil, vegetation, etc. For the above reasons, it is often impossible to determine the value of the landscape, as the theory of valuation has not fully defined the principles and criteria of valuation (Lješević, 1992).

Geoecological assessment is important for future tourism planning, design, protection and management, which implies further development and promotion of tourism-recreational activities (Pecelj et al., 2016). There are several methods for geoecological assessment of mountain areas for recreational tourism needs, of which the quantitative diversity method (V-Wert method) is the most commonly used. This method was formulated in 1967 by the German geoecologist Hans Kiemstedt (Golijanin, 2015).

Geoecological assessment using this method has been the subject of intensive research in recent years in the urban areas of Belgrade, Novi Sad, Loznica, Trebinje, Niš (Pecelj et al., 2016; Pecelj et al., 2017; Pecelj et al., 2018; Lukić et al., 2018; Manić et al., 2019), as well as in the mountains of Romania and Kozara National Park (Pecelj et al., 2018; Popović et al., 2018). The method proved to be advantageous for the analysis of mountainous regions, with certain advantages and disadvantages.

In this paper, the V-Wert method will be applied in the surroundings of GIS to determine the extent to which the natural components of Šavnik, which has mountain character, are favorable for the purposes of recreational tourism.

Research Area

The research object of this work is the municipality of Šavnik, whose natural diversity offers great potential for the development of leisure tourism. Šavnik is located in the northern region of Montenegro, in the high mountain zone of the Dinarides, between 42°52'31" - 43°7'30" N and 18°52'47" - 19°22'31" E (Figure 1). The area of the municipality is about 553 km². According to the 2011 census, Šavnik municipality has the lowest population (2077 inhabitants) and population density (3.74 inhabitants/km²) in Montenegro. The area is located on the slopes, in the valleys and on the surfaces of the mountain massifs: Durmitor in the north and northwest, Sinjajevina in the north and northeast, Moračke Mountains in the east and southeast, Krnovo Plateau in the south and Vojnik Mountains in the south and southwest. The municipality borders: Žabljak to the north, Mojkovac to the northeast, Kolašin to the east; Nikšić to the south and Plužine to the west and northwest (Šuntić, 2012; IBI-CAU, 2014).

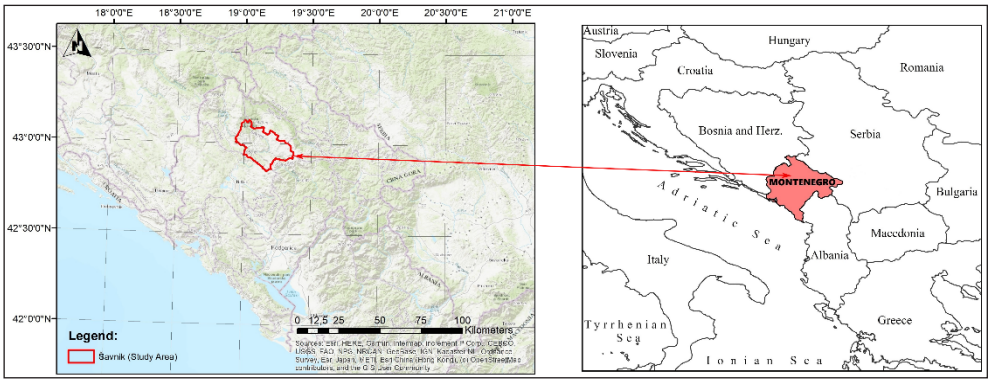

Figure 1. Map of the position of the municipality of Šavnik

Materials and methods

For the evaluation, the entire process was implemented in the GIS environment using QGIS 3.14 software.

For the evaluation, a vector GRID polygon vector network of dimensions 1000x1000 m was formed at the beginning of the study, covering a larger study area of the municipality of Šavnik with 627 cells or an area of 627 km².

The geoecological assessment was performed by the method of quantitative diversity (V-Wert method) using a cartographic algebra tool according to the following formula (Kiemstedt, 1967):

$$V = \frac{W + G * 3 + R + N}{1000} * K$$

Where: W - forest edges (m/m²), G - water edges (m/m²), R - relief energy (-), N - land cover (-), K - climatic criteria (-).

After applying the cartographic algebra according to the defined formula, the obtained values were divided into four diversity categories according to Table 1, based on which a map of the degree favorable for recreational tourism was created.

Table 1. Categories of diversity by Hans Kiemstedt

Categories	Classes	Span
I	Unfavorable	V<3,72
II	Conditionally favorable	3,72 < V < 7,44
III	Favorable	7,44 < V < 11,16
IV	Very favorable	V > 11,16

Source: Kiemstedt, 1967

The first criterion used in this method is the length of forest edges (W). According to Pecelj et al. (2015), forest edges are carriers of contrasts and spatial changes that influence the senses of the observer and represent typical elements of the cultural landscape. A crucial role in assessing the tourist value of a landscape is played by green spaces, which greatly contribute to the movement of tourists and are the basis for the development of sustainable tourism (Mihajlović et al., 2016; Đukin et al., 2018; Pecelj et al., 2018). Data from the Copernicus Forest type product digital spatial database for 2018 were used to determine the forest edge (Figure 2). Spatial analysis was performed by measuring the edge length for forest classes for each cell separately.

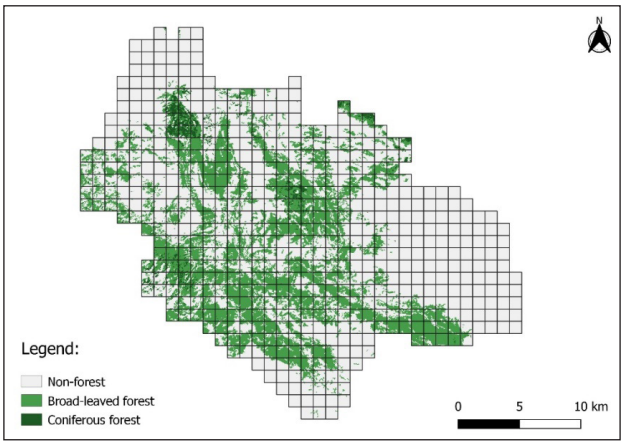

Figure 2. Map of forests

Another criterion used in this method is the water edges (G). Water edges significantly increase the tourist value of the area and make it more attractive from the recreational point of view, as they favor the development of a greater number of recreational and tourist activities (Pecelj et al., 2016; Pecelj et al., 2017; Popović et al., 2018). The data source for this criterion is data from the Open Street Map database, which was improved based on a publicly available 2018 orthophoto from the former Ministry of Sustainable Development and Tourism (Fig. 3). As with the first criterion, the edge length for this criterion was measured individually for each cell.

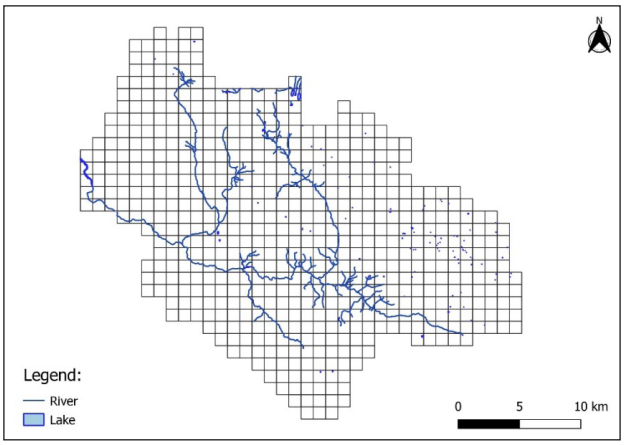

Figure 3. Map of waters

As a third criterion, this method uses relief energy. Relief energy represents the potential energy of a given part of the topographic surface defined by the difference in elevation between the highest and lowest points (Dragićević & Filipović, 2016). The impact of relief on the development and spread of tourism is reflected in three basic types: recreational value, aesthetic value, and locational value (Kadušić et al., 2018). This criterion was obtained by applying zonal statistics using EU-DEM 25m model data (Fig. 4). Then, the obtained values were ranked according to the scale for the obtained values as shown in Tab. 2.

Table 2. The scale of relief energy values

Altitude difference (m)	Values of the relief
10-20	220
20-30	300
30-60	400
60-100	590
100-250	860
250-500	1200

Source: Kiemstedt, 1967; Hoffman, 1999

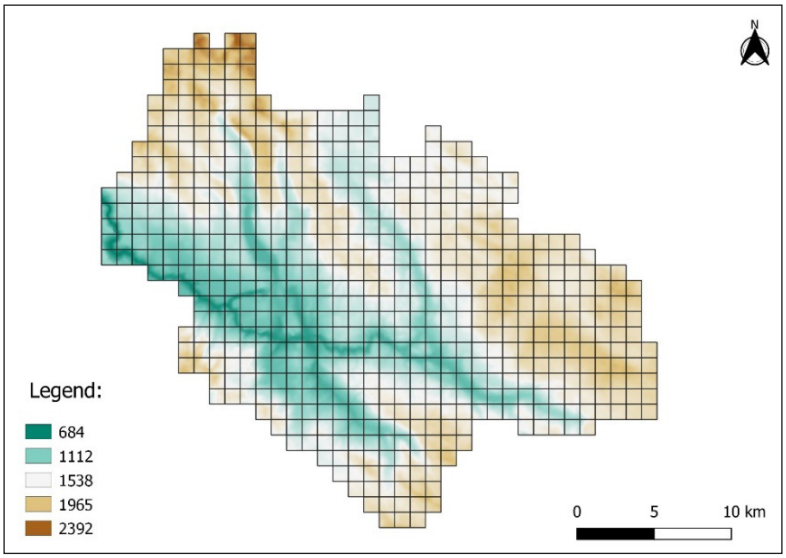

Figure 4. Map of elevation

Land cover is indispensable in this analysis to determine the potential of different landscape elements to meet the needs of recreational tourism (Lukić et al., 2018). The criterion related to land cover was determined based on the percentage in the cell and multiplication by the appropriate weighting factor from Table 3. Data from the Copernicus CORINE Land Cover 2018 database were used as the data source for this criterion (Figure 5).

Table 3. Weight factors for land cover

Land cover type	Weight factors
Cultivated fields and gardens	6
Meadows and pastures	15
Orchards and vineyards	8
Forests	19
Heath	21
Swamps	10
Barren land	21
Rivers	50
Lakes	50
Streams	20
Canals (main)	10

Source: Kiemstedt, 1967; Hoffman, 1999; Pecelj, 2017

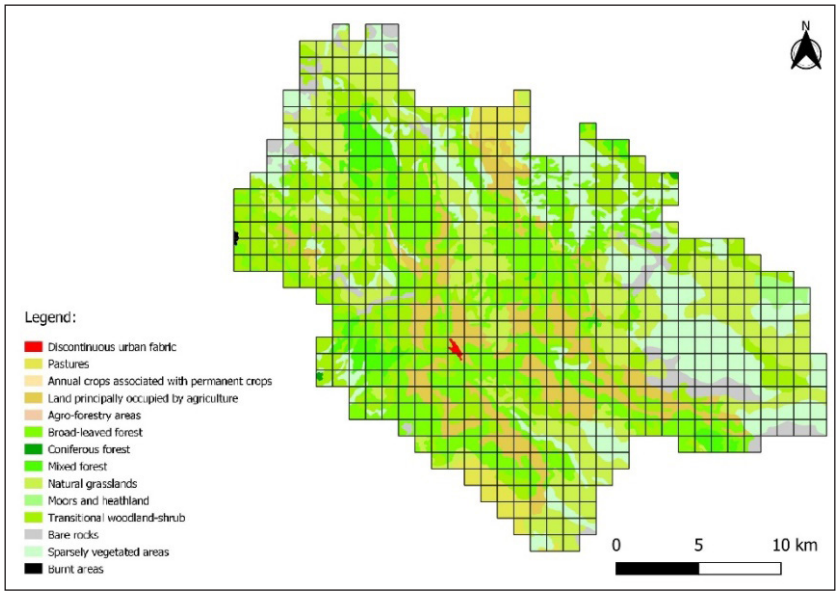

Figure 5. Map of Corine Land Cover

The climate criterion is the last element to apply this method. Kiemstedt (1967) proposed values for this criterion for the study area in Germany. Since the values were proposed for the area of Germany, it is difficult to establish values for other areas. In reviewing the proposed climatic values from Table 4 in this document, a value of 1.4 was assumed for the entire study area based on the Koeppen classification (Burić et al., 2014).

Table 4. Weight factor for climate types in Germany

Climate type	Weight factors
Urban climate	0.62-0.80
Climate of basin	0.70-0.90
Climate of North - Germany lowland	0.90-1.10
Coastal climate (Baltic and North Sea)	1.10-1.20
Climate of sub mountainous zone	1.20-1.40
Climate of high mountains	1.30-1.50
Climate of central Alps	1.30-1.80

Source: Kiemstedt, 1967

Results and discussion

The assessment was carried out in a slightly larger area than the administrative boundaries of the municipality of Šavnik and includes border areas with other

municipalities, so instead of an area of 553 km^2, an area of 627 km^2 was assessed. The reason for this is the size of the vector polygon unit GRID of 1000x1000 m, so for a correct evaluation the parts of the area located in other municipalities were not cut off.

The results of the evaluation were presented based on the degree of favorability of the different parts of the considered areas for recreational tourism based on the V-Wert diversity categories (Figure 6). The degree of favorability (Table 5) shows that unfavorable areas occupy 247 km^2 (39%), conditionally favorable 185 km^2 (30%), favorable 141 km^2 (22%) and very favorable 54 km^2 (9%).

According to the Šavnik Municipal Spatial Plan until 2020, the natural beauties of mountains, gorges, forests, rivers and lakes, as well as the diversity of flora and fauna are the main tourist recreational potential of Šavnik. The mountain area with the Durmitor massif, Sinjajevina, Vojnik, Lola, Morača and Javorje is rich in favorable areas for mountain adventures. Komarnica valley with Nevidio gorge and Boljske degree is also considered a very favorable area. The gorge itself is the axis of tourist development in the municipality of Šavnik, because it is a world-class natural attraction. The village of Pošćenje is also recognized as a favorable area, with the Great and Small Lakes of Pošćenje having exceptional potential (IBI-CAU, 2014).

The results can be considered relatively good, as most of the areas in the "favorable" and "very favorable" categories are recognized as part of the Spatial Urban Plan of Šavnik until 2020 (IBI-CAU, 2014). According to this document, the exceptions are parts of the mountain area that are considered to be conditionally favorable or favorable and are placed in an unfavorable category using this method.

The potentials of mountain landscapes in winter and summer seasons have been insufficiently exploited economically in the function of tourism development, although the Spatial Plan of Montenegro until 2020 and the Strategy for the Development of Tourism in Montenegro until 2020, the Municipal Spatial Plan of Šavnik, the Strategic Development Plan of the Municipality of Šavnik 2012-2017, give them a high priority and include them among the priority development centers (Montenegroinženjering et al, 2008; Ministarstvo turizma et al., 2008; Opština Šavnik, 2011; IBI-CAU, 2014).

In these planning and strategy documents, it was pointed out that the accommodation capacities are of poor quality, and the quality of accommodation and infrastructural facilities are insufficient. Tourists visiting Šavnik are mostly transients whose final destination is the Montenegrin coast or Žabljak. The current developments do not correspond to the actual possibilities and potentials that exist. Despite the significant natural potential that is partially recognized by this method, all forms of tourism in the municipality are underdeveloped, which is confirmed by the analysis of objective indicators of tourism development in Montenegro (Milošević, 2017).

In Šavnik, the construction of a hydroelectric power plant and the reservoir "Komarnica" is planned. If the construction takes place at all, the detailed spatial plan for the area of the multipurpose reservoir on the Komarnica River indicated that the construction will not endanger the Nevidio Gorge and the town of Šavnik, as well as the development of tourism. However, it is important to say that negative impacts are still possible and the construction could endanger the development of tourism (Jovanović et al., 2019).

Today's tourism trends show that such non-valorized destinations with preserved and diverse nature attract the interest of tourists of different categories. Tourism based on passive and active recreation is an effective tool for local and regional development in many European countries such as Austria, Germany, the Netherlands, and France, as significant socioeconomic benefits can be achieved with minimal investment (Panfilov, 2020).

For the development of leisure tourism, Šavnik lacks synergies with accompanying economic activities, experienced workforce, quality accommodation, a good offer throughout the year and a unique identity that would promote natural resources, valorization and demand orientation while respecting the principles of sustainable development.

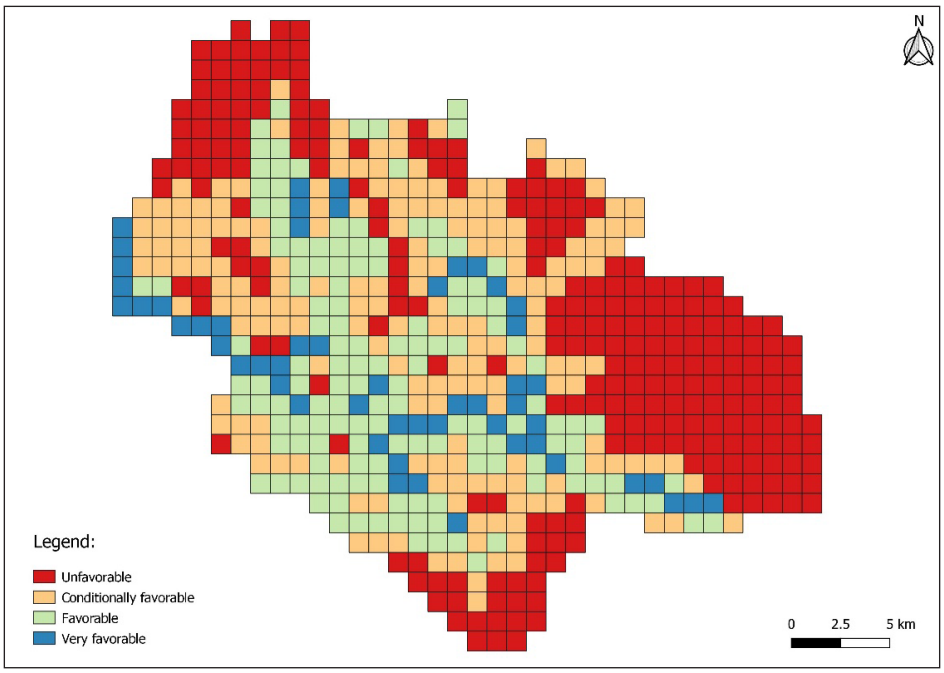

Figure 6. Map of favorable areas for the purposes of recreational tourism

Table 5. Categories of diversity by area and percentage in Šavnik

Classes	Area (km^2)	Percentage (%)
Unfavorable	247	39
Conditionally favorable	185	30
Favorable	141	22
Very favorable	54	9
Total	627	100

Conclusion

This work confirms the complexity and importance of geoenvironmental assessment. The V-Wert method of evaluation in terms of recreational tourism development, like other quantitative methods, has its advantages and disadvantages. The main advantages of this method are the rapid searchability for a large area, the availability and the possibility of using open geodata, the ease of data processing, analysis and presentation of the results at GIS. The input data for most of the criteria used in this work have certain deficiencies in terms of resolution and quality, so much better results could be obtained with LiDAR technology. However, this method also has drawbacks in that it did not detect some of the favorable surfaces. Perhaps these shortcomings could be addressed in future geoecological research by adding more criteria and correcting the values for the climate criterion. Validation of the obtained results is difficult for an unknown area and a large studied area, since data from the field are needed.

Despite the significant natural potential of the municipality of Šavnik for the development of recreational tourism, which the method used in this study partially recognizes, all forms of tourism in the municipality are underdeveloped. This potential for the development of recreational tourism needs to be upgraded and focused on demand, while respecting the principles of sustainable development.

References

Burić, D., Ducić, V., Mihajlović, J. (2014). The climate of Montenegro: Modificators and types-part two. *Bulletin of the Serbian geographical society*, 94(1), 73-90. doi: 10.2298/GSGD1401073B

Čirjak, B.R., Mamut, M. (2017). Geoekološko vrednovanje reljefa otoka Hvara s aspekta poljodjelske valorizacije. *Socijalna ekologija*, 25(3), 211-234. doi: 10.17234/SocEkol.25.3.1.

Crnogorac, Č., Spahić, M. (2012). *Osnovni geoekologije*. Banja Luka: ARTPRINT.

Dragicevic, S., Filipovic, D. (2016). *Prirodni uslovi i nepogode u planiranju i zaštiti prostora - drugo dopunjeno izdanje*. Beograd: Geografski fakultet.

Đukin, A., Mihailović, M., Petrović, J., Stavretović, N. (2018). Značaj rekreacionog potencijala Stare Planine za unapređenje održivog turizma. *Ecologica*, 25 (89), 169-174.

European Environment Agency. (2020). *Corine Land Cover 2018*. http://land.copernicus.eu/pan-european/corine-land-cover/clc-2012/. Accessed May 20, 2021.

European Environment Agency. (2020). *Forest type 2018*. https://land.copernicus.eu/pan-european/high-resolution-layers/forests/forest type1. Accessed May 20, 2021.

European Environment Agency. (2010). *EU-DEM*. https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1. Accessed May 20, 2021.

Golijanin, J. (2015). *Geoekološka evaluacija prirodnih potencijala planine Ravne i Pale kotline u funkciji održivog razvoja*. Doktorska disertacija, Univerzitet u Beogradu, Geografski fakultet.

Hoffmann, G. (1999). *Tourismus in Luftkurorten Nordrhein-Westfalens, Bewertung und Perspektiven* [Tourism in Luftkurort North Rhine-Westphalia, Evaluation and Perspectives]. PhD Thesis. der Universität-Gesamthochschule, Paderborn

IBI-CAU. (2014). *Prostorno urbanistički plan opštine Šavnik do 2020. godine*. Podgorica.

Kadušić, A., Smajić, S., Mešanović, Dž. (2018). *Turistička geografija: fizičkogeografske i društvenogeografske osnove turizma*. Tuzla: OFF-SET.

Kiemstedt, H. (1967). *Zur Bewertung der Landschaft für die Erholung* [To assess the landscape for recovery]. Hannover: Contributions to Land Conservation.

Lješević, M. (1992). Ocena prirodnih abiotičkih uslova za potrebe istraživanja optimuma poljoprivredne proizvodnje. *Zbornik radova - Geografski fakultet Univerziteta u Beogradu*, 39, 125-141.

Lukić, M., Filipović, D., Pecelj, M. (2018). Vrednovanje predela u funkciji razvoja sportsko-rekreativnog turizma – primer grada Trebinja, *Ecologica*, 25(92), 821-827.

Manić, M., Milovanović, M., & Đorđević, M. (2019). Geoecological evaluation of Niš landscape for the purpose of sport and recreational tourism. *Serbian Journal of Geoscience*, 5, 7-12.

Mihajlović, D., Maksimović, M., Urošević, S. (2016). Ekološka dimenzija održivosti ruralnog turizma Stare planine. *Ecologica*, 23(82), 336-340.

Miklós, L. (1994). *Landscape ecological principles of the sustainable development, Roskilde University*. Department of Geography and International Development Studies: Roskilde.

Milošević, S. (2017). Analiza objektivnih pokazatelja razvijenosti turizma u Crnoj Gori. *Tims. Acta*, 11(1), 31-43.

Ministarstvo održivog razvoja i turizma Crne Gore. (2018). *Multiview Ortophoto*. http://www.geo.mrt.gov.me:3800/www/?fbclid=IwAR26S3-BL0w2gPvglw6pSDt_uUh2Db6r_iQGDoF90WY89SZCcU-0dKK0jI. Accessed May 20, 2021.

Ministarstvo turizma., DEG., GTZ. (2008). *Strategija razvoja turizma u Crnoj Gori do 2020. godine*. Podgorica

Montenegroinženjering., IAUS., Urbanistički inštitut Republike Slovenije. (2008). *Prostorni plan Crne Gore do 2020.godine*. Podgorica.

Nikolić, G. (2016). Systematization of geoecological maps and their role in spatial planning. *XV Symposium in engineering Geology and Geotechnics*, Beograd.

OpenStreetMap contributors. (2020). Planet dump retrieved from https://planet.osm.org, https://www.openstreetmap.org. Accessed May 20, 2021.

Opština Šavnik. (2011). *Strateški plan razvoja opštine Šavnik 2012-2017*. Šavnik.

Panfilov A. V., Vernikova, V. D. (2020). Global development trends in organization of tourist and recreational areas. In IOP *Conference Series: Materials Science and Engineering*, 775(1).

Pecelj, M. R., Pecelj-Purković, J., Pecelj, M. (2015). *Geoekologija*. Beograd: Univerzitet u Beogradu, Geografski fakultet.

Pecelj, M., Lukić, M., Vučičević, A., De Una-Alvarez, E., Esteves da Silva, CGJ. Freinkin, I., Ciganović, S., Bogdanović, U. (2018). Geoecological evaluation of local surroundings for the purposes of recreational tourism. *Journal of the Geographical Institute "Jovan Cvijić"*, 68(2), 215-231. doi: 10.2298/IJGI1802215P

Pecelj, R. M., Lukić, M., Pecelj, M., Srnić, D., & Đurić, D. (2017). Geoecological evaluation of Novi Sad and environment for the purposes of health tourism and recreation. *Archives for Tehnical Sciences*, 17(1), 89–97. doi: 10.7251/afts.2017.0917.089P

Pecelj, R., M., Šušnjar, S., Lukić, M. (2018). Evaluacija predela za potrebe turizma - studija slučaja jugo-zapadnih padina planine Romanija. 6. Međunarodni naučni skup, 705–717.

Pecelj, R., M., Šušnjar, S., Lukić, M. (2018). Evaluacija predela za potrebe turizma-studija slučaja jugo-zapadnih padina planine Romanija. *6. Medjunarodni naucni skup "Nauka i praksa poslovnih studija": Banja Luka*, 705–717. doi: 10.7251/ZUPS1806705P

Pecelj, R.M., Vagic, N., Pecelj, M., & Djuric, D. (2016). Geoecological evaluation of Belgrade and environmet for the purposes of rest and recreation. *Archives for Tehnical Sciences*, 14(1), 63–72.

Popović, D., Doljak, D., Kuzmanović, D., & Pecelj, R.M. (2018). Geoecological evaluation of protected area for recreation and tourism planning - The evidence from Bosnia and Herzegovina National Park. *Journal of the Geographical Institute "Jovan Cvijić" SASA*, 68(1), 119-131. doi: 10.2298/IJGI1801119P

Šuntić, I. (2012). *Šavnik – tajne prirode.* Beograd: Turistička organizacija opštine Šavnik.

Svetlana Jovanović et al. (2019). *Detaljni prostorni plan za prostor višenamjenske akumulacije na rijeci Komarnici*. Podgorica.

Troll, C. (1939). Luftbildplan und ökologische Bodenforschung. Ihr zweckmäßiger Einsatz für die wissenschaftliche Erforschung und praktische Erschließung wenig bekannter Länder. *Zeitschrift der gesellschaft für erdkunde zu Berlin*, 8, 241-298.