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Geoecological evaluation of Niš landscape for the purpose of sport and recreational tourism

Miloš Manić[1], **Milan Milovanović**[2], **Milan Đorđević**[2]

[1] University of Belgrade, Faculty of Geography, Studentski Trg 3, 11000 Belgrade, Serbia
[2] University of Niš, Faculty of Sciences and Mathematics, Department of Geography, Višegradska 33, 18000 Niš, Serbia

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Abstract

This paper deals with the possibility of the GIS application for the evaluation of natural resources to assess the full geoecological potential for recreational purposes. The quantitative diversity method (V-Wert method) was used to evaluate the city of Niš for tourism and recreation purposes. The methodology is based on Kiemstedt's model, and the criteria used in the analysis of a given area are the length of forest and water edges, relief energy, the way of land use, and climate factor. Using this model, we obtain an estimate of more or less favorable areas for the development of these activities. The GIS tools used the method to analyze and categorize a given area. By performing the evaluation process, a map of the recreational potential of the research area was obtained. Results show us that the most favorable area for recreational purposes is in the Municipality of Niška Banja and Pantelej.

1. Introduction

In this paper, we attempt to show to what extent the natural components of an area are suitable for the development of recreational tourism and sports activities. One of the practical methods suitable for spatial planning and management is geoecological evaluation. The aim of the paper is geoecological evaluation of the city of Niš and its surroundings using the quantitative diversity method, ie. V-Wert method. Several papers have already been published on the topic of geoecological evaluation of cities such as Belgrade, Novi Sad, Loznica, using the same method (Pecelj et al., 2016; Pecelj et al., 2017;. Pecelj et al., 2018). Case studies of mountain evaluation Ravna (Golijanin, 2015), Romanija mountain (Pecelj et al. 2018) and the National Park Kozara (Popovic et al. 2018) have also used same method for geoecological evaluation of area for recreation and tourism planning. The diversity method ('V-Wert' method) was formulated by the landscape ecologist Hans Kiemstedt, and it is based on natural characteristics of a landscape (Hoffmann, 1999). The natural tourist values that underlie recreational tourism are attracting a growing number of recreational tourists, and therefore many regions in Europe have recognized sports and recreational tourism as a direction for the future development of a sustainable and environment-friendly type of tourism. (Pecelj et al., 2018).

2. Study area

This paper presents a geoecological evaluation of the territory of the city of Niš, precisely for sports and recreational tourism. The area occupying the territory of the city of Niš is positioned in the south and southeastern part of Serbia. It is defined by a complex landscape structure with high and low mountains, canyons, and valleys. The area of geoecological evaluation is limited to the territory of the city of Niš, which includes the municipalities: Medijana, Pantelej, Crveni Krst, Palilula, and Niška Banja. The city covers an area of 593.7 km^2 (area calculation based on the geometry of shapefile). The most pronounced character of this area is given by the Niš valley, which is one of the largest in Serbia. It is about 44 km long and 22 km wide and occupies more than 70% of the administrative area of Niš.

Corresponding author. e-mail address: nicmamejl@yahoo.com (Manić M.)

3. Materials and methods

The aim of the paper is to create a map of benefits for the development of sports and recreational tourism. The geoecological assessment was performed using a quantitative diversity method, ie. Hans Kiemstedt's V-Wert Methods. This model has some drawbacks, but over time the model has improved and is still being used successfully in the areas of area planning and management. The literature points out that it is a particularly useful method for assessing mountainous areas. The formula determines area suitability for the purpose of sport and recreational tourism:

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

where: W — forest edges [m/m²], G — waterfronts/water edges [m/m²], R — relief energy [m/m²], N — land use [%], and K — climate (Kiemstedt, 1967)

This method is based on the analysis and inventory of landscapes so that the valuation process can then be carried out. Based on the analysis of the obtained data, a map of recreational amenities is made. The model is based on knowledge of the natural elements of the landscape and is recognized as a method of diversity (Golijanin, 2015). Finally, the area is classified into one of four eligibility categories. The values of the categories are shown in Table 1.

Table 1. Categories of diversity by 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

At the beginning of the research, a vector of grid cell dimensions of 1000x1000m was formed covering the entire territory of the study area, so that for each cell suitability can be determined concerning each criterion of the values represented by the formula above. In total, 676 cells were constructed that corresponds to the boundary of the studied area.

The first criterion W represents the length of the forest edge. Forest edges are carriers of contrasts and changes in the area that affect the senses of the beholder and represent typical elements of the cultural landscape (Pecelj et al., 2015). A digital database on the status and changes of land cover and land use across Europe - Corine Land Cover was used as the source of forest edge length data. The Corine map of the land cover consists of surfaces representing different classes of phenomena. The defined nomenclature is hierarchical, with 44 classes in the third, 15 classes in the second, and five classes at the first level. According to the Corine Land Cover 2012, 32 classes in the third level, 13 in the second and 5 in the first, are represented in Serbia (Đorđević, 2016). Based on the available data, there are three types of forest in the area of Niš: coniferous, broad-leaved, and mixed forests. The evaluation also covers transient forest-shrub ecosystems. The geospatial analysis was performed by measuring the length of the forest edge in meters per km² separately for each square. The forests were extracted as separate layers for which the total forest edge length was calculated.

Another criterion in the geoecological evaluation of the area is the length of the water's edge. Water bodies, as well as forests, make similar impressions on the senses of the beholder. According to many researchers, the water bodies are hugely enriching the given area, and therefore, the length of all the water banks is multiplied by a factor of 3.

The OSM base, adjusted with the help of topographic maps of the Military Geographical Institute of Yugoslavia, in the scale 1: 25000, was used to determine the length of the water body edge (sheets: 582-1-2 Vrćenovica, 582-1-4 Merošina, 582-2-1 Mezgraja, 582-2-2 Kravlje, 582-2-3 Medjurovo, 582-2-4 Niš, 582-4-2 Barbeš, 583-1-1 Niševac, 583-1-3 Niška Banja, 583-1-4 Tamnjanica, 583-3-1 Gadžin Han). The edges of all hydrographic objects were calculated according to the same procedure as the previous criterion, in meters for each grid cell. Forest types and watercourses are shown in Figure 1.

The relief energy (R) represents the height difference between the highest and the lowest point in a given square of the raster. In each square, the relative height difference is determined, and then the relief value is selected using a defined scale (Table 2). For determining the relief energy parameter, a digital terrain model SRTM (Figure 2) of 30 m spatial resolution was used. The values of this parameter were obtained using zonal statistics.

Table 2. The scale of relief 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

The analysis of the hypsometric map of the relief of the city of Niš revealed that 17.54% (104.11 km²) of the territory is at an altitude of up to 200 m. In the 200-500 m above sea level is 57.57% of the territory of Niš (341.76 km²), from 500

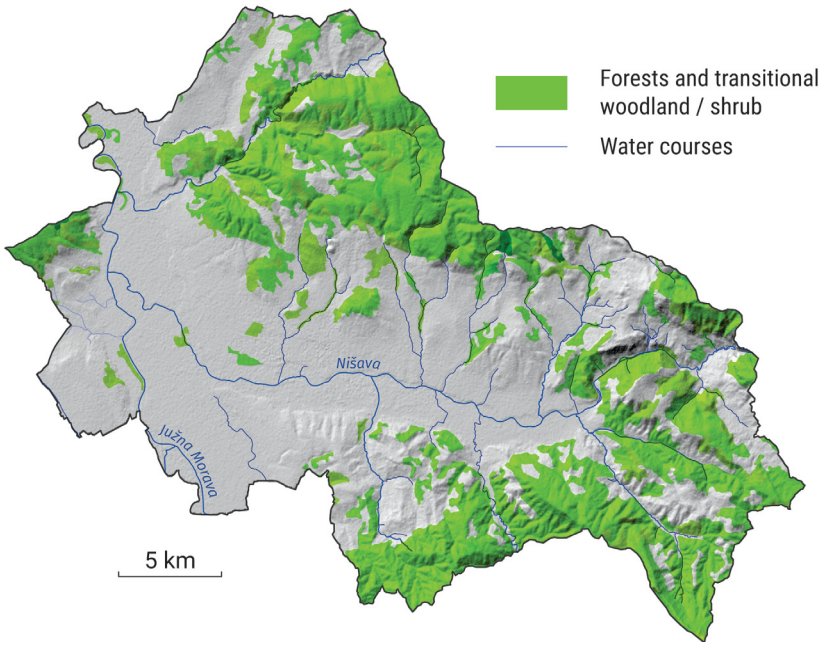

Figure 1. Forests and main watercourses in the territory of Niš

to 1000 m there is 24.59% (145.94 km^2) and over 1000 m there is 0.20% relief (1.16 km^2).

The criterion of land use (N) is obtained by calculating the percentage share of different types of land use in the corresponding square. Then the obtained percentages are multiplied by the corresponding weight factor, which is given in Table 3. By summing the obtained values of each type of use, we got a final value for each square. The Corine Land Cover (Figure 3) database was also used for this category. There are 19 land categories allocated for the city of Niš. The method of reclassification was applied to unify certain types of land.

Table 3. Weight factors for land cover.

Type of use	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

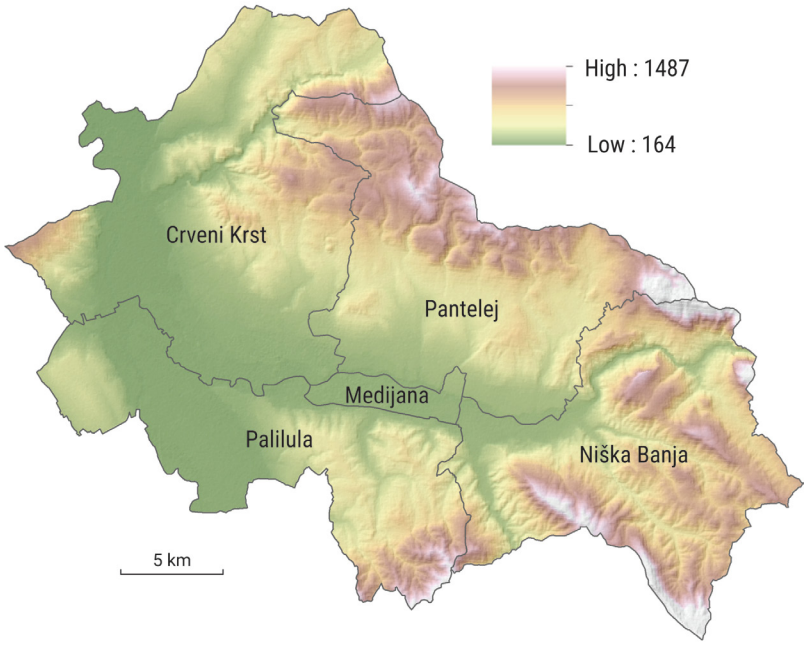

Figure 2. The relief (SRTM DEM) of the city of Niš with municipality boundaries.

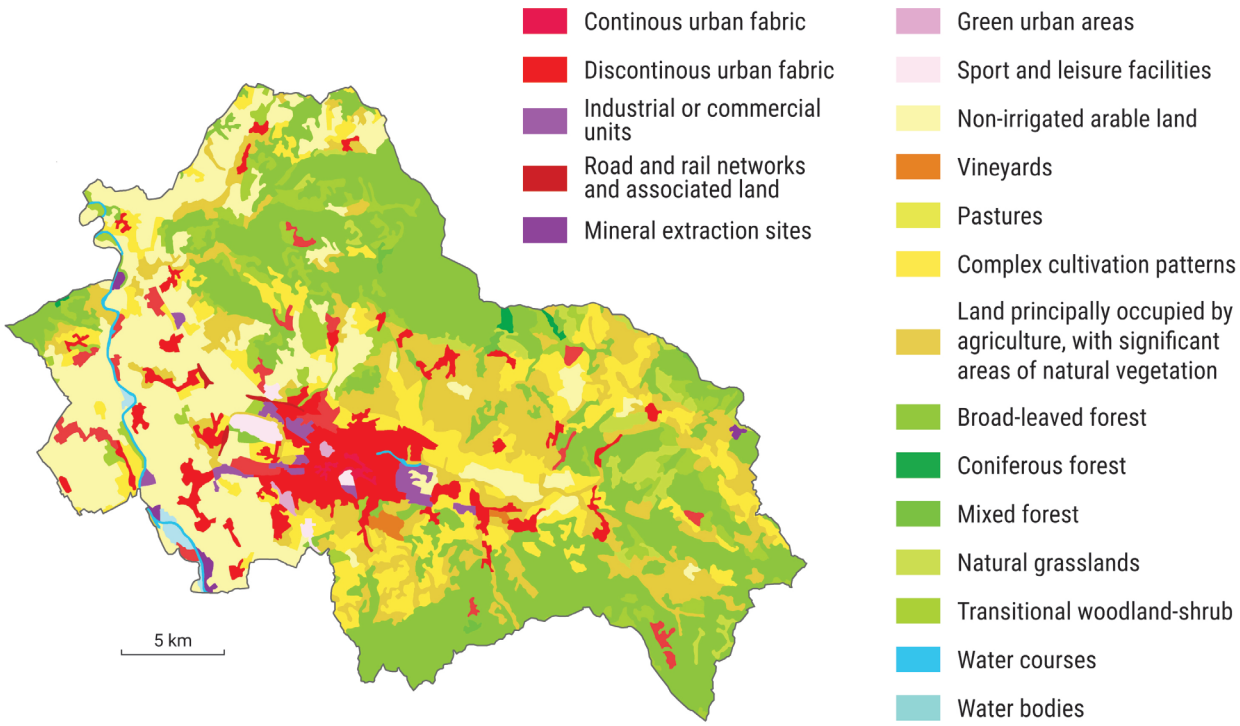

Figure 3. Land cover classes (CORINE).

The last element to consider when applying this method is the climatic factor. The climatic factor K is calculated based on the average annual temperature, precipitation, altitude, and type of landscape. Kiemstedt suggested ranges of values for the following bioclimates, which he applied to the study area of Germany (Table 4). Climate factor values are primarily assigned based on altitude. The problem with using this model is that the values for this criterion are only related to German territory. Due to these shortcomings, this method needs new climate data and bioclimatic indices so it could be suitable worldwide in order to obtain more accurate results.

Table 4. Weight factors of climate types.

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

4. Results and discussion

This analysis showed the assessment of natural resources of the observed area according to all criteria of the geoecological evaluation model for the purpose of sport and recreational tourism. The categorization was made based on the categories of diversity (Table 1), and four categories were distinguished: unfavorable areas 160.24 km^2 (26.99%), conditionally favorable areas 150.26 km^2 (25.30%), favorable areas 231.26 km^2 (38.95%) and a very favorable area of 51.94 km^2 (8.74%). The map of recreational potential (Figure 4) clearly shows that the favorable areas occupy the largest part and are mainly found in the northern, southern, and southeastern parts of the city. The unfavorable areas are located in central and western parts; conditionally favorable and very favorable areas are distributed mainly along with river courses and in the areas of forest complexes on the mountain slopes. According to the results of the evaluation, part of the territory of 160.24 km^2, or 26.99%, was allocated as unfavorable for the development of recreation tourism activities. One of the reasons for this is the way of land use since a significant part of unfavorable land covers agricultural land. This is especially evident in the part of the course around the South Morava, where agricultural land, wetlands, and low altitude played a dominant role in the final assessment of the area. Regarding the percentage of the unfavorable area for the development of recreational activities, the municipality of Medijana has the highest rate. This is somewhat expected as the municipality of Medijana occupies the inner city core. This percentage is as high as 68.49%, while the rest of 31.50% is determined to be conditionally favorable, while there is no favorable and very favorable land. Regarding the surface area, the municipality of Palilula has the most unfavorable

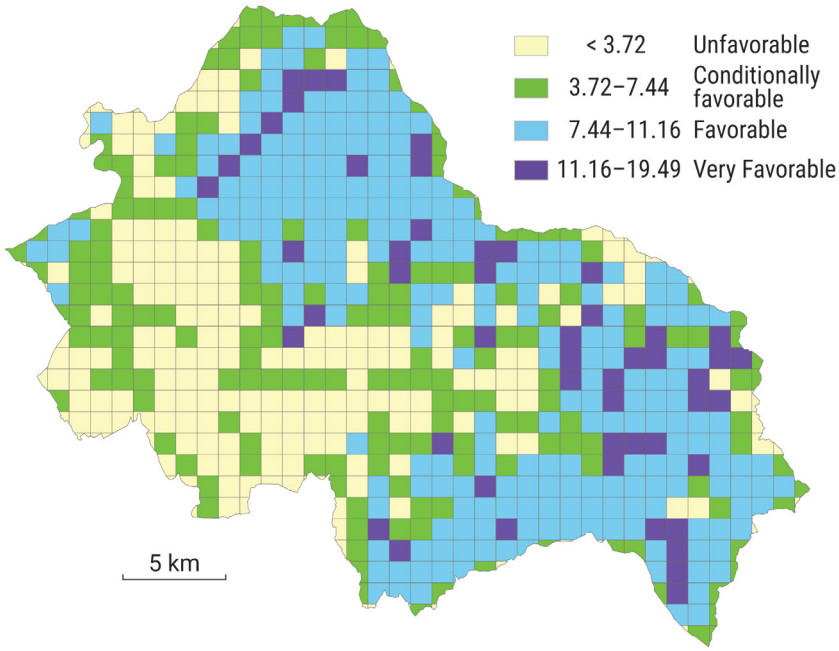

Figure 4. Map of recreational potential.

surface (57.67 km^2), followed by the Crveni Krst (56.14 km^2). The most favorable categories of land occur in the municipality of Niška Banja (22.95 km^2), which has as much as 16.01% of a very favorable land area, which is also the highest percentage within all municipalities. Detailed data sorted by municipalities are given in Table 5.

Table 5. Land suitability categories for recreational activities.

	Unfavorable		Condition. favorable		Favorable		Very favorable		Total
Municipality	km^2	%	km^2	%	km^2	%	km^2	%	km^2
Crveni Krst	56.14	30.88	53.98	29.69	61.37	33.76	10.29	5.66	181.78
Niška Banja	8.66	6.04	25.01	17.45	86.66	60.48	22.95	16.01	143.28
Pantelej	30.27	21.56	31.23	22.24	63.19	45.01	15.70	11.18	140.39
Palilula	57.67	49.16	36.59	31.19	20.04	17.08	3.00	2.55	117.30
Medijana	7.50	68.49	3.45	31.50	0.00	0.00	0.00	0.00	10.95
total	160.24	26.99	150.26	25.31	231.26	38.95	51.94	8.74	593.7

5. Conclusion

The most significant advantage of the V-Wert method, when evaluating the area for sport and recreation purposes, is that it uses multiple criteria relevant to the tourist valorization of area. However, the Hans Kiemstedt method has some drawbacks. The first is climate indices that are adjusted only for the German territory. This drawback could be overcome by using Meneks model as a substitution, which involves the exchange of heat between man and the environment. The second disadvantage of V-Wert method is directly related to data processing. For example, the values of a digital terrain model are limited to the accuracy and resolution of raster data. In this case, by calculating the relief energy, there is a possibility that the value of the mountain peak could be located at the edge of the cell or near the border so that it will be counted only for one cell. Another possible disadvantage, which has no direct link to the method but relates to the input data, is related to Corine land cover. Specifically, the minimum mapping unit refers to polygon widths of 100 m and an area of 25 ha. It may be more convenient to use satellite imagery (such as Landsat, Sentinel) for determining more precise land cover, though it also requires additional processing of raster data.

The city of Niš has excellent conditions for the development of sports and recreational tourism. In the evaluation of the area, 38.95% of the territory was rated as favorable, and 8.74% of the territory as very favorable. The great value of the identity of this area is protected natural landscapes. Most protected areas have been evaluated as favorable for recreational activities by evaluation.

The evaluation confirms that the analysis of natural components is important from the aspect of tourism promotion, especially the sport and recreational form of tourism. The results of this geoecological evaluation can contribute to a better affirmation of these areas, and the evaluation of the landscape alone opens up opportunities for future research.

ORCID iDs

Miloš Manić https://orcid.org/0000-0002-2452-5798
Milan Milovanović https://orcid.org/0000-0001-7157-2450
Milan Đorđević https://orcid.org/0000-0001-8068-8906

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