ISSN (Print) 2466-3549
ISSN (Online) 2466-3581

Serbian Journal of Geosciences

Volume 5, Number 1 (2019)

Faculty of Sciences and Mathematics
University of Niš

Contents

CIP - Каталогизација у публикацији

Народна библиотека Србије, Београд

Serbian Journal of Geosciences **5 (2019)**
University of Niš, Faculty of Sciences and Mathematics
Open Access

Variation of ^{137}Cs along the slopes of Mosna, Eastern Serbia

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Keywords:

Soil Erosion
Erosion Tracer
Fallout Radionuclide
^{137}Cs

Abstract

Fallout radionuclides (FRNs), e.g., ^{137}Cs, $^{239+240}Pu$, $^{210}Pb_{ex,}$ and ^{7}Be, have been successfully used to estimate soil erosion and deposition rates worldwide in the past few decades. The FRNs inventories can be converted to soil redistribution rates using different available conversion models. Among FRNs, artificial radionuclide cesium-137 is the most widely used as a tracer for soil erosion assessment. In this survey, the ^{137}Cs measurements have been used to found patterns of cesium-137 along the slope transects located in the Mosna site (Eastern Serbia). A typical example of the vertical distribution of the ^{137}Cs in an uncultivated soil was found. Patterns of downslope variation in ^{137}Cs content could be related to the field topography. Continuation of this research is important to provide insight into the potential of applying the ^{137}Cs method for the assessment of soil erosion and deposition rates within a study site.

1. Introduction

Radioactive ^{137}Cs is found globally in the environment due to fallout from atmospheric nuclear weapon tests (since the early 1950s with the peak in 1963) - bomb-derived ^{137}Cs and nuclear power plant - NPP accidents in the more recent past (Chernobyl 1986 and Fukushima Daiichi 2011 accidents). The properties and particular features of ^{137}Cs that have been explained in detail in numerous studies (Arata et al., 2016; FAO/IAEA, 2017; Mabit et al., 2008), indicate that ^{137}Cs is an excellent tracer for studying soil erosion. The video demonstrating the cesium-137 method for soil erosion assessment is available at www.iaea.org/newscenter/multimedia/videos/studying-erosion-with-the-help-of-radionuclides (Producer: Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture). Over the past years, different models (such as *Proportional Model, Mass Balance Model I, II and III, Profile Distribution Model, Diffusion and Migration Model, Modelling Deposition and Erosion Rates with RadioNuclides,* etc.) have been developed for cultivated and uncultivated soils in order to convert fallout radionuclides - FRNs (such as artificial ^{137}Cs and $^{239+240}Pu$, natural ^{210}Pb fallout and cosmogenic ^{7}Be) inventories into the soil redistribution rates (Arata et al., 2016; Walling et al., 2011). The ^{137}Cs is the most widely used FRN soil tracer for soil erosion assessment (Ceaglio et al., 2012; Haciyakupoglu et al., 2005; Iurian et al., 2012, 2014; Theocharopoulos et al., 2003). Advantages and limitations of the ^{137}Cs technique over traditional approaches can be found in the study of Mabit et al. (2008, 2013) and Walling et al. (2011).

Since erosion is one of the major sources of soil degradation and soil should be considered as a non-renewable resource and should be protected, determination of soil erosion rates is very important in order to design effective strategies for soil conservation. The recently applied RUSLE2015 model indicates the mean annual rate of soil loss in the EU erosion-prone lands of 2.46 t ha^{-1} yr^{-1}, ranged from 8.46 t ha^{-1} in Italy to 0.27 t ha^{-1} in the Netherlands (Panagos et al., 2015). According to erosion map of the Republic of Serbia (1966-1971), 86% of the total area of Serbia is endangered by soil

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erosion of various rates (Lazarević, 1983), available data in 2009 indicated that the ratio between individual erosion categories has changed (Lazarević, 2009). In recent years the use of ^{137}Cs method is developing abruptly in Serbia, and results were published in different studies (Forkapić et al., 2019; Kalkan et al., 2020; Krmar et al., 2015; Petrović et al., 2016).

The present study was carried out as a preliminary survey to assess the feasibility of using the ^{137}Cs to found patterns of soil movement along the slope transects located in the Mosna site (Eastern Serbia).

2. Study site

The Mosna site (Figure 1) is situated in the lower course of the Poreč River, in its narrowest part, between steep and high banks of the western slopes of Veliki Greben and the milder eastern slopes of Liškovac. From Mosna downstream, Poreč River begins to expand in the form of a funnel. That part of the mouth of Poreč River is the elongated funnel-shaped bay of the Đerdap Lake.

The geologic structure of the wider area around Mosna involves Proterozoic crystalline shales, Cambrian green shales with peridots, gneiss, and granite and gabbroid rocks of Deli Jovan Mountain. Devonian and Carboniferous sediments, volcanogenic-sediment series, Hercine-age granitoid, and Permian red sandstones were identified. In the broader area around the Mosna site, there is a significant distribution of Jurassic and Cretaceous sediments (andesites, dacites, pyroclastic rocks), Paleogene series of coal, plutonic rocks and Neogene and Quaternary sediments (Bogdanović, 1977).

From Miroč Mountain in the north (the highest peak Veliki Štrbac, 768 m) to the Popadija saddle (428 m) in the south, climatogenic reddish and darker (due to the presence of shale-derived materials) ore soils were identified (Milić, 1976; Petrović, 1974). These soils are formed by complex pedogenetic processes, denudation, and by drifting of Danube sediments. Their rubification occurred during the Pliocene under the influence of a subtropical climate. During the Würm, there was some accumulation of the loess and its mixing with other alluvial fragments during the flooding of the alluvial planes (Milić, 1976; Petrović, 1974).

According to the erosion map of Serbia (Lazarević, 1983), the study site is affected by medium erosion, and all the soil profiles are located within this soil erosion class.

3. Soil sampling and analytical methods

Soil profiles were taken during the summer of 2016 along two parallel transects to determine the distribution of ^{137}Cs within the soil profile. Soil samples were collected every 5 cm up to the depth of 30 cm at 11 spots along both transects. Soil samples were dried, homogenized, sieved through a 2 mm sieve, loaded into a Marinelli beaker and weighed for ^{137}Cs analysis. Soil samples were analyzed for ^{137}Cs using an HPGe gamma-ray spectrometer. The specific activity of ^{137}Cs was determined from its gamma-ray line at 661.6 keV, and ^{137}Cs content of the soil samples was expressed as specific activity (Bq kg^{-1}). Soil properties (sand (0.05-2 mm), silt (0.002-0.05 mm), and clay (<0.002 mm) content, dry bulk density, particle density, and total porosity) were analyzed using standard procedures (Blake and Hartge, 1986; Rowell, 1997). Software package OriginLab and MiniTab were used for statistical analysis of data.

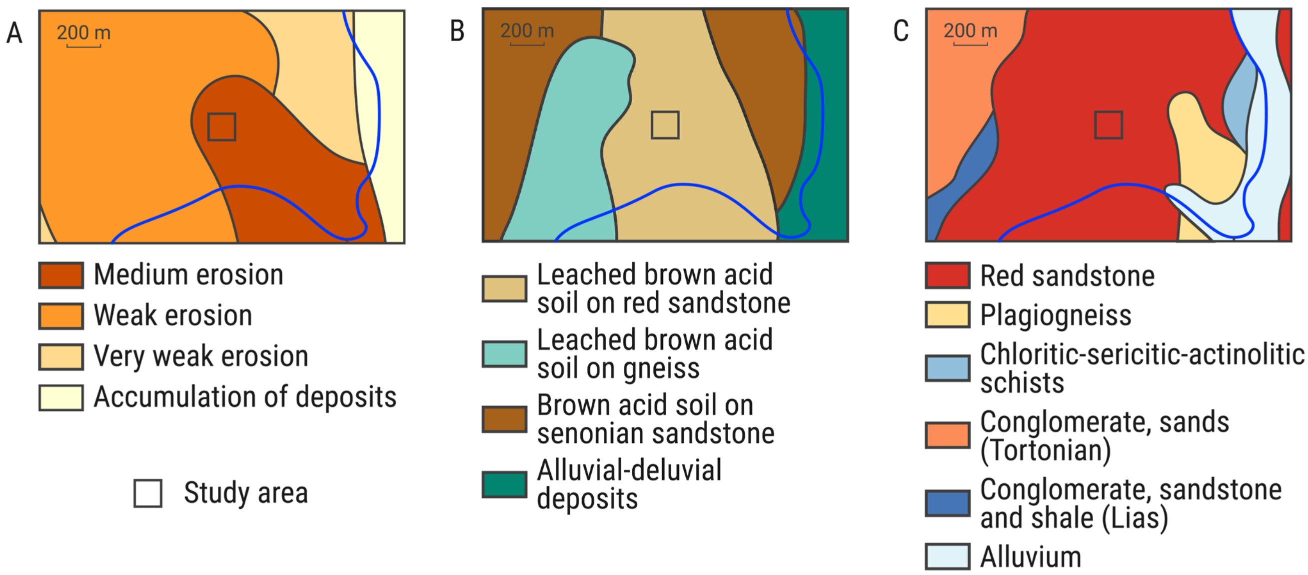

Figure 1. Erosion, soil, and geology maps of the study area and its surroundings.

4. Results and discussion

The [137]Cs specific activities in the studied surface soil layers showed a wide range of values (from 14.3 to 357 Bq kg^{-1} in the 0-5 cm layer and from b.d.l. to 304 Bq kg^{-1} in the 5-10 cm layer) (Figure 2), which indicate that study site is affected by Chernobyl fallout. Histogram of the [137]Cs specific activities in studied soils is presented in Figure 2. According to available data before the Chernobyl accident, the [137]Cs specific activity was below 5 Bq kg^{-1} in the soils of Serbia (Popović and Spasić-Jokić, 2006). After the Chernobyl accident, the different survey reported a wide range of the [137]Cs specific activity in soils of different regions of Serbia (Bikit et al., 2005; Dragović et al., 2012; Dugalic et al., 2010; Janković-Mandić et al., 2014).

The vertical distribution of the [137]Cs in soils of a study site is presented in Figure 3. A typical example of the vertical distributions of the [137]Cs in an uncultivated soil was found, its activity declines exponentially with soil depth, about 94% of the total activity was found in the top 15 cm (Figure 3). This indicates that the study site has not been cultivated since 1986, when the main input of [137]Cs into the landscape occurred. Constant decrease of [137]Cs, but with different configurations, in soil profiles collected along the transect was found in the study of Iurian et al. (2012), according to the authors this may be due to percolating water, growth conditions of microflora or biotic interactions within the soil. Different soil horizons may have different soil characteristics, which can influence the degree of retention and migration of [137]Cs through the profile (Nimis, 1996).

Descriptive statistics of [137]Cs specific activities and soil properties of studied soils are given in Table 1. According to the USDA soil textural classification, most samples belonged to the silty loam textural class.

Data transformations have been performed prior to analysis in order to follow a normal or near-normal distribution. The one-way ANOVA test results indicate that most of the variables means are statistically significantly different for at least one of the sampling locations and soil depth (Table 2).

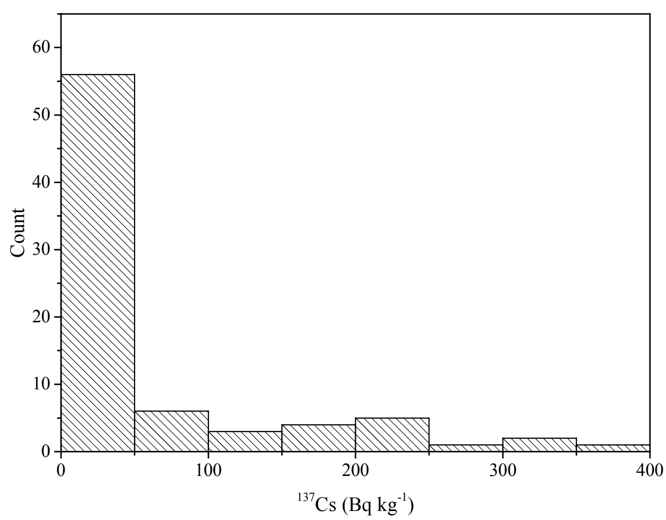

Figure 2. The histogram of the [137]Cs specific activities (Bq kg-1) in soil samples from the study site.

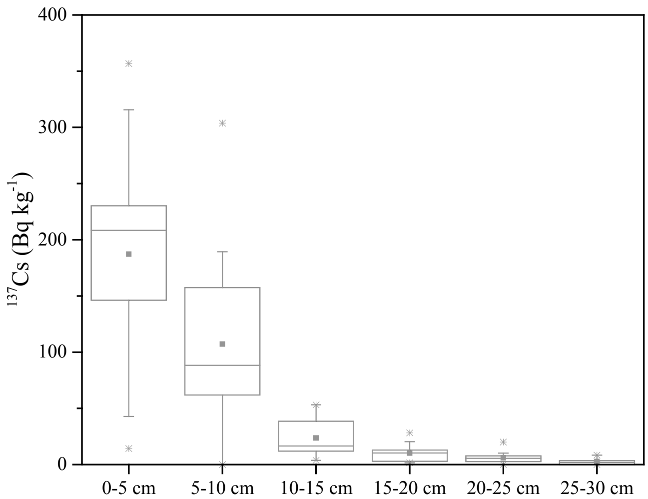

Figure 3. Mean depth profile of the 137Cs in soils from the study site.

Table 1. Basic descriptive statistics for [137]Cs specific activities and soil properties.

Parameter	Mean	St. Dev.	Coef. Var. (%)	Min	Median	Max	Shapiro -Wilk (Sig.)
^{137}Cs (Bq kg^{-1})	56.2	88.1	157	b.d.l.	12.7	357	0.000
Sand (0.05-2 mm) (%)	15.6	5.6	35.9	9.10	13.9	34.7	0.000
Silt (0.002-0.05 mm) (%)	66.7	7.24	10.9	49.2	69.3	79.4	0.001
Clay (<0.002 mm) (%)	17.7	7.21	40.7	9.20	15.3	37.1	0.000
Particle density (g cm^{-3})	2.59	0.03	1.29	2.52	2.59	2.65	0.011
Bulk density (g cm^{-3})	1.51	0.16	10.6	1.12	1.52	2.02	0.025
Total porosity (%)	41.7	5.75	13.8	23.5	41.3	55.9	0.025

b.d.l. below detection limit.

Table 2. One-way ANOVA test results for 137Cs and soil properties with soil depth and location.

Variable	Source of variation	F-value	Sig.
^{137}Cs (Bq kg^{-1})	Depth	25.2	0.000
	Location	1.70	0.087
Sand (0.05-2 mm) (%)	Depth	0.18	0.970
	Location	6.37	0.000
Silt (0.002-0.05 mm) (%)	Depth	4.08	0.003
	Location	8.29	0.000
Clay (<0.002 mm) (%)	Depth	5.58	0.000
	Location	6.77	0.000
Particle density (g cm^{-3})	Depth	21.7	0.000
	Location	2.05	0.033
Bulk density (g cm^{-3})	Depth	5.10	0.000
	Location	4.17	0.000
Total porosity (%)	Depth	4.20	0.002
	Location	4.23	0.000

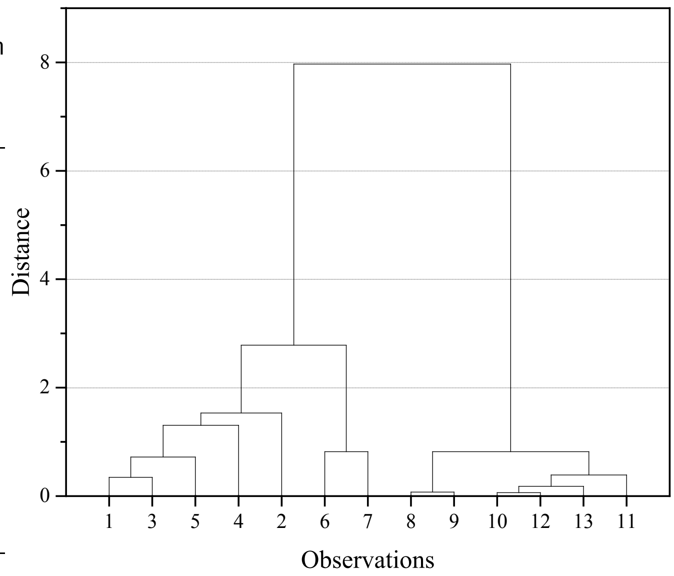

Figure 4. Dendrogram derived from the hierarchical cluster analysis

The cluster analysis using Ward's method and squared Euclidean distance was applied to obtain a dendrogram illustrating similarities between soil profiles (Figure 4). Two main clusters are distinguished - the first one represents soil profiles collected from the first transect. In the second cluster, soil profiles collected from the second transect are gr

In the area affected by Chernobyl fallout, some of the variability may reflect an initially non-uniform distribution of Chernobyl fallout, i.e., irregular distribution of rainfall during the short period after the accident in the landscape due to factors influencing the meso- and micro-scale variability in rainfall distribution (IAEA, 2014). According to Navas and Walling (1992), high spatial variability of ^{137}Cs can be mainly attributed to the distribution of vegetation cover along with the micro- and meso-topography, which control the small-scale redistribution of ^{137}Cs.

Along the transects, the downslope variation of ^{137}Cs activity shows similar patterns in the upper part of the slope (Figure 5). The ^{137}Cs activity decrease from hilltop locations to locations at the mid of the slope (Figure 5). From the middle of the slope at Transect I, there is a sudden increase of ^{137}Cs activity and then a decrease at the bottom of the slope, while at Transect II, there is a small increase of ^{137}Cs at the bottom of the slope. Patterns of downslope variation in ^{137}Cs activity could be described by field topography. Before started sampling, we were assured by the landowner that the land had never been used for agriculture before. But, according to the topographic map from 1971, most of the sampling locations are within an area classified as the orchard. There was no evidence about it on the field in the time of sampling and obtained vertical distribution of ^{137}Cs in soil profile confirmed that the land had not been cultivated since the main fallout ^{137}Cs occurred in 1986. According to the literature data (FAO/IAEA, 2017), the undisturbed site can be found at the hilltop, the eroded site is common at the mid-slope position, and the deposition site occurs at the bottom of the slope. The existence of eroding areas downside the slope due to the morphological pattern of the field was reported in the study of Iurian et al. (2012). The close relationship between erosion rates and variations in vegetation cover density was found in the study of Porto et al. (2001).

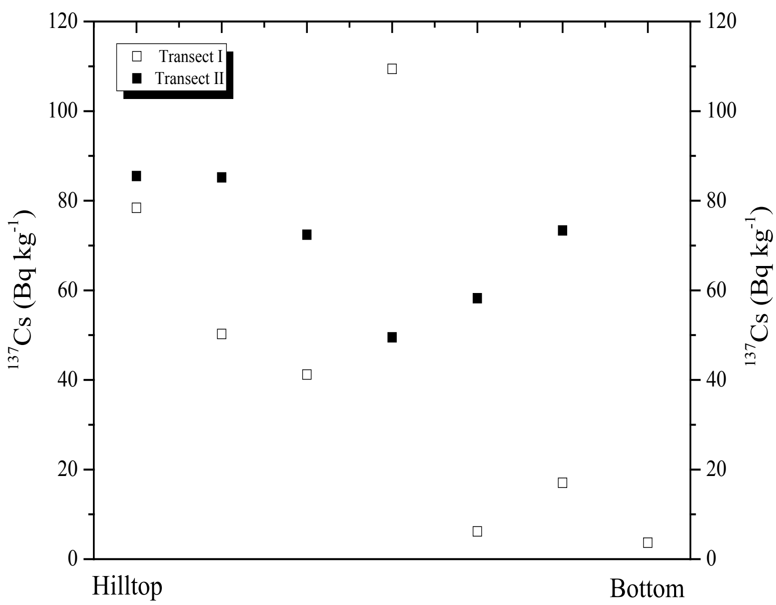

Figure 5. Distribution of ^{137}Cs along the slope transects.

5. Conclusion

In order to improve soil conservation strategies, the search for additional methods for soil erosion assessment, show that fallout radionuclides (FRNs), especially ^{137}Cs, can be used as a soil erosion tracer. This preliminary investigation provides insight into the possibility of using ^{137}Cs as soil erosion tracers within the Mosna site. To obtain quantitative estimates of soil erosion/deposition rates from ^{137}Cs measurements, using different conversion models, in further investigations, the reference site should be identified, and additional samples should be collected within the study site following the grid approach.

Acknowledgements

This work was supported by the Ministry of Education and Science of the Republic of Serbia (project III43009).

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Serbian Journal of Geosciences 5 (2019)
University of Niš, Faculty of Sciences and Mathematics
Open Access

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

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Keywords:

Quantitative diversity method
V-Wert
Kiemstedt's model
Geo-ecological evaluation
GIS

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.

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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

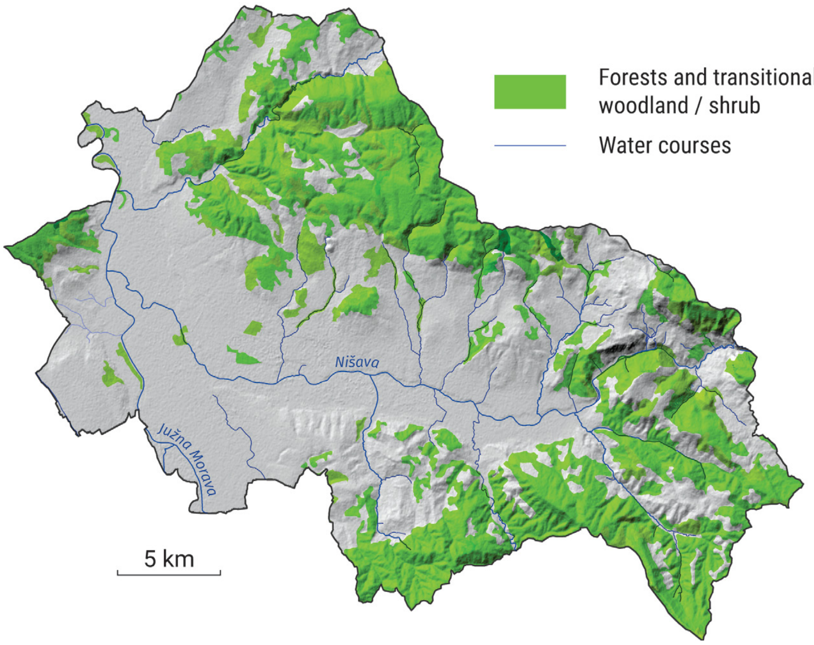

Figure 1. Forests and main watercourses in the territory of Niš

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

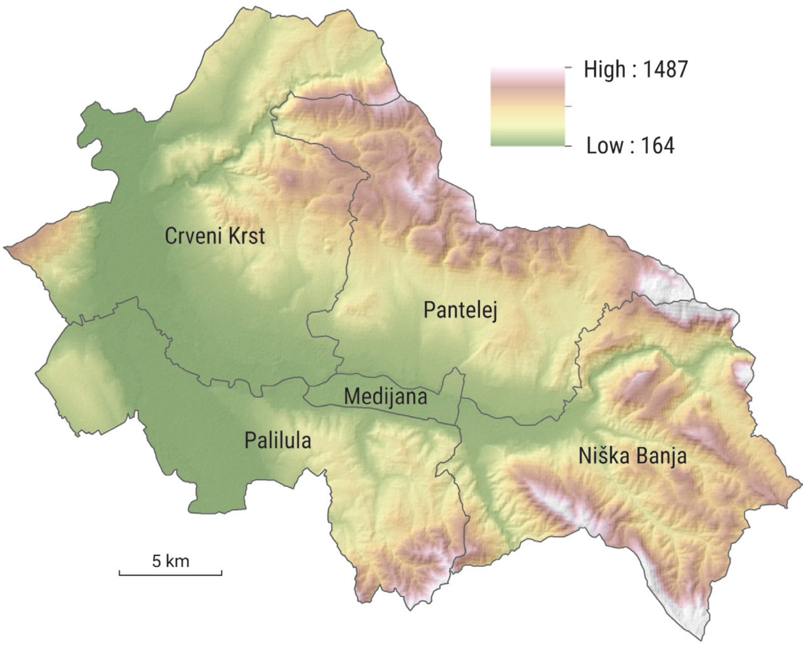

Figure 2. The relief (SRTM DEM) of the city of Niš with municipality boundaries.

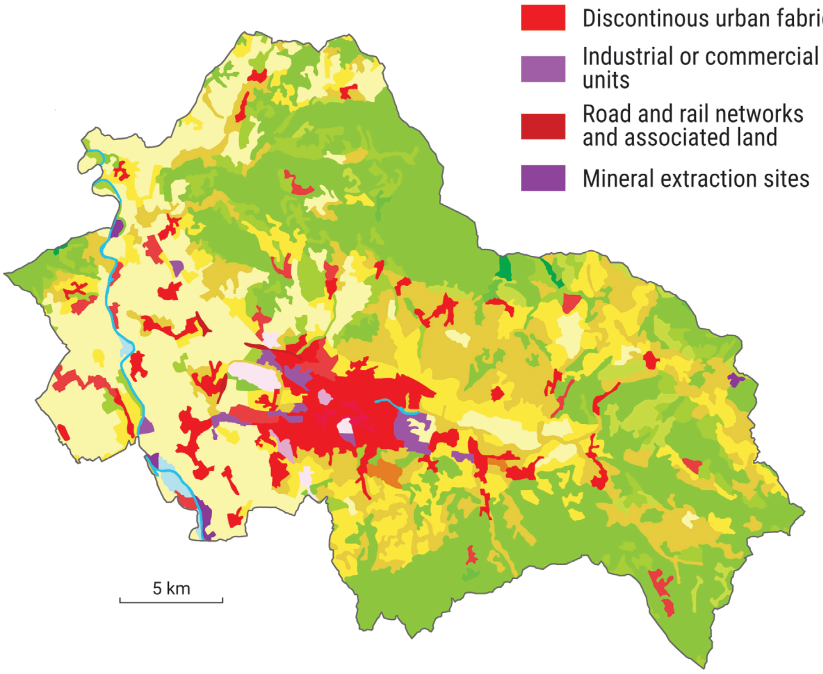

Figure 3. Land cover classes (CORINE).

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

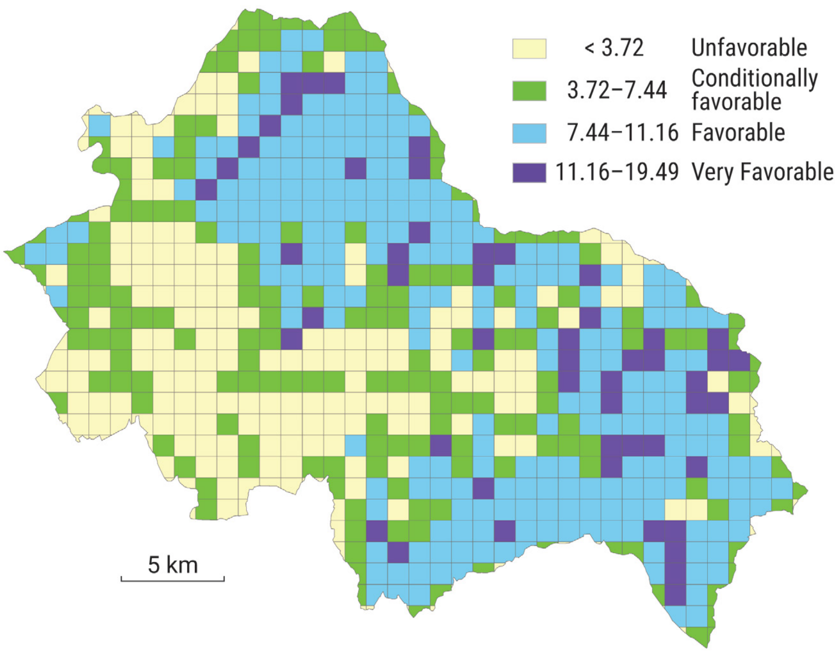

Figure 4. Map of recreational potential.

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.

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Topographic maps 1:25000, sheets 582-1-2 Vrćenovica, 582-1-4 Merošina, 582-2-1 Mezgraja, 582-2-2 Kravlje, 582-2-3 Međurovo, 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. Vojnogeografski institut, Beograd

Serbian Journal of Geosciences **5 (2019)**
University of Niš, Faculty of Sciences and Mathematics
Open Access

Seasonal movements in mountain tourism of Serbia: a review of methods and literature

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Keywords:

Seasonality
Mountain
Tourism

Abstract

Touristic destinations and thus mountain touristic destinations face serious seasonality challenges. The most often seasonal peaks are in the winter season (Kopaonik and Stara Planina) or during the summer season (Zlatibor) and fall during the rest of the season. The subject of the paper places particular emphasis on forecasting seasonality and methods to measure it by applying different statistical and economic techniques. Some of the causes and consequences of seasonal trends within the tourism development of the three leading mountain centers of Serbia in terms of the development of mountain, sports, and recreational tourism are also reviewed.

1. The phenomenon of seasonality

Seasonality is a common phenomenon present in human activities of hunter-gatherer societies as well as later in agriculture and manufacturing in manifestations, sport for instance (Higham and Hinch, 2002), or recreational activity (Hartmann, 1986; Butler, 1994). Research on seasonal variations in industry and trade has been held by Kuznets (1933), and the first comprehensive study on tourism seasonality was published by Bar-On (1975).

According to Koenig-Lewis and Bischoff (2005), seasonality represents repetitive movements in a time series during a particular time of the year. Butler (1994) Bar-On (1975) divide factors that influence patterns of seasonality into two groups - natural and institutional. The same approach regarding factors that influence seasonality had Hartmann (1986), Allcock (1989), Butler (1994), Hinch and Hickey (1997), Sylvester (1999), and many others. On the other hand, natural seasonality refers to climate and weather conditions (temperature, rainfall, snowfall, daylight, and visibility) and institutional reflects social aspects (human, religious, school, culture, ethnic and economic). Baum (1999) emphasize inflexibility within broad institutional frameworks as a cause of seasonal rigidity with respect to vacation patterns and so that major shifts in seasonal behavior are challenging to achieve. Butler (1994) also looked at institutional seasonality as the result of human decisions and is much more widespread and less predictable than natural seasonality.

The seasonality is a well-known problem all tourism development organizations are dealing with and trying to create a solution. The issue of seasonal trends has been explained by Koenig-Lewis and Bischoff (2010), who argue that seasonal impacts reflect on tourist activity, especially when talking about the number of fixed costs, rigid capacity in many private and public services.

Considering the mountain centers of Serbia, we can see a big difference in their origin, morphological evolution, dimensions, vegetation, the richness of hydrographic objects, and other characteristics. From this, we have concluded that they are not equally active for certain forms of human activities so that they can be valorized in different ways.

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Considering the business of tourism development companies in the mountain destinations of Serbia, the economic impact of seasonality is related to inefficient use of resources and facilities, which affects prices and income, as well as profit (Jovičić and Ilić, 2010). For this reason, many scientists, researchers, and practitioners are addressing the issue of seasonalization, which continues to be a significant challenge for many mountain tourism sites, not only in Serbia but worldwide.

Mountains have been attracting tourists' attention since ancient times, and some of them have been well geographically studied, and there is a basis for their purposeful tourist valorization (Jovičić and Ilić, 2010). However, the development and success of mountain tourism destinations in the tourism market depend on several internal and external factors (Dimić and Radivojević, 2017). Key factors are the following: the overall image of the destination, the quality of the tourist offer in the winter and summer season, the sense of security, as well as the overall impression of the quality of the destination management.

Seasonality in tourism in Serbia is a serious issue affecting numerous aspects of life like depopulation, economic decline, social displacement, and spatial depletion, despite becoming a secondary issue in tourism according to recent research since it has been mitigated in advanced western societies with different improvement measures such as enriching touristic offer by organizing events and festivals, etc. (Cannas, 2012).

Seasonality is commonly seen as a phenomenon that negatively affects the economy and life in general, but on the other hand, it can have some positive effects.

Balanced and sustainable development of mountain destinations could be achieved only with a comprehensive and integrated approach between society, economy, and environment. The development of ecotourism could not be possible if the image of a mountain is created as the center of mass winter tourism (Stankov et al., 2011). The negative economic impact of seasonality is a loss of aspect of profits due to the inefficient utilization of resources and structures (Sutcliffe and Sinclair, 1980; Manning and Powers, 1984; Williams and Shaw, 1991). In such variable circumstances, it is hard to keep quality standards (Baum, 1999) and retain full-time staff (Yacoumis, 1980) and a quality workforce.

On the other hand, seasonality could have a positive impact in an economic sense, such as increased revenues of local population and students, artists, housewives through temporary jobs for seasonal workers (Mill and Morrison, 1998) and opportunity to maintain buildings and attractions during in off-peak periods. Negative social impact reflects in congestion on traffic, a problem with free parking places, queues and increase in the costs services and goods Cannas (2012), the increase of crime (Mathieson and Wall, 1982), which might result in resentment from the local community towards all tourism activities (Manning and Powers, 1984). From the positive point of view, seasonality could allow the community relief from stress during the off-peak season (Mathieson and Wall, 1982) and enriching social life with cultural events in peak season. Ecological disruption and heavy use of the natural environment during the peak season (Manning and Powers, 1984), disturbance of wildlife, litter problems, physical erosion of footpath and other natural resources (Cannas, 2012), as well as pressure on resources, air, water and soil pollution are all the negative consequences of the impact on the environment. On the other side, the dead season is the only time of the year when the ecological environment could fully recover (Hartmann, 1986).

2. Describing seasonality, its causes, and effects

Different statistics are used to describe the level of seasonality present in the observed data. Some of them are the seasonal range, the seasonality ratio, the coefficient of variation, the amplitude ratio. The seasonal range represents the difference between the two most extreme monthly indices, the highest and the lowest. The higher the value of the seasonal range is, the higher is the level of seasonality. The seasonality ratio represents the ratio between the highest and the lowest seasonal value. Also, the higher value of this statistic reflects higher levels of seasonality. The coefficient of variation is defined as the ratio of the standard deviation and the mean. It is a measure of spread and describes the amount of variability relative to the mean, and it is a statistic having general use in describing the heterogeneity of data. The amplitude ratio represents the ratio between the amplitude observed in a particular year, and the average amplitude was taken over a long period. More on these measures could be found in (Lundtorp 2001, Þórhallsdóttir and Ólafsson, 2017)

The most common tools in describing seasonality are the Gini index and the Theil index. The Gini coefficient was introduced by the Italian statistician and sociologist Corrado Gini (Gini, 1912). It is based on the Lorenz curve, which represents, e.g., the percentage of the total number of tourists through the observed period on the timeline. The Gini coefficient is equivalent to the ratio of the size of the area between the Lorenz curve and the line of equality and the total triangular area under the line of equality (Figure 1). It ranges between 0 and 1. The coefficient value of 0 represents the

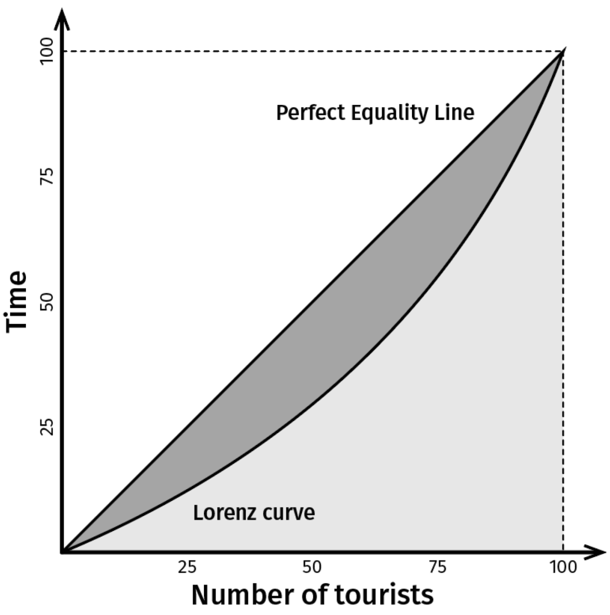

Figure 1. Lorenz curve

perfectly equal distribution of the number of tourists during the period. In this case, the Lorenz curve follows the line of equality. The more the Lorenz curve deviates from the line of equality, the higher will be the resulting value of the Gini coefficient. The coefficient value of 1 represents an unequal distribution of the number of tourists when, e.g., all tourists come at the same time. The appropriateness, advantage, and disadvantages are analyzed by many authors what can be found in (Atkinson 1975; Champernowne & Cowell, 1998; Campano, 2006).

The Theil index is a measure of inequality the same as redundancy in information theory, which is the maximum possible entropy of the data diminished by the observed entropy value. It is a special case of the generalized entropy index. It was induced by econometrician Henri Theil (Theil, 1967). The domain of the Theil index is the set of non-negative real numbers. The index value of zero reflects ideally equal distribution, while higher values indicate higher levels of inequality.

The authors, in (Ferrante et al., 2018), looked upon seasonality measures and emphasized the most commonly used indices: the Gini index and the Theil index. They, also, proposed an approach for the analysis and measurement of seasonality in tourism destinations, based on a review of the pattern of seasonal swing. They derived the relative seasonality index and showed its general purpose. This index enables a description of seasonal patterns as an initial step of analysis and, in a second step, a measurement of seasonal amplitude, taking into account the cyclical structure of periods.

In Sutcliffe's and Sinclair's paper (1980), two alternative methods of decomposing a change in seasonality between different years into a pure change in seasonality were presented. It consists of an increase in the concentration of annual arrivals, which occur in the same months of the year, and a pattern change giving the fluctuations over time in the proportions of tourist arrivals, which occur in different months. In that way, they gave a methodology for measuring the total level of seasonality, the amounts of the pure and pattern components of a change in the level of seasonality, and the extent and direction of the change in seasonality over time.

A traditionally used measure, such as the Gini coefficient, was used in (Rossello Nadal et al., 2004) for describing seasonality patterns through specific economic determinants. The authors summarized the intra-year variation in arrivals to the Balearic Islands through the Gini-coefficient, providing evidence of the influence of some economic variables on the seasonal distribution of tourist numbers, using regression analysis. They found the nominal exchange rate, GDP, relative prices, consumers' incomes to be significant factors influencing seasonality patterns.

Some advanced statistical time series analysis was used in (Pan et al., 2012) for forecasting hotel room demand with search engine data as predictors. They used analysis of ARMA time series models and identified a few forecasting models as the best for that purpose. Also, in (Pan, 2017) progressive techniques are applied to predict the level of seasonality. The author used big data analysis of weekly hotel occupancy as a tool for forecasting seasonality level.

In a number of articles, there are attempts to describe, measure, and forecast the level of seasonality by applying different statistical and economic techniques on variables and measures originated in the touristic context.

A connection of online booking and a level of seasonality was analyzed in (Bofa and Succurro, 2012). Their study explored how online booking affected seasonality, measured as the variation in hotel bed-places net occupancy rate between peak and off-peak periods. They tried to investigate the impact of those shifts in the search process of probably every tourist on the seasonal variation in the occupancy rate in hotels. One of their hypotheses was that the difference between high season and low season output increases as the discount rate decreases. They confirmed the causal relationship between online booking and seasonality. Because of online booking, firms modify their pricing strategy. The demand side behavior is altered only indirectly, through the price changes induced by online booking. This phenomenon has the other side, the rise for new business for online travel agents. They can now analyze customers' online searches and purchases and exploit them to provide customers with more tailored offers. This will alter the traditional way of advertising in the tourism sector, putting travel agents into a double role, drawing revenue from two distinct sources, consumers and advertisers. They concluded that managers and policymakers in the tourism sector should not simply rely on the Internet as a tool to reduce seasonality. Still, they should not exclude traditional ways of attracting people in the low season, and more scattered holidays, e.g., an organization of events and festivals.

Also, the authors in (De Cantis et al., 2011) analyzed the correlation between the bed occupancy rate as a standard efficiency measure and seasonality. To formulate a good tourism marketing and development policies, they proposed a structure constituting a way to unite a reasoned guide of approaches to and the statistical tools for measuring seasonality, and a way of presentation scheme of support practitioners in the study of seasonal tourism indicators.

Another way of modeling seasonality was given in (Oses et al., 2016). The authors proposed a model for explaining and predicting mean hotel occupancy rates by destination based on these prices. The results are auspicious, the fit is excellent, and the predictions are also good.

Also, there are a lot of articles in which the authors reveal and analyze different factors affecting seasonality and give suggestions and guidelines to combat seasonality or to avoid or mitigate its consequences.

About tough and sometimes unsuccessful fight against seasonality and influence of geographic position concerning Northland, New Zealand, wrote the authors in (Commons and Page, 2001). They said that in a specific regional context, it is apparent that "given that seasonality is largely institutionalized or directly affects major characteristics of the product (to do with climate), many bounds on demand are not variable by price or marketing inducements" (Bull, 1995) alone. But such inevitability in seasonality fails to recognize the action which the tourism industry and private sector can take to address the issue.

In the same spirit, in (Duro, 2016) it could be found that factors relating to the tourism product itself and seasonal climate variations would be behind behavioral extremes. The paper analyses the seasonal concentration of tourist activity, taking hotel nights as an indicator. They concluded that, during the analyzed period 1999-2012, there was a growth in seasonality, emphasizing the extremes in seasonal concentration, most prominence in the Balearic Islands and two of the Catalan provinces, and moderate in Madrid and the Canary Islands provinces

Additional measures to reduce seasonality could be found in (Parrilla et al., 2007). From a demand perspective, the most popular tactic for reducing seasonality is the organization of special events and festivals, introducing new market segments, and reduced prices. From a supply perspective, expanding the existing capacity should be one of the effective ways to reduce seasonality. However, these tactics do not eliminate all problems associated with seasonality. They gave their case study results of the hotels of the Spanish Balearics. They tried to identify the factors that influence the opening period with the conclusion that higher quality services in a hotel positively affect its opening period. Location, closer to urban areas and in Mallorca (the island with better transport connections with the continent during winter), is also related to a longer opening period. Their results justified the promotion of transforming lower-quality hotels into higher. It is also shown that other location characteristics are determinants for the length of an opening period.

One of the measures to combat seasonality are organizations of mega-sport events. The consequences of such actions are analyzed in Fourie et al. 2011. The authors emphasized the direct and immediately seen benefit of such events: the increase in tourist arrivals to the host country. But, in general, although the results suggest that mega-sport events promote tourism, the gain could vary depending on the type of mega-event, the participating countries, and whether the event is held during the peak season or off-season.

In (Koening-Lewis and Bischoff, 2005), the authors commented on the state in existing literature and research on seasonality. They noted that there are many gaps in studies and that many of the issues arising in this field are, at best, only partially understood. There is a distinct lack of in-depth and longitudinal research to underpin the tentative findings that have emerged. Tourism seasonality research has been dominated by a focus on practice, rather than being based on theoretical models, they said.

3. Case study: mountain destinations of Serbia

Seasonal movements in mountain centers of Serbia are still a burning problem in the economy and tourist industry. They are caused by many different factors such as bad economic situation, underdeveloped infrastructure, inadequate marketing strategies, non-competitive position in the world market, and lack of touristic elements in off-peak season.

We summarized several recent studies concerning seasonal movements in mountain touristic centers in Serbia

The review studies cover two periods related to two seasons in the mountain centers of Serbia. The aim was to analyze the possibility of developing year-round tourism in mountain destinations and reduce seasonality. In many studies, we have come to the same indicators. Based on the above indicators, two seasons are clearly identified in Serbia, of which many mountain centers are more dominated by winter than the summer season. The only case where the summer season is more pronounced than the winter is Zlatibor Mountain, while Zlatar Mountain has recorded year-round tourist movements in terms of spa tourism. (Paunović and Radojević, 2014)

Guided by research and analysis of several studies, we can see that to achieve proper measures for seasonalization many authors have made comparisons (Benchmark analysis) of data (annual share in tourist arrivals, the highest share in annual tourist arrivals and the ratio of arrivals in highest and the lowest month).

According to Milijić et al. (2010), seasonality could be described through monitoring of the accommodation occupancy, income from accommodation facilities, and the ratio of income and accommodation units. These variables were used in numerous studies concerning seasonality. Previous researches dealing with seasonality in Serbian touristic centers point that in main mountain resorts in Serbia such as Kopaonik, Zlatibor, and Stara Planina, there are clearly distinguished two seasons, winter and summer seasons.

Kopaonik and Stara Planina have a more prominent winter season and stronger development of winter sports and recreational tourist movement. The situation in Zlatibor is the opposite. There, the summer season has a richer offer and accordingly greater visit. (Dimić and Radivojević, 2017)

Based on research data, we have concluded that the winter season on Kopaonik is clearly defined and that in the future period, this mountain center must do a lot to improve and introduce new measures that would contribute to the development of tourism throughout the year. Particular emphasis on Kopaonik Mountain should be placed on mountain biking, as well as the organization of congresses and conferences, due to its well-equipped accommodation and a large number of conference rooms. Also, one of the forms of tourism, regardless of the winter season on this mountain, can certainly be spa and wellness tourism that can be linked with spa and health tourism, considering that there are three spa centers at the foot of this mountain. Better connection with near urban and spa centers will enrich touristic offer by adding different types of touristic forms such as rural, eco, spa, urban, cultural, congress, and manifestation tourism with mountain tourism. Mountain resort Kopaonik has a capacity for creating different types of tourist products that can be offered to clients of different demographic characteristics and purchasing power; such as summer vacations with family, and older couples in combination with wellness or summer activities (hiking, mountain biking, free climbing classes, gastronomic tradition, picking of herbs and collecting mushrooms). During the spring and autumn period, it can be used for congresses and seminars, summer and winter schools for students, smaller conferences, business meetings, and workshops. Also, the touristic offer could be widened with products dedicated to tourists with special interests such as horseback riding, orientation running, exploring flora and fauna, and similar. Connecting the mountain range with spa centers in its foothills, establishing new health touristic resources, and improving existing ones, better organization of recreational activities could significantly increase the satisfaction of the tourist, especially the eldest visitors.

In mountain resort Zlatibor, there is a clearly defined summer season. On this mountain, special attention should be paid to the development of rural areas at its foothills, with several specific manifestations, authenticity, ecological awareness, and the great benefits of natural values, such as the climate which gave this mountain its name as an air spa. These attributes form the basis of competitive advantage for a marketing strategy. According to the previously mentioned fact regarding the average age of tourists, mountain resort Zlatibor should establish or improve products that could attract elderly tourists like hiking, gastronomic tradition, patchwork, and knitting courses, picking of herbs, collecting mushrooms, exploring flora and fauna. The winter season is not far behind the summer season but still needs a lot of improvements. Due to the lack of long and steep ski slopes, on the mountain resort Zlatibor, capacities for a ski for beginners, ski for kids, ski schools, sledding should be developed and improved. Also, outside the summer and winter season, touristic products such as congresses and seminars, summer and winter schools, conferences, workshops should be offered

For the time being, mountain resort Stara Planina is the least developed of those three. It has a clearly defined winter season and has been mostly visited by families. It has a good choice of wide ski slopes of medium difficulty, perfect for ski recreationists and beginners. So, an improvement of winter offer should be directed to further development of ski schools and ski infrastructure. The summer season is far behind the winter season, and that should be a guide for future mitigation of more than distinct seasonality. The touristic offer outside the winter season should be more various. The mountain resort Stara Planina must use the richness of its natural and anthropogenic values and its mild slopes as an attraction for an opportunity for explorers and nature lovers, hikers, and mountain bikers. Also, wellness and spa capacities should be offered to tourists as well as capacities for rural, gastronomic, eco, and congress tourism. In order to maintain the richness, unplanned construction and construction of small hydropower plants on mountain rivers must be stopped.

What all touristic mountain centers in Serbia need to pay special attention to is the interest of tourists to connect several different types of tourist movements in a particular destination. The reason for that is people who are on the mountains with their families or older tourists, who, through tourism, most often carry out natural forms of movement in terms of hiking, running, animation, cycling, and more. The reason for this is a visit to these centers for sports and recreation, as well as the revival of body weight in organisms. In this way, people maintain a better quality of life and efficiently perform their daily activities.

4. Conclusion

Some of the proposed solutions for challenging the off-peak season are extending activities beyond the main season, organizing events through the off-peak season, seeking to cultivate an all-year-round market (Connell et al., 2015). Taking into account the development of tourism so far in the mountain centers of mountain destinations of Serbia, we conclude that there are two separate tourist seasons, summer and winter (Bratić, 2015). The summer season is more diverse in terms of the offer and exceeds the potential of the winter season by the effects of the offer in specific segments (Dimić and Radivojević, 2017).

By the analysis of the presented studies, we conclude that based on the samples and factors we have examined through the possibility of reducing the seasonalization of the mountain destinations in Serbia, the first and key weakness is the existing suprastructure and accommodation capacities which are not satisfactory, the second problem is inadequate traffic connections, i.e., bad roads that underlie tourist development. The third problem is the insufficient formation of the summer season. With the development of the summer season, mountain sports and recreational tourism would be just one of the products in a well-balanced tourist area, thus reducing the risk of over-emphasizing only one tourist season and only one tourist product.

Future research of the mountain destinations of Serbia should focus on its activities as well as on the demographic situation at the foot of the mountain centers as a basis for the tourism market segmentation.

Acknowledgements

This work was supported by the Ministry of education, science, and technological development of the Republic of Serbia by the bilateral project with the Republic of Slovenia "Challenges and approaches for tackling the seasonality issues in mountain tourism destinations" NO. 14:2017-2019.

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Serbian Journal of Geosciences 5 (2019)
University of Niš, Faculty of Sciences and Mathematics
Open Access

Basic touristic potentials and further tourism development in Sokobanja

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Keywords:

Sokobanja
Tourism
Market
Thermal mineral springs
Climate

Abstract

This research aims to present the specifics of Sokobanja regarding tourism development, as well as opportunities and prospects for better development. Also, the enrichment of the touristic offer of the spa resort with cultural contents, such as in this Sokobanja case, would lead to better placements on the tourist market and more positive economic results could be achieved. It is important to emphasise touristic potentials of Sokobanja as well as the possibilities for their further tourist exploitation to create better conditions for the development of tourism and the acceleration of economic effects in the tourist industry.
The analysis of the current development of tourism in Sokobanja is of great importance, which can best be presented through a SWOT analysis of an area. Also, the task of the research in this paper is to look at the overall tourism potentials and opportunities for their exploitation, with the tendency to achieve a better position in the market. In the very research, several methods were used: comparative method, descriptive method, analysis.

1. Introduction

Tourism in Serbia has a long tradition. In some tourist destinations, tourism has continuity of over 150 years. Up to now, the main attention of development has been focused, in addition to mountain tourism, to spa tourism, as one of two characteristic motive forms of movement. This is, first of all, caused by the abundance of thermo-mineral springs which spas have at their disposal, but also by the diverse morphological structure of the scenery.

Serbia has a large number of spas. There are over 300 mineral, thermal and thermo-mineral springs. It is especially important that more and more emphasis should be placed on the complementary development of spa and mountain tourism in future development plans. Such a way of combining different motive forms of movement would significantly contribute to the content that could be offered to tourists.

Sokobanja has significant natural, but also anthropogenic tourist potentials. They contribute to the realisation of various forms of tourism. This spa provides opportunities for the development of mountain, excursion, sports and recreational, eco-tourism and the like. A large number of activities which are practiced here can contribute to the establishment and maintenance of biological and psychological balance. There are also possibilities of running, hiking, swimming, rafting and more.

2. Touristic – Geographical Position

Sokobanja is located in the Balkan part of eastern Serbia, in one of the largest basins of this mountain-valley region. The basin was named after the largest settlement, Sokobanja – Sokobanja basin. The spa lies at 350 m above sea level (Marković, 1980). This spa is located in the basin, between the mountains Ozren (1,174 m) and Rtanj (1,560 m), on the left bank of the river Moravica. After the Second World War, Sokobanja became a touristic and a health centre of Serbia. With Vrnjačka and Niška Banja, Sokobanja is one of the three of our largest spa resorts (Janjić et al., 2007).

Sokobanja basin is located in the central part of Eastern Serbia. It is situated between 43° and 44° of northern latitude

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and 21° and 22° of eastern longitude. A significant characteristic of its geographic position is the fact that it is, as for the regional geography, located in the system of large Carpathian-Balkan mountain range, whereas its smaller part in the west encroaches in the zone of old Rhodope mass (Ršumović, 1974). In a broader sense, this area belongs to the mountainous-basin-valley macro region, whereas it belongs to the meso-region of Eastern Serbia (Marković and Pavlović, 1995). Such a position of Sokobanja basin in Serbian geo-space defines its particular climatic conditions which indirectly influence the very process of agricultural production. (Pavlović et al., 2011).

The first steps in the development of Sokobanja tourism began on April 1, 1834, when Prince Miloš issued an order to adopt a plan for the construction of the first public bath. The year of 1835 was crucial when the famous German expert in mining Baron Sigismund August Wolfgang Herder sampled water from the Sokobanja spring. Due to its healing properties, the water was compared with the waters of Bad Gastein and Pfaefers (Nikolić and Stanković, 2008). The crucial event in the life of this spa was the establishment of the ''Society for the Enhancement and Enrichment of Sokobanja and the Environment'' in 1895, the initiator of which was the Serbian Metropolitan Mihailo (Stanković, 2009). Sokobanja from the past is known under different names: Banja, Banjica, Varošbanja, Velika Banja, Aleksinačka Banja, Al Banja, Hajduk Veljkova Banja and Sokol Banja. The current name of the spa dates back to 1859. Even then, according to Felix Kanic, Sokobanja was a very special place because of the expected arrival of Prince Miloš to treatments, which led to the arrival of many well-known figures of Serbia at the time (Stanković, 2009). The ancient Roman people knew about Sokobanja medicinal springs. The proof that they used them is a part of the large pool wall, with fragments of antique bricks. Sokobanja thermal and mineral springs were also used by the Turks. They expanded the old pool and built several more bathing facilities. Since 1895, the ''Association for Enhancing and Enriching the Spa under Ozren'' was founded with the patriotic goal of stopping the money from going to foreign countries (Marković, 1980).

3. Natural Touristic Qualities of Sokobanja

3.1 Geomorphological touristic characteristics

The basic traits in the morphology of this area comprise the Sokobanja basin, and a mountains range along its periphery. We can distinguish three different parts of the whole: the valley, the hills and the mountain belt (Dakić, 1967).

The Sokobanja basin is a clearly rounded spatial unit, surrounded by mountain ranges on all sides: Rtanj in the north, Slemen and Krstatac in the east, Devica, Ozren and Leskovik in the south. There are the mountains Oštrikovac, Baljevin and Rožanj on the west end of the basin (Cvijić, 1912).

Rtanj, as an isolated mountain massif, has a vast base, oriented to the sides of the world. One side faces south, while the other two are in the northwest and northeast positions. Focusing on the dominant peaks of this mountain, Šiljak, as the central pyramid, and Kusak, as a rounded conical end of the rounded ridge and the Baba peak, as an ellipsoidal, stepped-mountainous form, we can see that the position of their peaks forms an equilateral triangle with another point. In the centre of the triangle is the Šiljak, under which lies a three-sided pyramid with the same orientation to the sides of the world as its triangular base. The edges of this three-sided pyramid, with its angle-to-sides ratio, place this mountain in the category of the Seven Wonders of the World, as a masterpiece of nature.

Located on the southeast side of the highest peak of Rtanj, the Ledenica Cave is a significant tourist attraction and a kind of curiosity. The entrance to the pit is at the bottom of a shallow sinkhole, about 20 m wide in diameter. The length of the pit is 50 m, the entrance gradually narrows, eventually entering a spacious hall, 15 m wide and 10 m high. The bottom of the hall is flat, covered with clay and stone blocks. The internal temperature of the Ledenica is quite uniform, ranging from -2°C (in summer) to -4°C (in winter) (Nađfeji S., 2009).

Ozren is a mountain in southeastern Serbia, with its highest peak being Leskovik (1,178 m). It lies between Niš and Aleksinac. Sokobanja and the medieval Sokograd are near this mountain. This mountain consists of several tourist attractions, which make it possible to complement the development of mountain and spa tourism. In the first place, it is a well-known climate resort rich with ozone. Ozren is one of the most densely forested mountains in Serbia. There are two hospitals on this mountain (for the treatment of lung and eye diseases). It is suitable for the development of health and recreational tourism but also the development of excursion tourism, as evidenced by other motifs. Here is also the waterfall Ripaljka (17 m) on the river Gradašnica. In addition to its natural tourist values, this mountain has rich anthropogenic tourist motifs, such as the Jermenčić Monastery (from the 14th century).

The Sokobanja basin represents a typical tectonic basin, formed in the Tertiary Period by lowering the terrain along several faults. The basin consists of the Sokobanja and

Dugopolje enlargements separated by the Sokograd Gorge. The mountain pass and the Skrobnik Gorge connect it with the Knjaževac basin (in the east), and the connection with the Aleksinac valley and Pomoravlje (in the west) is provided by the Moravica Bovan Gorge (Jovanović, 1923).

In the limestone region of the Sokobanja basin, there are numerous caves, sinkholes and ice-holes. Known, but insufficiently valorized are the Seselačka and Rujiška caves, then two passable Milušinačka caves and Čitlučka cave, 107 m long. On the south side of the Rtanj Mountain, in one big sinkhole, there is an ice-cave, the so-called. "The Evil Hole." Its depth is about 57 m and is filled with ice throughout the year. Another significant, but insufficiently investigated ice-hole is the so-called. "Vlaška Pećura", at the foot of the Golem Peak, on Devica. One should not ignore an attractive cave – a bridge cave on the river Zarvina, as well as a unique, legally protected window-like opening called "The Doors of God" (Jovanović, 1923).

3.2 Climate touristic characteristics

"The collection of climatological data for spa and climatic sites can be done in two ways: Firstly, the results of meteorological measurements and observations from the existing network of meteorological stations should be used. Second, by installing special bioclimatic stations in spa-climatic sites" (Mörikofer, 1955). Spatial-functional complementarity of balneological and climatic qualities is at work in Sokobanja, which is the basis for the development of tourist-recreational, health-preventive and healing functions (Radović and Marić, 1997). In a well-known discussion on "Sokobanja Climate", from the point of view of climate therapy, it was emphasised that Sokobanja "is similar not only in temperature but also in many other climatic details, with the well-known climatic site Hornberg, near Schwarzwald " (Radojković, 1907).

Sokobanja is characterized by moderate-continental climate. Summers are not too hot, and winters are mild. Autumn is warmer than spring. Relative air humidity is 75% (Dunić, 1936). The average annual cloudiness in Sokobanja is 57%, which means that insolation decreases in this relationship, which is an important element of recovery. Cloudiness is not evenly distributed. Rain is rare, and there are 25 days a year with snow. The small representation of extremely high temperatures, relatively small daily temperature amplitudes, the constant vertical flow of air from the surrounding mountains, as well as the increased presence of ozone in the air, especially after the splash of rain, make this spa very pleasant (Radović and Marić, 1997). Sokobanja is one of the largest balneological centres in Serbia, which is best evidenced by the healing properties of the spring water (Romelić, 2008). The air temperature in the territory of Sokobanja is conditioned by the air currents of the Moravska and Timočka basin, the position of mountains, vegetation, water surfaces, etc. The mean annual temperature in this area is 10.2°C (Đukanović, 1960).

The gridded data for this purpose is sorted between 12 series. The first grid belongs to January and presents the average value of data for each January, the twelfth belongs to average data from December, for each December. All grids were presented with normal dispersion of meteorological data. The climatological data is in the resolution of 30 m or 1 km² (Fick and Hijmans, 2017; Valjarević et al.,2018). From the official page of climate data with included IPCC reports we were downloaded gridded data of climate properties for the all territory of Serbia (http://worldclim.org/version2). After that, we included coordinates of the meteorological station of Sokobanja on a grid.

Table 1. Average annual air temperature in the territory of Sokobanja municipality, for the period 1988-2018.

Year	Temp (°C)	Year	Temp (°C)	Year	Temp (°C)
1988	10.5	1999	11.5	2009	10.8
1989	10.6	2000	12.3	2010	9.6
1990	11.3	2001	11.7	2011	9.4
1991	9.8	2002	11.6	2012	10.4
1992	11.2	2003	10.7	2013	10.2
1993	10.3	2004	10.6	2014	10.3
1994	12.0	2005	10.1	2015	10.7
1995	10.6	2006	10.6	2016	11.1
1996	10.0	2007	10.1	2017	11.2
1997	10.1	2008	9.9	2018	11.3
1998	11.2				

Source – Valjarevic et al., 2018.

In the observed period it can be concluded that in 2000 was recorded the highest average annual air temperature (12.3°C), while in 2011 was the lowest average annual air temperature (9.4°C). Based on the table (Table 1) it should be noted that the average annual air temperature is very favorable for tourism development in Sokobanja.

The coldest month is January (-1.2°C), and the hottest is July (19.5°C). Precipitation is usually caused by western winds. They are more abundant in the surrounding mountains than in the basin itself. There are no real rainy days, while dry periods have been more frequent in the recent years. The average annual precipitation amounts to 667 mm (Đukanović, 1960). Insolation is expressed in the number of hours of sunshine during a day. The average annual sunshine in the Sokobanja area is 1,861 hours, with the maximum in July (267) and the minimum in December (48) (Stanković, 1989). Fog also plays an important role in the development of tourism. Annually in Sokobanja, there is an average of 77 foggy days, with great fluctuations, which is explained by the influence of Bovan Lake (Dunić, 1936). The Sokobanja basin is surrounded by mountains on all sides. The layout of the mountains is such that there are intense currents to the basin from the south-west, south, east and southeast, while the northern, northwestern, northeastern and western winds are less frequent. The strongest wind of this region is Košava (a cold, very squally southeastern wind found in Serbia and some nearby countries), while the air pressure does not have any sudden and strong changes and stays around 736 mb (Đukanović, 1960).

3.3 Hydrographic tourist characteristics

Sokobanja is characterised by a diverse hydrographic network. Springs of hot and cold mineral water are fundamental qualities and a starting point for its touristic development. There are numerous hydrographic objects that independently or complementarily contribute to the overall attractiveness of the wider spa area, as well as the tourist-recreational and health function of the spa. The springs of thermo-mineral water, wells, lakes and rivers stand out (Radović and Marić, 1997). Thermo-mineral springs most often appear at the foot of mountains, that is, along the edges of the basin, but there are many in valleys because they are most often predisposed by faults (Maćejka, 1985).

The main river flow in the Sokobanja basin is Moravica. Cutting its riverbed in the southern edge of the basin, after the withdrawal of the neogene lake, it formed a distinct asymmetric river basin. From its start to the mouth to the South Morava (near Aleksinac), Moravica is 45 km long. Its upper part is famous for its numerous rapids and giant pots, which locals call "barrels" and there are numerous beaches: "Gentleman", "Six Barrels", "Čoka", etc. Tourists, who like to walk along the path above the Moravica bed, can enjoy the Sokograd Gorge (in the upper part) and Bovan Gorge (in the lower course of the river) (Stanković, 2000).

The following attractive hydrological facilities are distinguished:

Moravica Springs

Waterfall Ripaljka is located on Ozren, on the river Gradašnica. Ripaljka is the highest among them, with the height of 17 m. This waterfall is the first natural monument in Serbia, protected by law since 1948.

Bovan Lake, built in the system of regulation of the Morava river basin and the hydroelectric power plant "Djerdap". It is 8 km long, about 400 m wide and about 50 m deep. At its 33rd km, Moravica enters the Bovan Gorge, building an artificial reservoir, Bovan.

Vrmdža Lake is located close to the village of the same name, at the southern foot of Rtanj (Stanković, 2000).

Thermomineral springs have the greatest significance. They appear along the Moravica flow, in the bordering zone of the complex Ozren fold belt and Devica anticline, that is, on the route of the great Sokobanja fault. Sokobanja springs belong to the group of mineral and thermal waters. They are characterized by increased mineralization and radioactivity, which gives them a special balneological significance (Protić, 1995).

On the basis of the hydrogeological division, the Sokobanja Thermo-Mineral Springs belong to the Carpathian-Balkanides, and in the tourist-geographical view they are classified into the East-Serbian Spa Zone (Stanković, 2000). Based on the temperature, most of these waters belong to the group of thermal waters (20-25°C), while only a smaller number belongs to the group of homoeothermic or hypothermic waters (Filipović, 2003). Warm spring water comes from a depth of about 1,000 m and springs along the faults, at the contact of clays, marlstone, conglomerates and limestone. Cold springs with a temperature of 16°C emerge from shallow layers (Vujanović and Teofilović, 1983).

The oldest expert data, related to the analysis of thermomineral springs of Sokobanja, come from the Baron Sigmund von Heder, the mining captain of the Austrian army, who came to Serbia in 1835 to examine ores, minerals and mineral waters. He states that there are three groups of warm springs in Sokobanja:

1. hypothermia springs (20-34°C), such springs are "Banjica I" and "Banjica II" and the spring "Pijaca"
2. homeothermal springs (34-38°C)
3. hyperthermal springs (above 38°C), such springs are "Park" and the spring "Transfiguration"

The chemical analysis of Marko Leko shows that the Sokobanja thermal springs are similar and with the exception is silver and strontium to a certain extent. When comparing the chemical composition of hot springs with the spring of cold water from the "Zdravljak" fountain, significant deviations are observed in the content of silver in the cold spring, then chromium, iron, titanium and vanadium. Interestingly, the cold water "Zdravljak" contains molybdenum, copper, nickel, lithium and rubidium, as well as a large amount of potassium, which is much higher than in warm springs (Leko, 1922).

3.4 Biogeographical tourist characteristics

An exceptional advantage for the development of tourism (especially recreational) in the Sokobanja area is the diverse biogeographical tourist qualities. The ambience, recreational and landscape quality of this area is increased by rich mountain vegetation, which covers the entire Sokobanja basin. Large areas of deciduous and coniferous forests, meadows and pastures, regulated parks and resorts allow for long, and light walks along marked paths, through unspoilt nature or biking around mountainous terrain. Regulated parks in Sokobanja and in the immediate surroundings contribute greatly to the psycho-physical recovery of tourists. Famous parks are Central City Park, park "Banjica", park on Vrelo (Borići), park "Čuka I" and "Čuka II" (Marjanović, 2017). Special biogeographical quality of Sokobanja lies in wild medicinal herbs. This region has been known for medicinal herbs since ancient times (Rtanj tea, thyme, St John's wort). The research has identified 200 species. Medicinal plants have multiple touristic qualities, both for the area of Sokobanja (health function, the aesthetic attractiveness of the area), as well as for the activity of tourists (picking medicinal herbs in an environmentally preserved area). Harvesting of medicinal herbs and the collection of forest fruits are specific and insufficiently utilised tourist and recreational opportunities for enriching the tourist stay or even the primary motive for certain segments of demand (Radović and Marić, 1997).

In addition to the mentioned qualities of the flora of the Sokobanja region, it should be pointed out that diverse fauna is a significant biogeographical feature of this spa. White Falcon is a true rarity because, except in Italy and the Sokograd Gorge, it cannot be seen anywhere else in Europe anymore (Mišić, 1982). The importance of this space is also reflected in numerous habitats of wild hunting game (wolf, deer, wild boar, fox) and wildlife poultry (pheasant, partridge, wild bird, wild duck). Fishing is also important for tourism and the development of fishing tourism, and apart from the Moravica River, it is also contributed by Bovan Lake, located near Sokobanja (Jovanović and Radivojević, 2006).

4. Anthropogenic Touristic Characteristics of Sokobanja

According to the attractiveness of the impact, the anthropogenic tourist qualities are complementary and contribute to the enrichment of the content of the stay of tourists. Based on the tourist qualities, the possibilities of valorisation and forms of occurrence, they can be divided into cultural-historical monuments and cultural-tourist manifestations (Jovanović and Radivojević, 2006).

The most attractive anthropogenic tourist motifs which are valuable cultural and historical monuments are:

Sokograd is located in an ecologically preserved ambience of an attractive picnic site Lepterija in the gorge of the river Moravica. The fort was built during the period of the conquest of these territories by the Romans (1st century BC). Sokograd represents a cultural monument of national importance. The viewpoint from the towers of this ancient city allows seeing particular visual qualities of this area (Jovanović and Radivojević, 2006).

The remnants of the Antique period in Sokobanja are numerous. The most important are: Tetomir Town, Rujevica, Trubarevac Gradište, Latin City and Lipov Trap.

The Turkish bath "Amam" is located in the central spa park with a bath which was used by Prince Miloš Obrenović. The bath is from the period of the Romans, as evidenced by material traces – fragments of ancient bricks. The bathroom has been renovated several times to keep its historical value, tourist appeal and its health-recreational functionality.

Monastery Saint Archangel (known as "Jermenčić") is 8 km away from Sokobanja. It is located on the northern slope of Ozren, at about 850 m above sea level, in a natural and picturesque setting, surrounded by beech forest. Near the monastery, there is a large number of springs, two of which were captured by Hajduk Veljko. There are various folk tales about the origin of this monastery. The memorial fountain next to the monastery was built in 1874 and the bell tower in 1875. The monastery was restored during the First Serbian Uprising, at the order of Karađorđe. The last reconstruction was in 1992. Every year on July 26, on the day of St Archangel, there is a traditional fair held there (Petrović, 2004).

The building "Milošev konak" was built for the needs of the administration of the Principality of Serbia. It was adapted, and it is a catering facility now, which is directly included in the tourist offer of Sokobanja.

The Church of the Transfiguration of the Lord was built in 1892 beside the remains of the old church, which was built by King Milutin. The church has a gospel from 1836, with the original signature of Prince Miloš, and has an archive from 1835.

The memorial fountain of Miloš Obrenović is located at the entrance to Sokobanja, next to the archaeological site Trebič. It was built in 1860. Although it was renewed several times, it retained its authentic appearance.

The monument to the fallen soldiers in the wars from 1912 to 1919 is located within the central city promenade, not far from the "Amam" bath.

During the summer tourist season in Sokobanja, numerous manifestations are organised within the Banja Cultural Summer, which complement the content of the stay of tourists. The level of attractiveness and appeal to tourists is especially high for the following manifestations: The First Accordion of Serbia, Golden Hands – the fair of national handicraft, customs, forgotten national dishes (the manifestation has a local tourist attraction contractive zone), then St. Jovan Biljober (manifestation, organizing picking of medicinal herbs on the slopes of the mountain Rtanj). St. Jovan Biljober manifestation has gained significance in recent years, and its contraction zone is expanding (Radivojević, 2005).

5. Touristic Turnover

The spa tourism of Serbia has two critical characteristics: relatively long stay and seasonality. It is a period when 45% of arrivals and 55% of overnight stays are realized. According to its seasonality, Sokobanja belongs to the category of centres where, apart from the summer season, the winter season is also important (September-April), when more than 20% of annual turnover takes place (Jovičić, 2008).

5.1 Trends in the tourist market Sokobanja

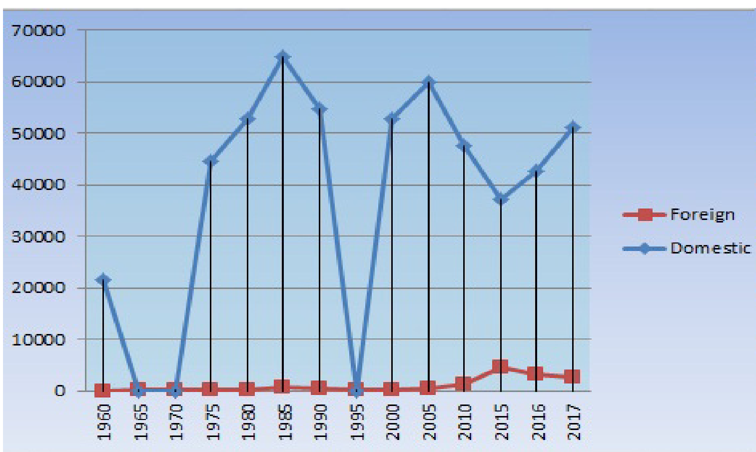
In the period 1955-1970, Sokobanja tourism had significant oscillations. Until 1959, the number of guests did not exceed 10,000. In the early 1960s, the number of guests grew from 14,009 to 34,146 (1970). At the beginning of the 1970s, the trend of growth continued, with 1970, 1971, 1972, and 1973 when the number of guests exceeded 30,000, In the next three years it was 40,000, and in 1977, 1978, and 1980, 50,000. The most successful year was 1979, with the record of 64,834 arrivals. Almost the entire turnover is made up of domestic guests, and the number of foreign guests is minor (Denda, 2015).

In the eighties, spa tourism in this area reached its peak. The high level of tourist visits was the result of the already formed positive image of Sokobanja, as well as favourable socioeconomic circumstances and an increase in the living

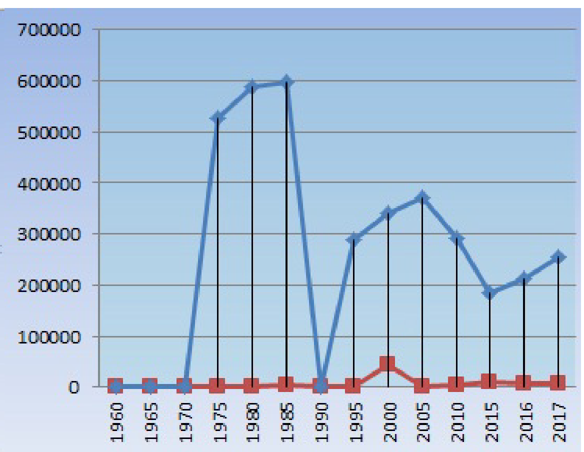
Table 2. – Tourist arrivals and overnights in Sokobanja in the period 1960-2017.

Year	Arrivals			Overnight stays		
	Domestic	Foreign	Total	Domestic	Foreign	Total
1955	5,732	-	5,732	81,219	-	81,219
1960	21,609	7	21,616	386,860	58	386,918
1965	19,460	192	19,652	241,000	469	241,469
1970	34,000	146	34,146	367,200	800	368,000
1975	44,642	189	44,831	527,116	937	528,053
1980	52,869	256	53,125	587,828	995	588,823
1985	64,848	893	65,741	597,111	4,161	601,272
1990	54,812	487	55,299	482,520	2,256	484,776
1995	40,340	143	40,483	289,016	418	289,434
2000	52,895	281	53,176	339,115	1,040	340,155
2005	59,911	630	60,541	369,581	1,852	371,433
2010	47,572	1,265	48,837	290,575	4,523	295,098
2015	37,154	4,522	41,676	184,022	10,874	194,896
2016	42725	3193	45918	212213	7011	219224
2017	51268	2647	53915	255150	6780	261930

Source – Data from the Statistical Office of the Republic of Serbia



Average number of tourists in Sokobanja, 1960-2017



The average number of overnight stays in Sokobanja, 1960-2017 standard of the population. The most important accommodation facilities in Sokobanja were built at that time. The best results were achieved in 1987 when the spa was visited by 96,771 guests (mostly in the period 1955-2016). The first negative tendencies were recorded at the beginning of the 1990s, with the peak in 1993, when only 28,837 guests stayed in the resort, which is 29.8% of the arrivals in 1987 (Denda, 2015). In the period 2000-2016, the situation changed, as a continuous decline in 2008 was recorded. During 2010 and 2012, the number of tourists was minimal (around 49,000). The rule is that there is a continuous decline in the number of domestic visitors, and the number of foreign visitors is growing slightly (2013 – 1,588, 2014 – 2,756, 2015 – 4,522, 2016 – 3,193, 2017 – 2,647).

As for the number of overnight stays, by 1961, the number of overnight stays steadily increased from 81,219 (1955) to 386,918 (1960). In the period 1964-1970, 200,000-300,000 nights were realized. During 1967, the largest number of overnight stays of foreign guests was recorded (1,317), which was only surpassed in 1979. At the beginning of the 1970s, an intensive trend of increase in the number of overnight stays continued, ranging around 400,000, and in 1975 it reached as many as 528,000. It is disturbing that the number of foreign overnight stays decreased and did not exceed the threshold of 1,000 overnight stays per year. An upward trend characterized the end of the 70's and the 80's. During 1986, a record number of overnight stays was recorded (818,556). Compared to 1985, it was an increase of about 220,000 overnights or 36.1% (Denda, 2014). In 1982, the largest number of foreign overnight stays were recorded (15,327). Since the 1990s, the total number of overnight stays steadily declined, reaching a minimum of 208,260 (1993). Nevertheless, the number of nights spent by foreign guests did not fall to such a pace; it even reached an increase in 1990. The historical minimum was recorded in 1994 (only 145 nights). Since 1995, we cannot speak about a significant number of overnight stays. In the period until 2010, the number of overnight stays did not exceed 400,000, except in 2007, when 409,000 overnight stays were recorded. Since 2010, the total number of overnight stays ranges between 200,000 and 300,000 per year (Denda, 2014). A positive indicator is the continuous increase in the number of foreign overnight stays until 2015 – 2010 (4,523), 2013 (5,327), 2014 (10,697), 2015 (10,874) . Over the next two years there is a decline in the number of foreign overnight stays –2016 (7,011), 2017 (6,780).

6. SWOT analysis of further tourism development in Sokobanja

SWOT or TOWS is an acronym for the initial letters of the English words: Strengths, Weakness, Opportunities, Threats. The purpose of this analysis is to help identify present and future opportunities, as well as surrounding threats (external factors), on the one hand, and strengths and weaknesses that can threaten the development of programs and projects (internal factors), on the other. The basic idea behind SWOT analysis is to enable such developmental behaviour in the tourism, which will ensure maximum use of strengths and opportunities, on the one hand, and minimize threats and weaknesses to such development, on the other (Stefanovic, 2010).

7. Conclusion

To position Sokobanja as highly ranked at the tourism market in the future, it is necessary to take some necessary measures and activities. More effort should be invested in improving infrastructure (quality of accommodation, traffic and communal infrastructure, etc.). Then, it is necessary to enrich the tourist offer of this spa with cultural contents, but also to work on the promotion of Sokobanja on the international market. To increase the number of visitors, especially foreign ones, it is necessary to invest in accommodation capacities, which means replacement of obsolete capacities with new ones. Construction of modern wellness and spa centres is also significant.

The complementary development of mountain and spa tourism in Serbia, which is well designed, synchronized, and planned in the long term, should be viewed in accordance with the functional division of the mountains, conditioned by the basic attractions and opportunities for certain types of tourist movements.

It is very important to emphasise the complementary development of mountain and spa tourism, as the two most important motivational factors for tourists. Considering that this spa is surrounded by mountains, the development of those forms of tourist turnover should be promoted, which are in line with the concept of sustainable tourism development (eco-tourism, rural tourism, sports and recreational tourism). The work on the awakening of ecological awareness among tourists has and will have a leading role in the future.

We should not neglect the economic effects of the future development of the spa. Local self-government activities have to be on a much higher level, which means that local self-government, and therefore the tourism industry, must invest much more in the construction of new infrastructure in Sokobanja.

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