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GEOECOLOGICAL EVALUATION OF LOCAL SURROUNDINGS FOR THE PURPOSES OF RECREATIONAL TOURISM

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Abstract: The paper presents geoecological evaluation of the city of Loznica for the purposes of sports and recreational tourism based on quantitative method of diversity, V-Wert Method. Using the GIS tool by the quantitative method, the criteria of natural components (relief, forest, water surface and climate) are evaluated for the analyzed area. In the proposed method, the climate factor was supplemented by the analysis of the bioclimatic index Universal Thermal Climate Index (UTCI). When the evaluation was completed, the final results were obtained based on which the degrees of convenience of different parts of the analyzed area have been presented. Out of the total analyzed surface, which amounts to 705 km^2, favorable surfaces comprise 21 km^2 (2.98%), and very favorable surfaces comprise 33 km^2, i.e. 4.68% of the territory. The largest area consists of conditionally favorable terrains — 333 km^2 (47.23%). Since one of the basic strategic priorities of the City of Loznica is improvement and development of sports and recreational tourism, the aim of this analysis is to emphasize the potential of the mentioned area in terms of general suitability of the terrain for the development of this type of tourism.

Keywords: geoecological evaluation, V-Wert Method, Universal Thermal Climatic Index, sports and recreational tourism, Loznica

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Introduction

In this study we try to present the extent to which natural components of an area are suitable for recreational types of tourism. One of the practical methods suitable for planning and management of space is its geoecological evaluation. Several papers were published with a topic of geoecological evaluation of city of Novi Sad, Kozara National Park, city of Belgrade using the same V-Wert method (Pecelj, Vagic, Pecelj, & Djuric, 2016; Pecelj, Lukić, Pecelj, Srnić, & Đurić, 2017; Popović, Doljak, Kuzmanović, & Pecelj, 2018).

This paper presents a geoecological evaluation of the City of Loznica territory, precisely for the purposes of sports and recreational tourism. Sports and recreation are an important part of a society. Picnics in nature, as well as passive and active recreation, may represent some of the ways to recover the spirit and the body from everyday rapid pace of life, especially in larger city centers. Natural tourist values that are the basis of recreational tourism attract a growing number of tourists–recreation seekers, and therefore many regions in Europe have recognized sports and recreational tourism as a direction for the future development of sustainable and ecofriendly type of tourism. One of the areas in Serbia that has been selected as the area with possibilities of development of the mentioned type of tourism is the area of the City of Loznica and its surroundings. So far, the development of tourism on the territory of the City of Loznica has been uneven. Most of tourist activities are concentrated in the zone of Banja Koviljača thermal health spa resort and Tršić, while the potentials provided by forest complexes of Mt. Cer, Banja Badanja thermal spa, Tekeriš and the coastline of the Drina River have been underused or poorly recognized. Loznica is located in the Jadar region in the northwestern part of Serbia, and it belongs to the Peripannonia and Podrinje region (Figure 1). From all the places in this region, the status of city centers is only given to Loznica and Banja Koviljača (Gajić & Vujadinović, 2010). The City of Loznica is positioned in Lozničko polje near the Drina River. Downstream from Zvornik, the Drina Valley extends considerably and transforms into a flatland stream in Lozničko polje. Lozničko polje is surrounded by low and medium-sized mountains which has a great impact on the formation of climate. The mountain Gučevo is located southeast from the city, mountains Iverak and Cer are positioned in the east and northeast, and the branches of Majevica are placed in the west and northwest. To the north, Lozničko polje opens following the direction of the Drina River, which contributes to the penetration of colder air masses from the north. The mentioned mountains that surround Loznica in the west descend along the faults with sulfur thermo-mineral water, where Banja Koviljača is located (Bilić, 1978). Banja Koviljača has already been affirmed as a medical and tourist

center. The subject of this paper is geoecological evaluation of the City of Loznica, with the aim of understanding the potentials and identifying the most favorable surfaces for the development and improvement of sports and recreational tourism.

Research Methodology

Geoecological evaluation of natural components of an area is widely accepted and there are several methods that help us perform it. In this study, geoecological evaluation was carried out by using V-Wert Method, the quantitative method of diversity, for the purposes of recreational tourism in the area of Loznica. Determining the favorable area for its possible usage in sports and recreational tourism was calculated based on a formula (1) (Kliemstedt, 1967):

$$V = \frac{W + 3G + R + N}{1000} K \quad (1),$$

where W is forest edges, G is water edges, R is relief energy, N is land use and K is climate factor. According to this model, for criteria of relief energy and way of land use, the values of weight factors are defined by means of which the final value of the mentioned evaluation criteria is determined (Table 1).

Table 1: Scale of relief values and Weight factors for each category of way of land use

Altitude difference (m)	Values of the relief
окт.20	220
20–30	300
30–60	400
60–100	590
100–250	860
250–500	1,200
Way of land use	Weight factors
Cultivated fields and gardens	6
Swamps	10
Meadows and pastures	15
Forests	19
Infertile and built land	21
River and waterland	50

Source: Hoffman, 1999.

In order to have the analysis completed, bioclimatic indices based on the exchange of human thermal energy with the environment were added to the climate factor. These are so called heat budget indices.

In the beginning of the research, a GRID cells network was formed with dimensions 1x1 km across the observed territory in order to determine the suitability for each such area (705 in total) in relation to each evaluation criterion presented by the given formula. After that several thematic maps were created on the basis of the data, and finally, the overlapping of the layers resulted in obtaining the synthetic map of the City of Loznica's benefits for sports and recreational tourism, which was the main goal of the paper. For the purposes of geo-ecological evaluation, research and cartographic presentation of results, GIS software based on ESRI technology ArcGIS 10.2 was used, and BioKlima 2.6 software was used to calculate bioclimatic indices.

Relief energy

The relief energy (R) represents the height difference between the highest and the lowest point in the corresponding square of the raster, expressed in meters. To determine this evaluation criterion, it was necessary to use the relief information obtained from a 1:25,000 topographic map made by the Military Geographical Institute in Belgrade. The digital height model (DEM) is shown on the relief map of Loznica (Figure 1). Each GRID cell is assigned a value that represents the difference between the highest and the lowest point of altitude. According to this difference, the relief values are assigned (Hoffmann, 1999) (Table 1). Geoecological evaluations are the most valuable through the relief analysis. Relief is one of the most important natural components that can be analyzed and evaluated, especially for sports and recreational tourism. Based on the geoecological evaluation of land use, the analysis of Mt. Ravna Planina (Republic of Srpska, Bosnia and Herzegovina) for the needs of winter tourism was performed (Golijanin, 2011).

Forest edges and water edges

Forest edges (W) are the bearers of contrast and change in the space that have an impact on the observer's senses and represent the typical elements of the cultural landscape. Forests and forest land occupy about 30% of Loznica and are a significant natural resource and development potential of the city. Forest areas of Boranja, Gučevo and Cer are particularly valuable. Water edges (G) increase the tourist value of the area, make it more attractive and, from a recreational aspect, more inviting because they are suitable for the development of a number of recreational and tourist activities. Water resources on the territory of the city are

diverse. Loznica is not only rich in surface waters, but also in underground and thermo-mineral waters, natural watercourses, and built reservoirs. The most important watercourse is the Drina River. Areas dominated by greenery and natural motives (areas along the Drina River and on the slopes of the mountains) are planned for open air activities. The improvement of sports and recreational activities in the coastal zone of the Drina River (hunting, fishing, cycling, sporting events, hiking activities) and the organization of sports and recreational tourism in forest complexes are some of the basic directions for the future development of tourism (Assembly of the City of Loznica, 2012). The roles of the forest and water edges in the geo-ecological evaluation of the landscapes are very similar, with the waters additionally enriching the area and, accordingly, the lengths of all water shores are valued by factor 3.

In order to obtain data on the lengths of the water and forest edges, a digital database on the status and changes of the land cover and land use throughout Europe CORINE Land Cover (EEA, 2012) was used. The database contains 44 categories of land use, and on the basis of available data for the city of Loznica, three types of forest are distinguished: deciduous, coniferous and mixed forests. The analysis also includes transient forest-bush ecosystems. Then, the lengths of forest and water edges were determined in meters for each individual GRID cell, for the entire surface of the analyzed area (Figure 2).

Land use

The next criterion, which is taken into consideration when carrying out a geo-ecological evaluation of the area by the methods mentioned, is the land use (N). This criterion is necessary in order to determine the possibilities of different regional elements for the purposes of sports and recreational tourism. In order to ascertain the values of this factor, it is necessary to calculate the proportion of different land use types in the appropriate square of the raster, which is then multiplied by the corresponding weight factor for this criterion (Table 1). By summing up the obtained partial values of each type of landscape use, the final value for every raster is obtained. In order to determine the land use, the data from the CORINE Land Cover (2012) were used (Figure 3).

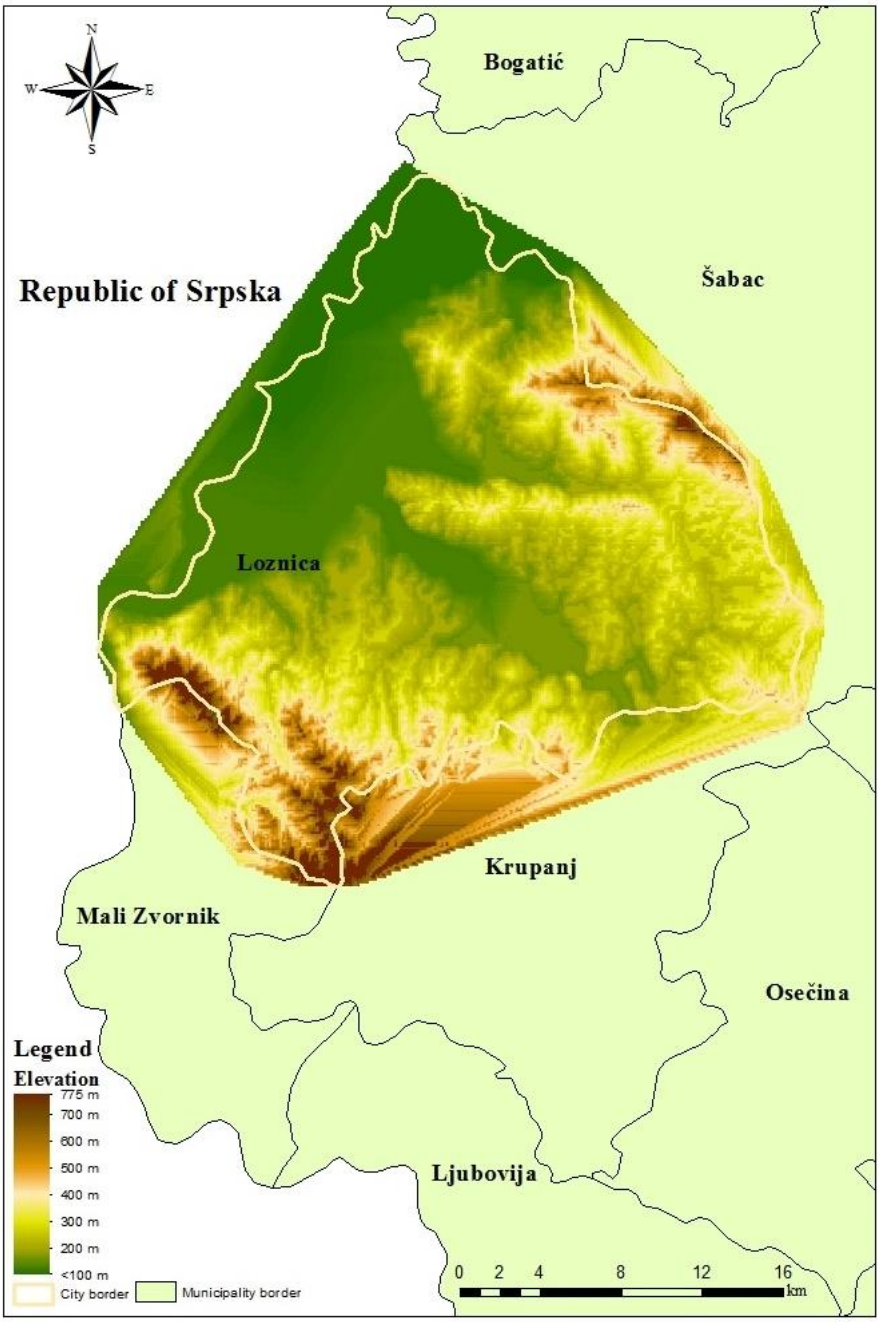

Figure 1. Relief of Loznica Municipality

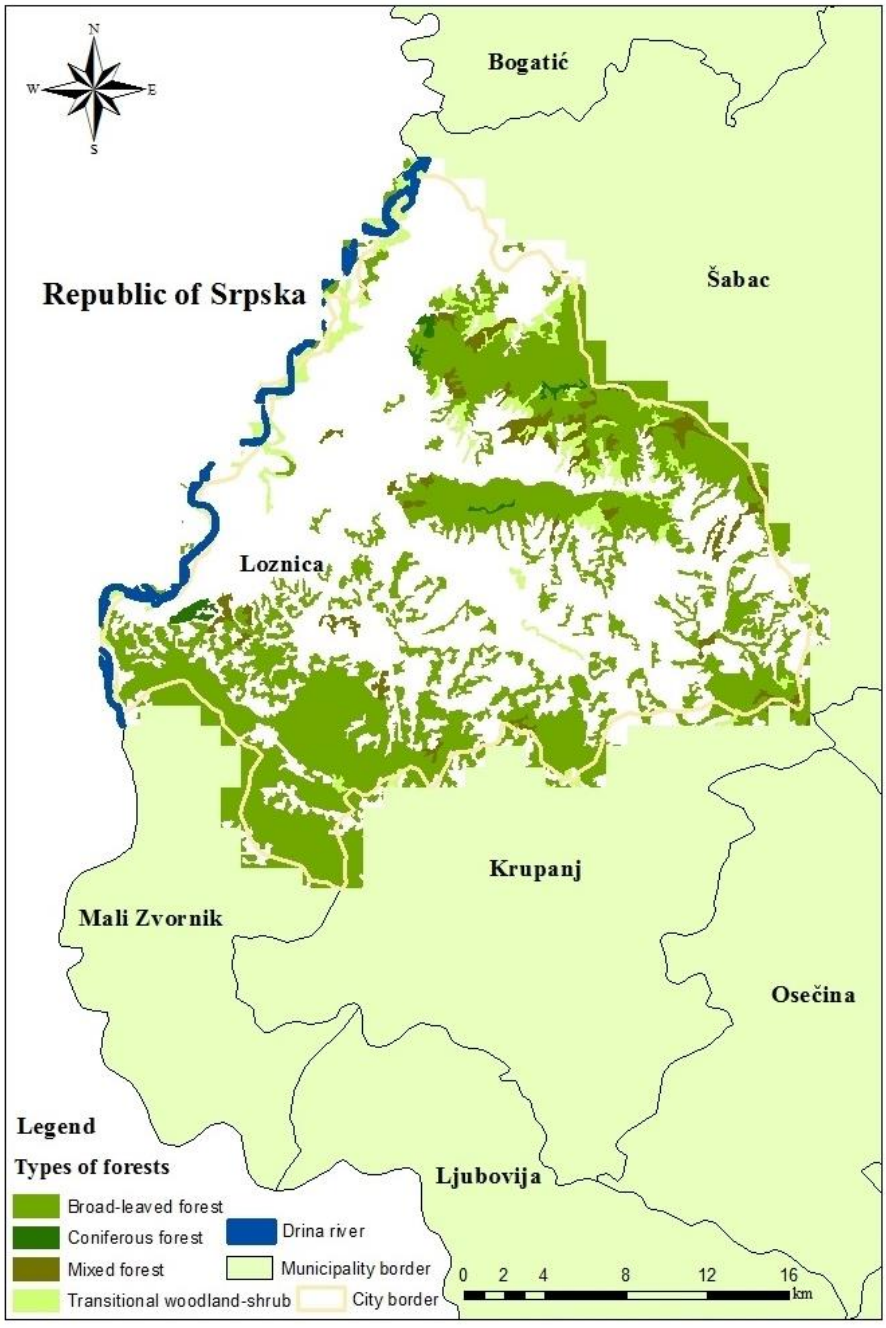

Figure 2. Map of forests and water edges in Loznica Municipality

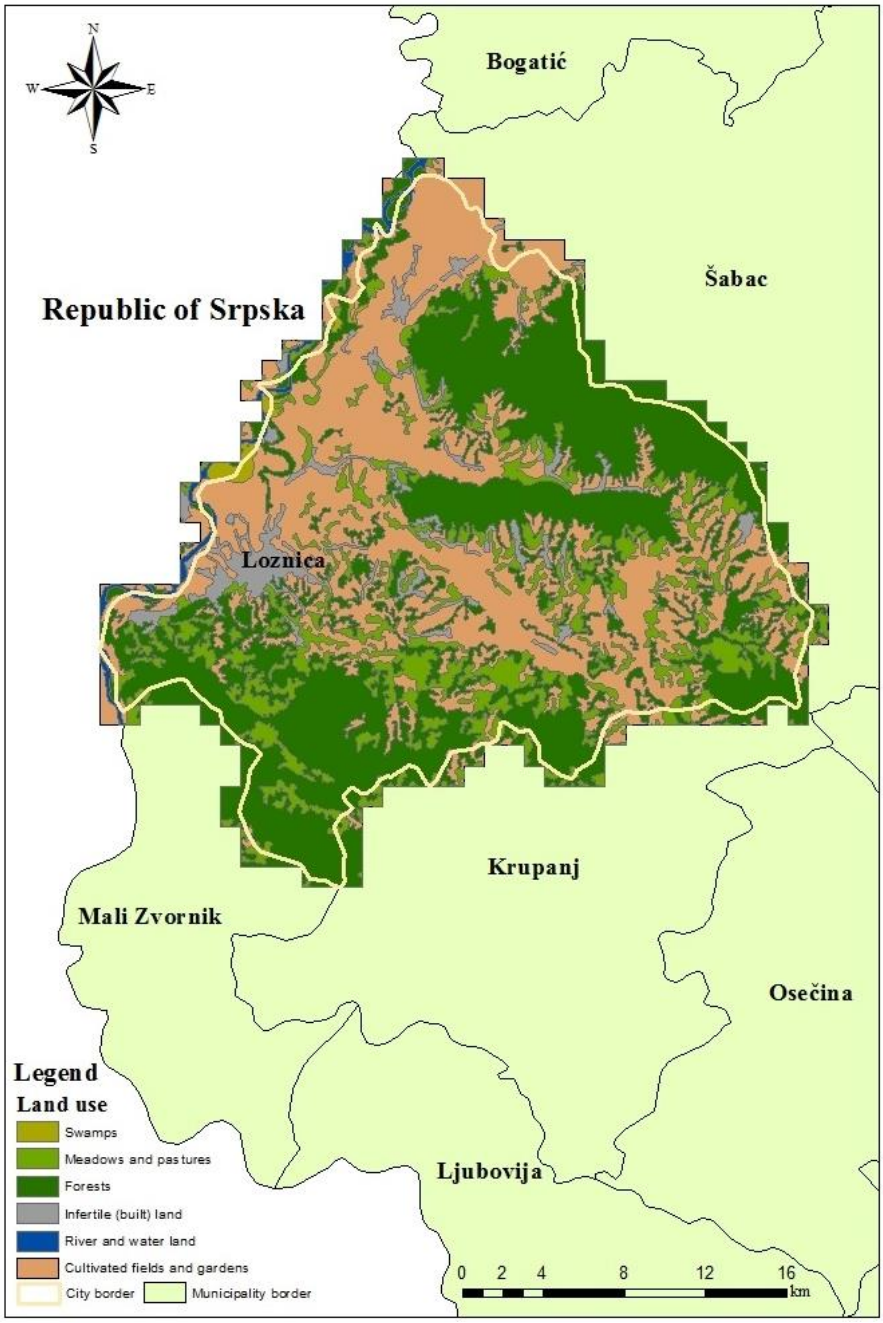

Figure 3. The land use in Loznica Municipality

Climate factor

In order to calculate the weight coefficient of climate factor K more precisely, bioclimatic analysis of Loznica was carried out based on bioclimatic index Universal Thermal Climate Index (UTCI). The idea is to add a bioclimatic analysis based on the average daily meteorological data to the original climate analysis based on the average annual temperature. The Universal Thermal Climate Index (UTCI °C) is defined as the air temperature of the reference environment that causes the same reaction of the model as the actual conditions do, i.e. UTCI is the air temperature that, in the conditions of the reference environment, would cause the same heat effort as the actual conditions. It is calculated on the basis of the predefined meteorological and thermo-physiological parameters. The scale of UTCI and the degree of comfort are provided in the Table 2. It is suitable for examining the external thermal comfort in the Central, Eastern and Southern Europe and has proved well in the temperate-climate area of the European continent (Błażejczyk, Epstein, Jendritzky, Staiger, & Tinz, 2012; Brode et al., 2013, Błażejczyk at al., 2013; Błażejczyk, Kuchcik, Błażejczyk, Milewski, & Szmyd, 2014).

Table 2. The scale of UTCI and the degree of comfort

UTCI (°C)	Stresscategory
> 46	Extreme heat stress
38–46	Very strong heat stress
32–38	Strong heat stress
26–32	Moderate heat stress
9–26	No thermal stress
9–0	Slight cold stress
–13	Moderate cold stress
–14	Strong cold stress
–13	Very strong cold stress
< –40	Extreme cold stress

Source: Blazejczyk et. al 2014

The index was calculated by using the Bioklima 2.6 software (https://www.igipz.pan.pl/Bioklima-zgik.html). The physiological data used for calculation are: metabolic rate, clothing insulation and velocity of the motion of the man. These parameters are estimated using empirical equations and they are considered as a constant value in the Bioklima Software (International Organization for Standardization, 2004, 1993). These are the metabolic rate (M = 135 Wm^{-2}), albedo of skin (ac = 30%), velocity of the motion of man (v' = 1.1

ms^{-1}) and clothing insulation (1clo). The input meteorological data used for this analysis are the mean daily values of air temperature t (°C), relative humidity f (%), wind speed V $ms^{-1}$and cloudiness N (%). All meteorological data were measured at the meteorological station Loznica (121 a.s.l.) and obtained from the Meteorological Yearbook for the period 2000–2016 (RHSS Serbia).

In the second half of the last century, a lot of indices appeared in the literature, with the aim of determining the more adequate thermal comfort or the limit of thermal stress. A detailed processing of climatological elements for Loznica was performed during the observation period 1952–1972. According to this analysis, a climate postcard was presented, where the May-October period was characterized as favorable for the tourist season (Bilić, 1978). It should be emphasized that the bioclimatic analysis for Banja Koviljača was performed based on the physiological equivalent temperature (PET) calculated for the 1961–2014 periods. The analysis shows a growing trend in the annual and seasonal values of PET. The increase in these trends is associated with an increase in air temperature and a decrease in relative air humidity (Stojićević, Basarin, & Lukić, 2016). The results of the bioclimatic index Heat Load in man (HL) calculated for July 2000–2010 shows that the high heat load was recorded in July 2006 and 2010 (Milovanović, Radovanović, Stanojević, Pecelj, & Nikolić, 2017). By comparing the index with a large number of simple indices as well as heat budget indices, it turned out that the UTCI index gives the most acceptable results in different geographic regions and zones (Błażejczyk, at al., 2012).

Results and Discussion

Preparation of synthesis map of favorability for sports and recreational tourism

By overlapping the maps and implementing the appropriate geospatial analyzes and questionnaires by using the formula given earlier in the paper, we examined the benefits of the monitored area for the purposes of sports and recreational tourism based on the diversity categories given in the Table 3.

Table 3. Categories of diversity by Hans Kiemstedt

Categories	Classes	Span
I	Unfavorable	V < 3.72
II	Conditionally favorable	3.72 < V < 7.44
III	Favorable	7.44 < V < 11.16
IV	Very favorable	V > 11.16

Source: KIiemstedt, 1967.

Taking the above into account, the geoecological evaluation was carried out in the area that was wider in comparison to the administrative boundaries of Loznica, so instead of 612 km^2, the estimated area amounted to 705 km^2, that is, the closer surroundings of the city was encompassed, a small part of which may be to the territory of the Republic of Srpska. The reason for this is that each raster unit (GRID cell) that contained even the smallest part of the territory of the city of Loznica was taken into consideration. After the evaluation, final results were obtained based on which the degrees of suitability of different parts of the analyzed space for the purposes of sports and recreational tourism were presented.

Degrees of suitability are classified into four categories: unfavorable areas of 318 km^2 (45.11%), conditionally favorable areas 333 km^2 (47.23%), favorable areas 21 km^2 (2.98%) and very favorable areas 33 km^2 (4.68%). The synthesis (Figure 4) clearly shows that conditionally favorable areas occupy most of the area and are predominantly concentrated in the south and south-eastern part of the city.

After that come unfavorable areas (north and northeast regions), and then very favorable and favorable areas positioned alongside the stream of the Drina River, and somewhat less in the area of forest complexes on mountain slopes. The border position of Loznica enables the development of additional, specific forms of tourist offer, and yet the tourist demand is low in comparison to real opportunities.

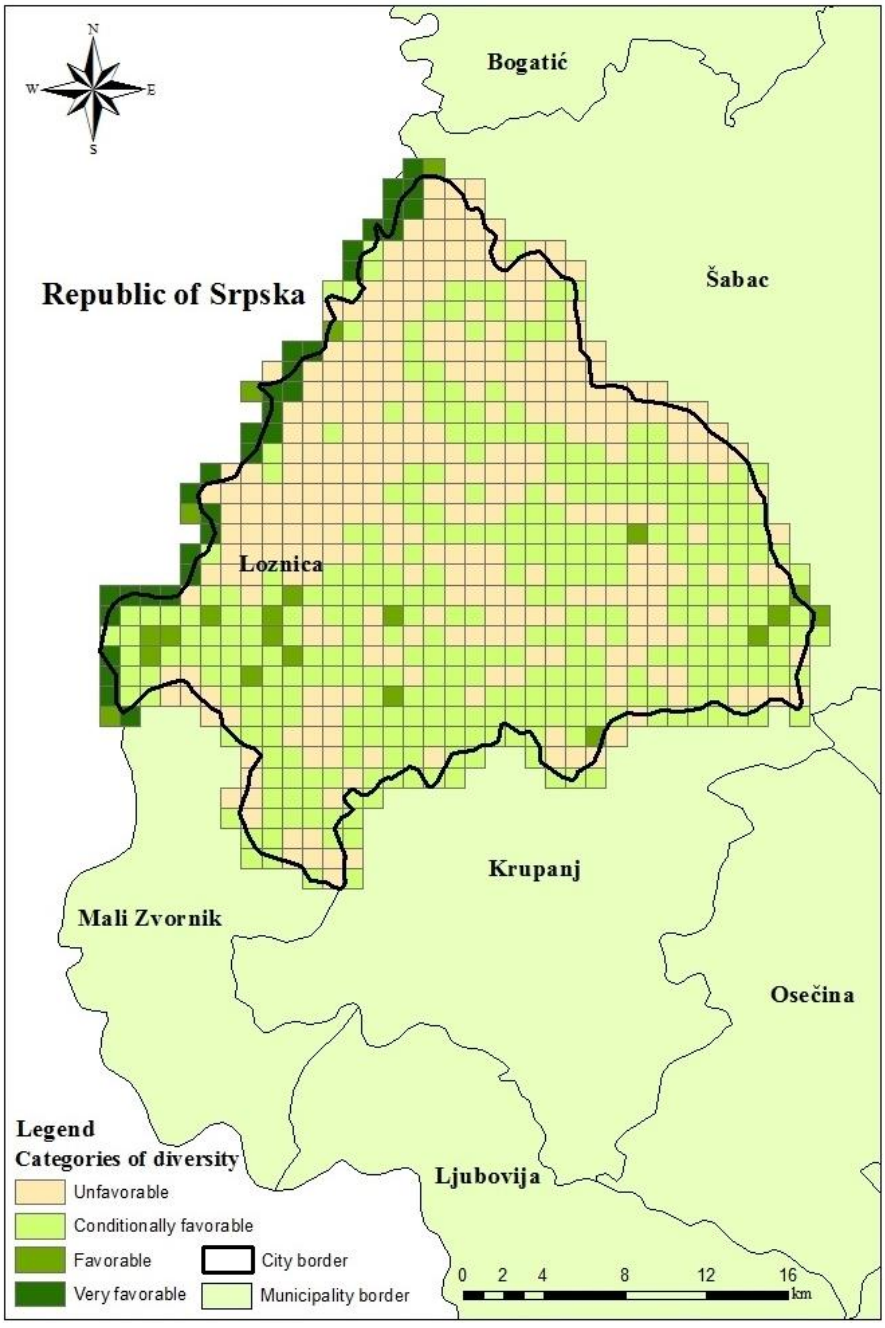

Figure 4. Suitability of Loznica Municipality for recreation

Bioclimatic conditions of Loznica

For the purposes of this work, July was chosen as a typical representative of the summer months, when the tourist season of Loznica is at its peak. July is generally the most unfavorable month of the year. By observing the UTCI index for July in the period from 2000 to 2016 (Table 4), it is easy to see that days with "moderate thermal stress" prevail, that is, the days when the UTCI index ranged between 26–32 °C, and that is followed by days with "strong thermal stress". The only case when UTCI has exceeded the limit value for "very strong thermal stress" is July 4, 2000, when the index value of 38.05 °C was recorded. Days without thermal stress are less frequent, as a result of an increase in the outside temperature in the warmer period of the year. During July 2002, 2012, 2013 and 2015, no favorable days were recorded according to the mentioned bioclimatic index. When planning and developing sports and recreational tourism, it is important to take into account the external thermal comfort described by the UTCI index, as well as the environmental stress caused by the environmental conditions.

Table 4. Values of UTCI index for the month of July (2000–2016)

year/day	1	2	3	4	5	6	7	8	9	10	
2000	29.9	30.8	35.2	38.1	33.4	31.5	33.9	33.1	17.2	28.6	
2001	26	25.7	26.4	29.2	30.4	30.4	34.4	32.4	29.4	26.9	
2002	30.3	32.6	35.9	27.3	28.2	31.7	26.5	32.1	33.4	34.7	
2003	33.3	29.1	29.9	30.1	28.3	26.3	24.9	24.4	24.4	27.6	
2004	30.7	28.2	28.7	28.6	32	34.9	31.1	34.7	37.4	30.8	
2005	31.3	25.1	25.2	27.9	29.7	25.6	29	30.8	29.1	28.3	
2006	26.2	28.4	24.2	26	27.7	29.3	31.5	25.9	32.4	31.6	
2007	29.7	30.2	32.6	25.2	24.6	28.7	30.8	33.4	32.9	21.3	
2008	30.8	32.2	32.2	30.3	25.4	30.3	33.2	30	29.2	28.3	
2009	30.5	31.7	30.8	27.2	29.5	30.8	28.9	23.8	26.2	27	
2020	30.2	24.7	30.6	30.3	28.1	25.2	24	25.3	27.4	26.7	
2011	24.4	25.4	27.1	30.6	29.2	28.8	30.8	34.9	32.4	36.7	
2012	35.3	35.9	35	35.4	34.4	29.6	34.5	33.8	34.7	34.3	
2013	26.2	28.3	29.9	30.4	28.8	30.4	29.4	29.7	28	32.5	
2014	26	30.6	22.8	26.5	32.3	33.1	34.4	32	29.1	26.8	
2015	29.9	31.7	30.9	31.3	31.9	34	34.4	36.4	29.9	27	
2016	34.3	35.4	28.9	28.8	30.2	30.5	27.6	29.7	31.3	31.6	
year/day	11	12	13	14	15	16	17	18	19	20	
2000	29.6	25.7	16.6	22.8	25.2	21	23.6	26.8	25.3	25.5	
2001	33.1	26.4	32.6	35.3	34.2	35	30	30.1	32.4	28.4	
2002	36.1	33	31.6	31.4	34.4	32.5	29.1	28.6	28.8	28.2	
2003	26.5	30.2	20.5	25.3	27.7	32.9	34.5	28.4	25.3	32.6	

Table 4. Values of UTCI index for the month of July (2000–2016)

year/day	1	2	3	4	5	6	7	8	9	10	
2004	28.4	27.1	25.3	22.7	25.1	30.4	31.9	32.4	34.4	35	
2005	25.5	23.5	28.1	27.7	28.1	29.8	33.2	35	28.6	29.5	
2006	29	30.5	30.3	28.2	26.3	26.2	27.4	26.6	28.7	32	
2007	26.2	24.9	27.2	28.2	31.9	33.7	34.7	36.3	35	35.3	
2008	31.6	34.5	35.3	29.7	24.2	23.3	28.9	28.3	30.6	33.1	
2009	26	22.6	29.9	33.3	34.3	34.6	34.7	29	25.8	26	
2020	33.2	31.7	34	35	35.5	35.9	35.8	31.5	29.1	32.5	
2011	32.1	33.2	32.9	35.9	33.6	31.6	33.3	33.4	33.7	29.9	
2012	34.9	31.6	33.7	35	29.8	26.7	26.4	27.3	32.3	31.9	
2013	28.7	29.6	30.2	29.6	23.8	20.9	30.5	31	32.2	32.8	
2014	20.3	27.5	28.7	29.6	31.1	26.7	27.9	30.5	30.9	31.5	
2015	29.3	30	29.8	30.8	33.5	34.9	36.5	36.2	36.7	35.4	
2016	32.6	35.2	36.1	30.7	23.7	14.6	22	28.1	29.5	30.8	
year/day	21	22	23	24	25	26	27	28	29	30	31
2000	22.4	26.1	31.5	33	31.7	34.4	31.5	31	25.2	28.6	22.2
2001	18.2	21.4	26.9	29.5	29.3	26.8	26.3	27.9	29.6	25.3	31.3
2002	30.2	27.1	28.6	31.7	25.9	27.8	27.1	27.1	30.7	32.7	30.8
2003	34.3	35.1	29.6	33.1	30.2	27.8	32.3	32.6	311	24.1	30.5
2004	35.3	34	35	30.9	28.8	30.4	24.9	22.1	24.6	28	29
2005	29	29.7	27.9	30	31.4	33.1	33.5	36	34	34.4	35.8
2006	34	32.3	34	31.6	29.3	31.7	31.6	32.8	32.9	28	32.1
2007	35.3	37.3	34.4	34.9	29.8	27.8	30.5	30	31.8	24.6	25.2
2008	23.8	22.7	21.6	24.8	29.3	29.8	31.4	32.1	30.9	29.9	32.3
2009	31.1	32.2	34	34.8	26.2	27.8	29	30.9	31.5	31.9	30.1
2020	34.5	35.4	34.5	30.2	16.4	24.2	28.9	28.7	28.7	29	26.3
2011	28.4	29.6	30.1	29.2	26.9	27.3	29.1	30.5	28.3	23.5	29.2
2012	28.1	28.2	29.4	29.5	32.1	28.5	32.4	34.5	31.7	32.1	32
2013	29.6	30.5	28.9	30.4	32.6	33.7	32.9	35.9	37.1	28.8	31.1
2014	31.8	30.6	28.7	31.5	30.5	31.7	29.8	29.5	30.7	31.8	29.5
2015	34.2	35.2	35.8	34.5	31.3	27.9	30.3	31.9	33.1	29.4	26
2016	31.6	33.7	35.4	35.7	31.6	32.2	33.8	32	33.2	33.4	33.7

< .26	No thermal stress	26–32	Moderate heat stress	32–38	Strong heat stress	38–46	Very strong heat stress

According to the data of the Republic Institute for Statistics (Statistical Office of the Republic of Serbia, 2016) in 2015, Loznica was visited by 2,411 tourists, out of which 2,086 were domestic and 325 foreign. The total number of overnight

stays is 3,946 (average number of overnight stays for domestic tourists is 1.6, and for foreign tourists 1.8). A general assessment of the situation can be characterized as unsatisfactory. In the following period, it would be good to pay more attention to the diversification of the tourist offer, the greater promotion of Loznica as a tourist destination at the national and regional level, the improvement and expansion of content, infrastructure and facilities for sports and recreational tourism. The warmer period of the year is the period when the number of tourists who visit Loznica reaches its maximum. Spring and fall are intended for recreational activities, cultural events, picnics in nature, educational camps, excursions of students and pupils, etc. Tourist movements and recreation are more frequent in the summer, during the holiday season. Wellness, spa and health-care tourism attract the largest number of tourists in summer months, when sports and recreational tourism is also present (hunting and fishing competitions, other sports competitions, mountaineering, cycling, hiking routes, Drina's regattas, bathing and river tourism on the Drina River etc.).

Conclusion

Analyzing the natural components of the Loznica city area, which covers 705 km^2, the areas evaluated as favorable are separated. The application of the quantitative method V-Wert classified the area of 33 km^2, or 4.68% of the total territory, as the most favorable for the purposes of sports and recreational tourism. Very favorable and favorable areas in the region of mountainous forest complexes and along the Drina River are also recognized within the Spatial Plan of the Municipality of Loznica from 2011, as zones for the development of tourism in nature, sports and recreation. Bioclimatic analysis showed that the spring-fall period is most favorable for sports and recreational tourism, with less bioclimatic benefits in July. Evaluation confirms that the analysis of natural components (relief, water surfaces, forest vegetation and climate) is important from the aspect of tourist improvement of this city, in particular sports-recreational forms of tourism. The results achieved by this geo-ecological evaluation can contribute to new affirmations in the areas of planning and evaluation of the landscape, the development of tourism and possibilities for further research in other disciplines: spatial and urban planning, ecology, forestry and architecture.

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