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APPLICATION OF THE MENEX MODEL IN BIOCLIMATIC ANALAYSIS OF NOVI SAD AND ENVIRONMENT FOR THE PURPOSES OF TOURISM AND RECREATION

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ABSTRACT

The subjects of research are Novi Sad, its immediate surroundings and the bioclimatic conditions prevailing in the given area. As Novi Sad is the administrative, cultural, educational, commercial, economic, health, social and historical center of Vojvodina it has a number of tourist potentials that are conducive to the development of various forms of tourism. The authors want to contribute with this paper to the affirmation of bioclimatic analysis and research using the Menex model in the field of geo-ecological evaluation of the urban landscape for the development and improvement of tourism and recreation as representative city functions. It is necessary to assess with what intensity and howbioclimatic conditions affect health or the psycho-physical state of a man in order to develop climatotherapy, recreation and certain forms of tourism. By applying the Menex model we can obtain an objective perception and data about real bioclimatic impact on the territory of Novi Sad and its surroundings. These can then be used for planning and management of urban areas and development of urban functions. During the research we used the daily meteorological data from 2015 by which thermo bioclimatic indices have been determined: Physiological Subjective Temperature (PST), Heat Load (HL) and Physiological Strain (PhS).

Key words: *bioclimatic analaysis, bioclimatic evaluation, tourism and recreation, Menex*

INTRODUCTION

Novi Sad is a city of international importance with the highest level of urbanization in the Republic of Serbia (besides Belgrade). It is the administrative center of Vojvodina and the South Backa district, but at the same time the center of economy, education, culture and history. The city is located on the Danube River, near the mountain and the National Park "Fruska gora" and formed by the merger of three independent settlements that eventually integrated, creating a continuous urban whole. We can say that it is a cosmopolitan city which considering the administrative area of the City of Novi Sad (together with Petrovaradin) has 341,625 inhabitants according to official data of the Census of 2011.

The significant cultural and historical heritage, rich architecture of the city with strong Austro-Hungarian characteristics and an abundance of natural resources (some of them are presented in Figure 1.) make Novi Sad very attractive to an increasing number of foreign and domestic tourists

[1,2]. The favorable geographical position, good transport links, the diversity of natural and anthropogenic tourist values have enabled the development of the rich tourist offer of Novi Sad, so it today represents one of the most important tourist centers of Vojvodina. The old urban core, numerous churches and monasteries, Sremski Karlovci as a historical village and the developed economyhave caused the development of the city break, cultural, educational, excursion and business tourism.

The Danubeas a current of international significance, with its town beach "Strand" is linked to the development of the spa, fishing, river and nautical tourism and the Iodine Spa that includes the hospital complex with a rehabilitation center is related to the health tourism. The NP "Fruska Gora", the SNR "Koviljsko-petrovaradinski rit" and the NR "Begecka Cave" as well as many ranches around the city (known as "salaši") are attractive locations aimed at the sustainable, eco, rural, excursion, scientific, hunting tourism and numerous daily and/or half-day recreational activities. The City of Novi Sad is also known for organizing numerous trade fairs, sporting events and music events of which the best known and the most visited in this part of Europe is "Exit".

Urban landscapes such as the city of Novi Sad and its surroundings represent complex spatial areas and a result of the interaction of men and the nature. The man has been increasingly changing the environment, adapting it to his own needs, whereby the natural landscapes have been over time transformed into cultural (urban and rural landscapes). Urban landscapes illustrate the evolution of the human society under the influence of the physical constraints of the natural environment, but also of social, economic and cultural conditions of the environment. Nowadays, landscapes are usually places whose habitus is an outcome of many biophysical and anthropogeographic combinations that give a specific physiognomy. Because of the complexity of its origin, the bioclimatic evaluation of landscapes is often a demanding and a complex processwhich includes a number of different indicators. Geoecological evaluation of urban and rural areas, as well as different bioclimatic analysis can be of great importancefor their future planning, development and protection, as well as for further development and improvement of tourism and recreation activities [3,4,5]. For this study a geoecological evaluation of Novi Sad and the surroundings was performed using the Menex model in order to obtain information that can be used for the improvement of tourist and recreational functions in the city.

Figure 1. Novi Sad (City centre) and National park „Fruska gora“
(monastery Grgeteg) Source: aut

METHODOLOGY OF THE RESEARCH

The climatology and the meteorology are sciences dealing with the study of meteorological elements and phenomena and therefore are in a large correlation with bioclimatic analysis. They provide the basic data used for bioclimatic researches. It is necessary to assess with what intensity and howbioclimatic conditions affect health or the psycho-physical state of a man in order to develop

climatotherapy, recreation and certain forms of tourism [6]. Since many physical and chemical reactions are carried out in the human body (the metabolism) while performing different activities, a body constantly produces and releases heat in order to establish the thermal balance in the body (Human Heat Balance) and adjust (adapt) to different weather conditions. The Menex model (Man-Environment-Exchange) provides the possibility of perceiving the real impact of weather on humans and is used to represent the heat exchange between a man and the environment [7,8].

The aim of this paper is a geoecological evaluation of Novi Sad and the surroundings using the bioclimatic model Menex and the thermo physiological bioclimatic index Physiological Subjective Temperature (PST) that describes a subjective feeling that occurs in a person duringan active stay outdoors, for a period of 15-20 minutes after the adaptation. In the course of the geoecological evaluation two dimensionless indices will be used too - the Physiological Strain (PhS) and the Heat Load (HL), in order to obtain a complete bioclimatic picture of the landscape.

The Physiological Subjective Temperature (PST °C) represents a subjective feeling of the thermal environment. The feeling of heat in humans occurs as a result of the activation of receptors for cold and hotthat mediated by the nervous system send signals to the brain which establishes an appropriate response to a stimulus in the form of the body thermoregulation. The thermal influence of the environment is expressed by the average temperature of the radiation on the skin surface. The Physiological Subjective Temperature is the level of a thermal stimulus arising directly near the surface of the skin after 15-20 minutes of an intensive process of adaptation [6,9].

The Heat Load (HL) is used to describe the load of the central regulatory systemthat occurs in the process of man`s adaptation to his environment. The thermal load is determined based on the three main heat fluxes: the total heat accumulation (S), the absorbed solar radiation (R) and the loss of heat by evaporation (E) [7]. The limit values for the level of comfort of two mentioned indices are presented in Table 1.

Table 1. Range of Physiologica Subjective Temperature, Heat Load and the level of comfort

Physiological subjective temperature PST (°C)		Heat Load (HL)		
< -36,0	Frozen	≤0,250	Very cold	-3
-36 – -16,1	Very cold	0,251 – 0,820	Cold	-2
-16,0 – 4,0	Cold	0,821 – 0,975	Chilly	-1
4,1 – 14,0	Chilly	0,976 – 1,025	Pleasant	0
14,1 – 24,0	Comfortably	1,026 – 1,180	Warm	1
24,1 – 34,0	Warm	1,181 – 1, 750	Hot	2
34,1 – 44,0	Hot	>1,751	Very hot	3
44,1 – 54,0	Very hot			
> 54,0	Sweating			

The Physiological Strain (PhS) is used to represent the intensity of the process of adaptation to a cold or hot environment. It depends on the relationship of the conventive flux and the flux of evaporation, and it is calculated using the formula listed below, where C is the heat transfer by convection, while E is the loss of heat by evaporation (E):

$$PhS = C/E$$

If the value of PhS is greater than 1.5, there is a cold physiological strain which is manifested through a reduction of the skin temperature, an increased blood pressure, a reduction of peripheral blood circulation, a tremor and an increased thermal insulation. On the other hand, if the value of PhS is less than 0.75, there is a warm physiological strainwhich is manifested through an increased peripheral blood circulation, an intense sweating, a dehydration, major changes in the skin temperature and a rapid heartbeat [10]. Range and the limit values for the level of comfort of Physiological Strain (PhS) are presented in Table 2.

Table 2. Range of Physiological Strain and the level of comfort [10]

Physiological Strain (PhS)		
<0,0	Extremely warm strain	Warm physiological strain
0,00- 0,24	Big warm strain	
0,2 – 0,74	Moderately warm strain	
0,75 – 1,50	Thermoneutral	Mild response of thermoregulatory system
1,51 – 4,00	Moderately cold strain	Cold physiological strain
4,01 – 8,00	Big cold strain	
>8,00	Extremely cold strain	

The physiological parameters have been used in the form of constant values: the 135 Wm-2 metabolism, which according to the international standard ISO 8996 corresponds to a 30-year-old man, who weighs 75 kg and is 175 cm tall and whose body surface is 1.8 m² or a 30-year-old woman with a body weight of 65 kg, a height of 170 cm and the skin surface of 1.6 m² who is moving at the speed of 4 km/h. This bioclimatic analysis is based on an average dressed man (standard business clothes), so we have chosen the value for the parameter of clothing isolationto be 1 clo (0.155 m-2KW-1) [9].

An adequate biogeoecological evaluation involves the use of daily climate data for the whole year: air temperature t (°C), relative humidity f (%), air pressure p (hPa), wind speed V (m/s) and cloudiness N (%). During the evaluation, we used the data obtained from the meteorological station "Rimski Sancevi" in 2015 (a city district that is located within the city of Novi Sad, at an altitude of 86 m) [11], which were processed and classified in the software BioClimate 2.6.

RESEARCH RESULTS

Tourist movements and recreational activities in the city of Novi Sad are most numerous in the warmer periods of the year, at the time of vacations and weekends, when the largest number of half-day, daily or weekend tourist tripstake their place. In terms of the number of tourists, the musical event "Exit"was the most important for the tourism of Novi Sadin July 2015 (which is the year of observation), visited by about 200 000 people.The winter period of the year, specifically the end of December and the beginning of January (time of New Year, Christmas and other religious holidays) is also a period when Novi Sad is the destination of many tourist trips, excursions and recreational visits. Spring and autumn are intended for recreational activities, sports events, excursions in nature, educational camps, student excursions and others.The rich tourist offer of the city enables Novi Sad to be attractive for visitors in almost every part of the year, regardless of weather conditions. But, the emphasis is on the summer period of the year because of the aforementioned number of tourists.

Three thermo-bioclimatic indices were determined in this paper: Physiological Subjective Temperature (PST), Heat Load (HL) and Physiological Strain (PhS). The analysis has been based on the daily meteorological data from 2015. The investigated parameters are presented as a summary in the Table 3. for each month of the year. In order to obtain a more detailed insight into the changes that occur on a daily basis,the daily values of observed bioclimatic indices are represented for May, July and October in the tables 4, 5 and 6. These months were chosen as the typical representatives of seasons (spring, summer and autumn). The daily values of bioclimatic indices in the winter months are fairly uniform, therefore, are not presented separately in the paper.

Analyzing the results obtained in the survey led to the following conclusions: considering the index Physiological Subjective Temperaturethe warmer part of the year is suitable for tourist and recreational activities. The human body is better adapted to warmer than colder ambient conditions. However, the initial feeling that a human has when in contactwith the environment is reversed and at the beginning a colder environment makes a more pleasant stay than a warmer (the index

Physiological Subjective Temperature (PST) clearly reflects this). But, the body is not able to keep that feeling for a longer period of timebecause of the inability to successfully adapt to such conditions. The most of days marked as "comfortable" according to the PST index came into being in May (12 days)and the least in the winter months January-March and December (not a single "comfortable" day). The summer is the most suitable among the seasonswith 20 days marked as "comfortable", followed by the spring with 17 and autumn with 6 comfortable days, which means that in the area of Novi Sad and its surroundings 43 "comfortable" days were recorded overall.

Table 3. Number of pleasant days in the month (PST, HL and PhS index, 2015)

Month	Number of pleasant days		No. days with a mild response
	PST	HL	PhS
January	/	31	/
February	/	28	/
March	/	31	/
April	2	24	2
May	12	14	14
June	6	10	20
July	6	2	13
August	6	/	12
September	7	15	8
October	4	27	1
November	/	30	/
December	/	31	/
In total	43	243	70

On the basis of the values of the results obtained for the bioclimatic indexHeat Load (HL) it can be noted that the number of "pleasant" days decreases when ambient temperature rises, so in the periods January-March and November-December all days had the label "pleasant", while a smaller number of pleasant days was recorded in the warmer part of the year. The minimum of "pleasant" days was recorded in August (no), followed by July with 2, June with 10 pleasant days, etc. As indicated in the text above, the HL index is used to describe the loadsuffered by the central thermoregulatory system during the adaptation to the currently environmental conditions. In the warmer part of the year, the thermoregulatory system definitely suffers far greater load than in the winter period. In the winter months the index HL value never fell below the threshold of 0,976 for "pleasant", while it exceeded several times the limit value of > 1, 751 for "very hot" in the hot summer months during July and August (July had 4, August 7 very hot days). Thus, in 2015, 243 "pleasant" days were recorded in total in the city of Novi Sad according to the index Heat Load.

The last bioclimatic index analyzed on this occasion is the Physiological Strain (PhS). This index is very significant because it indicates the intensity of the process of adaptation of a man to a cold or hot environment. At the same time it also shows physiological reactions of the organism to stimuli and weather conditions of the environment. Thanks to the index PhSone can get an insight into how the human body (the organism) reacts when it finds itself in a warmer or cooler environment: whether it reflects more intensive or weaker tremors in colder conditions, a rapid heartbeat, an increase or decrease in the blood pressure, sweating and/or dehydration of the organism influenced by a stay in a very hot environment, what changes occur in relation to the body and skin temperature and others.

As the subject of the paper is the bioclimatic analysis for tourism and recreation purposes, the focus is on those days when "a mild response of the thermoregulatory system" was recorded, i.e. when environmental conditions do not cause violent reactions of the human organism during adaptation. The lowest number of days when the index PhS was suitable for tourism and recreational activities occurred in the colder, winter period (January-March and November-December – not a single day). This is the result of the fact that the human body adapts better to conditions of a warmer environment and easier to a higher than toa lower temperature. The human body is simply not able to adapt to the

long-term unfavorable conditions prevailing in areas with low temperatures. According to the PhS index June is the most favorable month with 20 days in which a body gives "a mild response of the thermoregulatory system", followed by May - 14 and July with 13 such days. Hence, the most appropriate time of the year is the summer with 36 days, then the spring 31 and the autumn with 3 days with "a mild response of the thermoregulatory system". The total number of days in 2015, which according to this index are estimated as favorable for tourism and recreational purposes was 70.

Table 4. Indexes PST, HL and PhS (Novi Sad, May 2015)

Day	Physiological subjective temperature PST		Heat Load (HL)		Physiological strain (PhS)	
1	12.88	Chilly	1.01	Pleasant	1.60	Cold physiological strain
2	9.88	Chilly	1.00	Pleasant	2.05	Cold physiological strain
3	12.71	Chilly	1.00	Pleasant	1.74	Cold physiological strain
4	24.72	Warm	1.09	Warm	1.14	Mild response
5	26.17	Warm	1.27	Hot	1.06	Mild response
6	32.85	Warm	1.38	Hot	0.77	Mild response
7	14.42	Comfortably	1.19	Hot	1.55	Cold physiological strain
8	17.83	Comfortably	1.14	Warm	1.28	Mild response
9	16.79	Comfortably	1.22	Hot	1.31	Mild response
10	12.04	Chilly	1.21	Hot	1.73	Cold physiological strain
11	8.17	Chilly	1.00	Pleasant	2.00	Cold physiological strain
12	14.86	Comfortably	1.01	Pleasant	1.57	Cold physiological strain
13	26.51	Warm	1.23	Hot	1.01	Mild response
14	18.12	Comfortably	1.07	Warm	1.45	Mild response
15	10.51	Chilly	1.00	Pleasant	1.95	Cold physiological strain
16	18.17	Comfortably	1.02	Pleasant	1.43	Mild response
17	16.92	Comfortably	1.04	Warm	1.47	Mild response
18	20.61	Comfortably	1.15	Warm	1.20	Mild response
19	23.20	Comfortably	1.28	Hot	1.11	Mild response
20	28.92	Warm	1.38	Hot	0.97	Mild response
21	11.61	Chilly	1.00	Pleasant	1.95	Cold physiological strain
22	16.41	Comfortably	1.03	Warm	1.76	Cold physiological strain
23	18.60	Comfortably	1.04	Warm	1.51	Cold physiological strain
24	11.25	Chilly	1.00	Pleasant	2.07	Cold physiological strain
25	9.68	Chilly	1.00	Pleasant	2.13	Cold physiological strain
26	10.12	Chilly	1.00	Pleasant	2.12	Cold physiological strain
27	4.37	Chilly	1.00	Pleasant	2.63	Cold physiological strain
28	7.50	Chilly	1.00	Pleasant	2.16	Cold physiological strain
29	10.77	Chilly	1.00	Pleasant	1.83	Cold physiological strain
30	18.91	Comfortably	1.07	Warm	1.39	Mild response
31	26.14	Warm	1.13	Warm	1.04	Mild response

Table 5. Indexes PST, HL and PhS (Novi Sad, July 2015)

Day	Physiological subjective temperature PST		Heat Load (HL)		Physiological strain (PhS)	
1	30.71	Warm	1.33	Hot	0.83	Mild response
2	32.88	Warm	1.40	Hot	0.77	Mild response
3	28.85	Warm	1.43	Hot	0.87	Mild response
4	31.05	Warm	1.31	Hot	0.84	Mild response
5	33.98	Warm	1.58	Hot	0.69	Warm physiological strain
6	39.63	Hot	1.66	Hot	0.33	Warm physiological strain
7	36.31	Hot	1.72	Hot	0.43	Warm physiological strain
8	35.79	Hot	1.72	Hot	0.44	Warm physiological strain
9	17.56	Comfortably	1.02	Pleasant	1.54	Cold physiological strain
10	15.30	Comfortably	1.11	Warm	1.47	Mild response
11	24.80	Warm	1.25	Hot	1.03	Mild response
12	34.93	Warm	1.51	Hot	0.66	Warm physiological strain
13	24.05	Comfortably	1.14	Warm	1.19	Mild response
14	27.44	Toplo	1.30	Hot	1.02	Mild response
15	36.13	Hot	1.50	Hot	0.59	Warm physiological strain
16	36.63	Hot	1.55	Hot	0.52	Warm physiological strain
17	36.16	Hot	1.83	Very hot	0.37	Warm physiological strain
18	38.71	Hot	1.66	Hot	0.28	Warm physiological strain

19	37.53	Hot	1.54	Hot	0.37	Warm physiological strain
20	35.98	Hot	1.75	Hot	0.41	Warm physiological strain
21	38.39	Hot	1.71	Hot	0.33	Warm physiological strain
22	36.99	Hot	1.86	Very hot	0.31	Warm physiological strain
23	36.21	Hot	2.11	Very hot	0.32	Warm physiological strain
24	35.47	Hot	1.72	Hot	0.47	Warm physiological strain
25	36.01	Hot	2.10	Very hot	0.31	Warm physiological strain
26	23.61	Comfortably	1.29	Hot	1.11	Mild response
27	23.36	Comfortably	1.11	Warm	1.23	Mild response
28	27.41	Warm	1.27	Hot	0.99	Mild response
29	35.46	Hot	1.41	Hot	0.69	Warm physiological strain
30	25.69	Warm	1.20	Hot	1.10	Mild response
31	15.44	Comfortably	1.02	Pleasant	1.66	Mild response

Table 6. Indexes PST, HL and PhS (Novi Sad, October 2015)

Day	Physiological subjective temperature PST		Heat Load (HL)		Physiological strain (PhS)	
1	11.50	Chilly	1.02	Pleasant	1.91	Cold physiological strain
2	7.70	Chilly	1.00	Pleasant	2.15	Cold physiological strain
3	14.90	Comfortably	1.03	Warm	1.72	Cold physiological stress
4	18.95	Comfortably	1.03	Warm	1.45	Mild response
5	18.26	Comfortably	1.05	Warm	1.54	Cold physiological strain
6	12.54	Chilly	1.02	Pleasant	1.85	Cold physiological strain
7	16.42	Comfortably	1.05	Warm	1.64	Cold physiological strain
8	0.60	Hladno	0.99	Pleasant	3.41	Cold physiological strain
9	8.08	Chilly	1.00	Pleasant	2.16	Cold physiological strain
10	2.84	Cold	0.99	Pleasant	3.03	Cold physiological strain
11	5.75	Chilly	1.00	Pleasant	2.50	Cold physiological strain
12	0.58	Cold	1.00	Pleasant	2.94	Cold physiological strain
13	3.91	Cold	1.00	Pleasant	2.60	Cold physiological strain
14	1.85	Cold	0.99	Pleasant	3.14	Cold physiological strain
15	5.37	Chilly	0.99	Pleasant	2.70	Cold physiological strain
16	3.74	Cold	0.99	Pleasant	3.07	Cold physiological strain
17	8.23	Chilly	1.00	Pleasant	2.18	Cold physiological strain
18	10.89	Chilly	1.02	Pleasant	1.99	Cold physiological strain
19	7.43	Chilly	1.00	Pleasant	2.28	Cold physiological strain
20	0.52	Cold	0.99	Pleasant	3.08	Cold physiological strain
21	1.89	Cold	1.00	Pleasant	2.72	Cold physiological strain
22	2.47	Cold	1.00	Pleasant	2.63	Cold physiological strain
23	2.72	Cold	1.00	Pleasant	2.63	Cold physiological strain
24	5.40	Chilly	1.00	Pleasant	2.36	Cold physiological strain
25	3.52	Cold	1.00	Pleasant	2.54	Cold physiological strain
26	6.63	Chilly	1.01	Pleasant	2.27	Cold physiological strain
27	3.13	Cold	1.00	Pleasant	2.60	Cold physiological strain
28	0.97	Cold	0.99	Pleasant	2.97	Cold physiological strain
29	1.08	Cold	0.99	Pleasant	2.95	Cold physiological strain
30	1.52	Cold	1.00	Pleasant	2.73	Cold physiological strain
31	-2.29	Cold	0.99	Pleasant	3.41	Cold physiological strain

CONCLUSION

The urban landscape of Novi Sad is a complex combination of natural and cultural segments which favors the development of tourism and recreational activities. The tourism as an economic activity has been generating increasing economic benefits thanks to its expressed diversificationand has great significance for the city of Novi Sad as a supplementary and/or principal source of income of the population and as a support for the local and regional economy. A sustainable tourism development is possible only if there is an adequate planning taking into account the specificities of the landscape. Abioclimatic evaluation is an integral part of the landscape planning and it can provide the needed inputused in various studies in the field of agriculture, forestry, industry, transport, tourism and others.

The aim of this study was to verify the role of the Menex model application within the bioclimatic analysis for tourism and recreation purposes. The paper has territorially covered the area of Novi Sad

and the surroundings and the time-scope is based on 2015. We have analyzed three bioclimatic indices: Physiological Subjective Temperature (PST), Heat Load (HL) and Physiological Strain (PhS) and the values of each one are presented on a monthly basis for the entire year, as well as the daily values for the month of May, July and October. The analysis of the results has showed that the spring and summer (warmer) part of the year, which are also the most appealing for tourists, aregenerally favorable to carry out tourism and recreational activities considering PST and PhS index. The possibility of adaptation of the human organism to environmental conditions is less in the cooler than in the warmer part of the year. The ability of the organism to adjust for a longer period of time to the colder environment is very limited. This is why the warmer period of the year with favorable bioclimatic conditionsshould be elected when planning and organizing tourist and recreational activities related to the external environment. HL index values gave the slightly different results. This index evaluated as favorable the winter/colder part of the year when the value of the heat load was moving in a range from 0.976 to 1.025 which is marked as "pleasant", while the days in the warmer periods of the year generally rated as "warm" or "hot"and in some cases the HL index exceeded the limit value for the assessment of "very hot". The research results can contribute to a better time positioning of various sports, recreational and tourist activities, entertainment and cultural manifestations and events which requiring a certain physical effort.

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LITERATURE

[1] Просторни план Града Новог Сада . Сл. лист Града Новог Сад“, бр. 11/2012.

[2] Упоредни преглед броја становника 1948, 1953, 1961, 1971, 1981, 1991, 2002, 2011. Београд: Републички завод за статистику, књига бр. 20, 2016.

[3] Pecelj, J., Pecelj, M., Pecelj, M. (2011). Mogućnost primene geoekologije u prostornom planiranju. Planska i normativna zaštita prostora i životne sredine. Beograd: Asocijacija prostornih planera Srbije, Univerzitet u Beogradu - Geografski fakultet, str. 401-406.

[4] Pecelj, M., Vagić, N., Pecelj, M., Đurić, D. (2016). Geoekological evaluation of Belgrade and environment for the purposes of rest and recreation. Archives for Tehnical Sciences, year VIII, No. 14. Bijeljina: Tehnical Institute Bijeljina, page 63 – 72.

[5] Pecelj, M., Pecelj R.M., Mandić, D., Pecelj, J., Milinčić, M., Tošić, D. (2010). Informational Technology in Bioclimate Analysis of Banja Luka for Tourism and Recreation, in the book of 9th WSEAS International Conference on Telecomunication and Informatics, Included in ISI/SCI Web of Science and Web of Knowledge, ISBN: 978-954-9260-2-1, ISSN: 1790-5117, University of Catania, Sicily, Italy, pp. 35-39.

[6] Blażejczyk, K. (1994). New climatological and physiological model of the Human Heat Balance outdoor (MENEX) and its applications in bioclimatological studies in different scales. In Blażejczyk K, Krawczyk B, editors. Bioclimatic Research of the Human Heat Balance. Warszawa: PolishAcademy of Sciences Institute of Geography and Spatial Organization; 28: page 27-58.

[7] Пецељ, М., Пецељ – Пурковић Ј., Пецељ, М. (2015). Геоекологија. Београд: Универзитет у Београду, Географски факултет, стр. 5 – 295.

[8] Błażejczyk, K. (2006). MENEX_2005-the Revised Version of Man-Environment HeatExchange Mode. www.igipz.pan.pl/geoekoklimat/blaz/menex.htm.

[9] Pecelj, M., Vagić, N., Pecelj, M., Pecelj, J., Đurić, D. (2016). Primena bioklimatskog modela MENEKS_05 u vrednovanju Beograda i okoline za potrebe odmora i rekreacije. Lokalna samouprava u planiranju i uređenju prostora i naselja – U susret evropskim integracijama. Beograd: Asocijacija prostornih planera Srbije, Univerzitet u Beogradu – Geografski fakultet, str. 389 – 396.

[10] Blażejczyk, K. (1999). Influence of solar radiation on skin temperature in standing and walking subjects outdoors. J.A. Hodgdon, J.H. Heaney, M.J. Buono (ed.), Enviromental Ergonomics VIII, International Series on Enviromental Ergonomics, vol. 1, Selected papers from 8th Int. Conf. of Enviromental Ergonomics, San Diego, California, USA, 18-23 Oct.

[11] Метеоролошки годишњак 1. Климатолошки подаци 2015. Београд. Републички хидроме–теоролошки завод, 2016.