

## **Informational Technology in Bioclimate analysis of Banja Luka for tourism recreation**

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*Abstract:* Some types of tourism strongly depend of weather conditions. The aim of the paper is to present how weather variables come together in order to give a climate meaning for tourism. The study has a goal to present a bioclimate analysis of Banja Luka to explore climate-recreation relationship evaluating actual weather conditions. The analysis is based on the human heat balance through the bioclimate model man-environment heat exchange. The final results show biothermal weather classification for recreation based on the outdoor human heat balance. In this analysis, daily meteorological data were used for two extreme months, January and July 1990 (meteorological station of Banja Luka). We use software with related database created by authors. The idea is to show how weather can be evaluated for recreational needs in the health resorts of Banja Luka surroundings within development of health tourism and spa therapy in Bosnia and Herzegovina.

*Key Words:* Bioclimatology, Informational Technology, Biothermal weather classification,

### **1. Introduction**

Untouched nature, unpolluted air, traditional hospitality, with the beneficial healing water, spas in Bosnia and Herzegovina obtained the epithet of old medical and recreational centers, suitable for holiday. Due to the specific high vegetation, rich forests, and microclimatic benefits, the majority of

mountains in Bosnia and Herzegovina are a kind of air spa resorts. Bosnia and Herzegovina has several spa and health centers based on the thermal or mineral springs, with different development and different tourism affirmation. The most interesting among them, for this paper, are Laktaši, Slatina, Kulaši and Vrućica close to Banja Luka (Fig1). Banja Luka is the second largest town of Bosnia

and Herzegovina and the largest town in the Republic of Srpska entity. It is located on the northwest of country as the center of Donjovrbasko-donjobosanski region. The town lies on the Vrbas river, altitude 153 m, in the southern part of the Banja Luka basin and it is surrounded by hills. The tributary rivers of the Vrbas river, Suturlija, Crkvena, and Vrbanja, flow into the Vrbas at Banja Luka. The city itself is built in the Banja Luka valley, which is located at the transition between high and low mountain areas. The most notable of these mountains are Manjača (1214m), Čemernica (1338m), and Tisovac. These are all part of the Dinaric Alps mountain range. Banja Luka has a continental climate, with harsh winters and warm summers. The warmest month of the year is July, with an average temperature of 21.3 °C. The coldest month of the year is January, when temperature average near freezing at 0.8 °C. Annual precipitation for Banja Luka is about 988 mm. Banja Luka has an average of 143 rainy days a year. [4]

resource for many types of tourism, represented by meteorological data, climate can be measured and evaluated. [3]

Bioclimate evaluation starts from idea that some of climate variables are physical such as rain, wind, snow, pollution, UV, physiological such as temperature, atmospheric pressure and some of them are psychological such as blue sky, visibility, day length etc. They are presented as various facets of tourism climate: thermal, physical and aesthetic. Bioclimate evaluation means actual weather condition impact on the human body through the heat fluxes of man and environment heat exchange (convection, evaporation, respiration, conduction) and physiological parameters (metabolism, skin temperature, peripheral blood flow). It is represented by outdoor human heat balance. For this purpose, the man and environment heat exchange model was used (Blazejczyk 2001). (The calculations of the human heat balance were made using BioKlima 2.5 software)

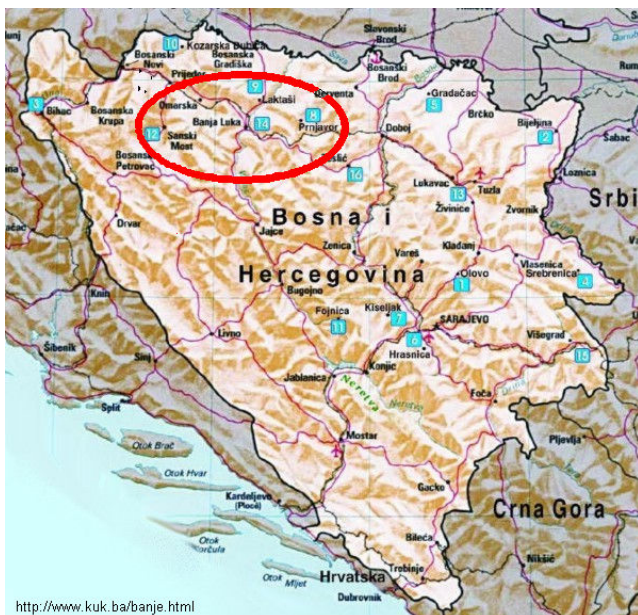


Fig 1. Geographic position of health resorts in Bosnia and Herzegovina and geographic position of the Banja Luka

### 3. Biothermal weather classification

Bioclimate weather classification is based on thermal, physical and aesthetic facets and includes seven digits represent actual biothermal weather characteristics (Table 1). First four digits are based on thermal components and represent both weather type and weather subtypes. First digit is weather type and describes thermal sensation presented by Heat load (HL). Next three digits are weather subtype and describe solar radiation absorbed by a nude man, physiological strain of an organism and sultriness. Those are presented as Radiation stimuli (R'), Physiological strain (PS) and Sultriness intensity (SI). Other three digits are based on physical components such as Daily amplitude of air temperature (dt), Daily totals of precipitation (RR), and Snow cover (SC).

## 2. Weather as natural resource

Weather is an important factor for recreation within the study of climatology and tourism. According to Freitas, it is a natural resource of the place for recreation together with geographical location, landscape, flora and fauna, etc. As a natural

Table1. Biothermal weather types, subtypes and classes

	weather component						
	type	subtype			class		
elements	HL	R'	PS	SI	dt	RR	SC
indicator	1	2	3	4	6	5	7
codes	2						
	-1	1	H	0	0	0	0
	0	2	T	1	1	1	1
	1	3	C	2			
	2						

We made Data Base Management system with related database which is consisted by all variables presented in this paper [6].

### 3. Weather classification results

Tables 2 and 3 present a “day by day” digital description of weather condition in Banja Luka. Meteorological data for two extreme months, January and July (1990) were analyzed.

Biothermal conditions in January (Table 2) show that almost every day thermoneutral weather condition was registered. Only in the first part of month three days with moderate cold stress weather type and great cold stress weather type were registered. Radiation stimuli type was recognized as weak and thermal condition of the ambient air recognized as cold physiological strain. There is no sultry in January. The stimulative amplitudes of the air temperature were observed in the second part of month while snow was observed in the first part of month. There where four days with rain and snow. [2]

Table 2 Weather conditions in Banja Luka January 1990

day	HL	R'	PS	SI	dt	RR	SC	weather
1	-2	1	C	0	0	0	0	-2_1C0_000
2	-1	1	C	0	0	0	0	-1_1C0_000
3	-1	1	C	0	0	0	0	-1_1C0_000
4	0	1	C	0	0	0	0	0_1C0_000
5	0	1	C	0	0	0	0	0_1C0_000
6	0	1	C	0	0	0	0	0_1C0_000
7	0	1	C	0	1	1	1	0_1C0_011
8	0	1	C	0	0	1	1	0_1C0_011
9	0	1	C	0	0	0	0	0_1C0_000
10	0	1	C	0	0	0	0	0_1C0_000
11	0	1	C	0	0	0	1	0_1C0_001
12	0	1	C	0	0	0	1	0_1C0_001
13	-1	1	C	0	0	0	0	-1_1C0_000
14	0	1	C	0	0	0	0	0_1C0_000
15	0	1	C	0	0	0	0	0_1C0_000
16	0	1	C	0	1	0	0	0_1C0_100
17	0	1	C	0	1	0	0	0_1C0_100
18	0	1	C	0	1	1	0	0_1C0_110
19	0	1	C	0	1	0	0	0_1C0_100
20	0	1	C	0	1	0	0	0_1C0_100
21	0	1	C	0	1	0	0	0_1C0_100
22	0	1	C	0	1	0	0	0_1C0_100
23	0	1	C	0	1	0	0	0_1C0_100
24	0	1	C	0	1	0	0	0_1C0_100
25	0	1	C	0	1	0	0	0_1C0_100
26	0	1	C	0	1	1	0	0_1C0_110
27	0	1	C	0	1	0	0	0_1C0_100
28	0	1	C	0	1	0	0	0_1C0_100
29	0	1	C	0	1	0	0	0_1C0_100
30	0	1	C	0	1	0	0	0_1C0_100

31	0	1	C	0	1	0	0	0_1C0_100
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Biothermal condition in July (Table 3) shows dominated moderate warm stress, while five days show great warm stress, four in the first decade and one in the last decade. There is also some thermoneutral weather type recognized. Radiation stimuli type was recognized as great. Thermal condition of the ambient air is the most neutral while days with hot and cold strain occurred as well. There is no sultry in July. There is 19 days with stimulative temperature amplitudes and 6 rainy days. January shows more uniformity with weather conditions than July, where conditions are differentiated.

Table 3 Weather conditions in Banja Luka July 1990

day	HL	R'	PS	SI	dt	RR	SC	weather
1	2	3	H	0	1	0	0	2_3H0_100
2	1	3	T	0	1	0	0	1_3T0_100
3	2	3	T	0	1	0	0	2_3T0_100
4	2	3	T	0	1	0	0	2_3T0_100
5	2	3	T	0	1	1	0	2_3T0_110
6	0	3	C	0	1	0	0	0_3C0_100
7	0	3	C	0	1	1	0	0_3C0_110
8	1	3	T	0	1	0	0	1_3T0_100
9	2	3	T	0	0	0	0	2_3T0_000
10	2	3	T	0	1	0	0	2_3T0_100
11	0	3	C	0	1	1	0	0_3C0_110
12	1	3	T	0	1	0	0	1_3T0_100
13	2	3	T	0	1	0	0	2_3T0_100
14	2	3	T	0	1	0	0	2_3T0_100
15	2	3	T	0	1	0	0	2_3T0_100
16	2	3	T	0	0	0	0	2_3T0_000
17	2	3	T	0	1	0	0	2_3T0_100
18	0	3	C	0	1	0	0	0_3C0_100
19	1	3	C	0	1	1	0	1_3C0_110
20	1	3	T	0	1	0	0	1_3T0_100
21	2	3	T	0	1	0	0	2_3T0_100
22	2	3	T	0	0	0	0	2_3T0_000
23	2	3	T	0	0	0	0	2_3T0_000
24	1	3	T	0	0	0	0	1_3T0_000
25	0	3	C	0	0	1	0	0_3C0_010
26	1	3	T	0	0	1	0	1_3T0_010
27	2	3	T	0	0	0	0	2_3T0_000
28	2	3	T	0	0	0	0	2_3T0_000
29	2	3	T	0	0	0	0	2_3T0_000
30	2	3	H	0	0	0	0	2_3H0_000
31	2	3	T	0	0	0	0	2_3T0_000

Summarized biothermal weather in January shows two dominant weather conditions represented as 0\_1C0\_100 and 0\_1C0\_000. In January 27 days

(87%) have biothermal weather type with thermoneutral stress, subtype with weak radiation stimuli and cold physiological strain with no sultriness and finally classes with 16 days with stimulative amplitude of the air temperature, four rainy days and four snowy days. Three days (10%) show moderate cold stress weather type with weak radiation stimuli and cold physiological strain with no sultriness, no stimulative amplitude of air temperature, no rainy and snowy days

(-1\_1C0\_000). Finally one day (3%) shows extreme with great cold stress, with weak radiation stimuli and cold physiological strain with no sultriness, no stimulative amplitude of air temperature, no rainy and snowy days

(-2\_1C0\_000). Diverse biothermal weather conditions are represented in July with dominant heat load risk. Those dominant weather conditions are represented as 2\_3T0\_100 and 2\_3T0\_000. In July 19 days (61%) have biothermal weather type with great warm stress with different weather subtypes and classes. Two from those 19 days have great radiation stimuli with hot physiological strain and no sultriness intensity. Weather classes show no rainy days but one day with stimulative amplitude of air temperature. The other 18 days with great warm stress have great radiation stimuli with thermoneutral physiological strain and no sultriness. Weather classes show 9 days with stimulative amplitude of air temperature and only one rainy day. There is seven days with moderate warm stress weather type (23%), great radiation stimuli, thermoneutral physiological strain and no sultriness intensity as weather subtypes. Five days observed with daily amplitude of air temperature as stimulative and two days observed as rainy days. Only five days (16%) in July have thermoneutral stress weather type, great radiation stimuli, thermoneutral physiological strain and no sultriness intensity as weather subtypes. Weather classes show four days with stimulative daily amplitude of air temperature and two rainy days.

#### 4. Conclusion

Bosnia and Herzegovina has several spa and health centers based on thermal or mineral springs. The couple of them mentioned in this paper are located in the Banja Luka surroundings. The concept of the

health and spa resorts includes various forms of recreation in order to reduce the stress in organism caused by the various daily activities. The crucial importance for outdoor recreation is weather condition. We made DBMS with related databases to analyze several variables.. The analyzed data show several dominant biothermal weather types in Banja Luka. Those are types with thermoneutral stress, with weak radiation stimuli, cold physiological strain, no sultriness, stimulative or no stimulative amplitude of air temperature, no rainy days, no snowy days (0\_1C0\_100 and 0\_1C0\_000) in January and with great warm stress, great radiation stimuli, thermoneutral physiological strain, no sultriness, stimulative or no stimulative amplitude of air temperature, no rainy day (2\_3T0\_100 and 2\_3T0\_000) in July.

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