

## Bioclimate Weather Classification of Doboj for Helth Spa Tourism

MILOVAN PECELJ

University of Belgrade, Faculty of Geography  
SERBIA

MILICA PECELJ

University of East Sarajevo, Faculty of Philosophy, Department of Geography  
BOSNIA AND HERZEGOVINA

MILISAV CUTOVIC

University of Belgrade , Faculty of Medicine  
SERBIA

MILA PAVLOVIC

University of Belgrade, Faculty of Geography  
SERBIA

DRAGICA ZIVKOVIC

University of Belgrade, Faculty of Geography  
SERBIA

LJILJANA ZIVKOVIC

University of Belgrade, Faculty of Geography  
SERBIA

SNEZANA VUJADINOVIC

University of Belgrade, Faculty of Geography  
SERBIA

JELENA PECELJ

University of East Sarajevo, Faculty of Philosophy, Department of Geography  
BOSNIA AND HERZEGOVINA

SERBIA

MIRJANA GAJIC

University of Belgrade, Faculty of Geography  
SERBIA

DANIMIR MANDIC

University of Belgrade, Faculty of Education  
SERBIA

*Abstract:* The goal of this paper is to show possibilities of multidisciplinary approach to the bioclimatic research in tourism, particularly in the spa tourism. In addition to the treatment of various diseases with thermal and mineral water, mud, gas and healing climate, modern spa also implies their importance in disease prevention and more often in recreation. The idea of the paper is to present how weather can be evaluated for recreational needs in the spa resorts. The results show biothermal weather classification for recreation based on the outdoor human heat balance. In this analysis, daily meteorological data (meteorological station of Doboj) were used for two extreme months, January and July. Town of Doboj was taken for analysis because there is a spa resorts in its vicinity.

*Key Words:* Bioclimate, Spa Tourism, Biothermal weather classification

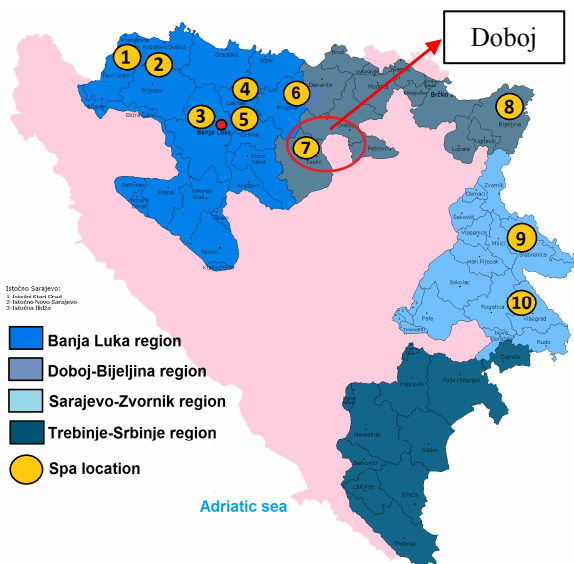
### 1. Introduction

Bosnia and Herzegovina has 16 spa resorts with thermal mineral waters that have been registered as

a medical facility. Of these 16 spas nine is located in Republic of Srpska entity. Recently, mineral water are increasingly being used as places of recreation and medical prevention. Seven of those spas are grouped in northern Bosnia (Republic of Srpska entity), which is huge part, of the southern edge of the Pannonian Basin.

The regionalization of Republic of Srpska entity identifies four nodal functional regions. Those are Banja Luka region (Krajina), Doboj-Bijeljina region, Sarajevo-Zvornik region and Trebinje-Srbinje region (Figure1). Mlječanica spa, Kulši spa, Toplice spa and Slatina spa belong to the Banja Luka region (Krajina). Dvorovi spa and Vrućica spa belong to the Doboj-Bijeljina region. Visegrad spa and Guber spa belongs Sarajevo-Zvornik region. In the Trebinje-Srbinje region there is no spa (Figure1).

In this paper, the bioclimatic analysis of Doboj will be presented by weather classification. The idea is to present the importance of climate in health and spa tourism, especially when it comes to outdoor recreation. Doboj has very favorable geographical position. The town is located in the alluvial plain (146 m above sea level) on the left bank of the Bosna river, between the Usora and Spreča mouths of the Bosna river (Figure1).



Source: [http://sr.wikipedia.org/srrel:Republika\\_Srpska.PNG](http://sr.wikipedia.org/srrel:Republika_Srpska.PNG), dopunila M.P

Fig 1. Geographic position of the spa resorts in Republic of Srpska entity (1-Mlječanica, 2- Lješljani, 3-Slatina, 4-Laktaši, 5-Toplice, 6-Kulaši, 7- Vrućica, 8-Dvorovi, 9-guber, 10-Višegrad)

The northern part of Doboj municipality is characterized by hilly terrain, composed of Cenozoic deposits, which slopes gently to the flat land (river valleys) with alluvial plains. On the south these hills become higher courts, relying on the mountain-depression region. Vrućica is one of the most popular health and spa resort in Republic of Srpska entity and belongs to Doboj-Bijeljina region. It is located in the valley of the Great Usora, at altitude of 204 m, on the main road Doboj - Teslic - Banja Luka and belongs to the municipality of Teslić. Distance from Banja Luka is 85 km and from Doboj 26 km. The nearest highway is 100 km and the nearest railway line is just 25 km while distance from the Adriatic Sea is 190 km. Besides the hydrological characteristics on which the spa has developed in medical-touist center, relief, specific climate and biogeography, then anthropological content are factors that complement the Vrućica environment which is very important for outdoor recreation.

The climate is mostly affected by the southern edge of the Pannonian Basin from the north, which belongs to the moderate-continental climate zone. This means that summers are hot and winters are moderate cold. Usora river basin stretches in meridian direction and allows continental influence to the area of northern Bosnia. Valleys of Great Usora river and Little Usora river are relatively closed by Vučja planina and Borja mountain from the south, so the area is closed to the Mediterranean influences. Teslić depression and lower mountains up to 1000 m above sea level determined mesoclimate and microclimate characteristics in this area. The average annual temperature in Doboj is 10.6° C and participation is 877mm (1961-1990).

## 2. Bioclimate weather classification for Doboj

Bioclimate weather classification is based on thermal, physical and aesthetic facets and includes seven digits represent actual biothermal weather characteristics (Blazejczyk, 2007), (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).

Table1. Biothermal weather types, sub types and classes

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

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).

For this purpose, the man and environment heat exchange model was used. (The calculations were made using BioKlima 2.5 software).

According to the bioclimatic classification which is based on the human heat balance in man (Blazejczyk, 2007), Dobož has the following characteristic features. Digital description of weather condition in Dobož is presented by table 1 and 2. Meteorological data for two extreme months, January and July (1990) were analyzed. The first part of the month has cool stress weather type while the second part of the month has combination of thermoneutral and warm stress weather type. Five days of warm stress weather type was registered.

Table 3. Weather conditions in Dobož, January

day	HL	R'	PS	SI	dt	RR	SC	weather
1	-1	3	C	0	0	0	1	1_3C0_001
2	-1	3	C	0	0	0	1	1_3C0_001
3	-1	3	C	0	0	0	1	1_3C0_001
4	-1	3	C	0	0	1	1	1_3C0_011
5	-1	3	C	0	0	0	0	-1_3C0_000
6	-1	3	C	0	0	0	0	-1_3C0_000
7	-1	3	C	0	0	0	0	-1_3C0_000
8	-1	3	C	0	0	0	0	-1_3C0_000
9	-1	3	C	0	0	1	0	1_3C0_010
10	-1	3	C	0	1	0	0	-1_3C0_100
11	-1	3	C	0	0	0	0	-1_3C0_000
12	-1	3	C	0	0	0	0	-1_3C0_000
13	-1	3	C	0	0	0	0	-1_3C0_000

14	-1	3	C	0	0	0	0	-1_3C0_000
15	-1	3	C	0	0	0	0	-1_3C0_000
16	-1	3	C	0	1	0	0	-1_3C0_100
17	0	3	C	0	1	0	0	0_3C0_100
18	0	3	C	0	1	0	0	0_3C0_100
19	0	3	C	0	1	1	0	0_3C0_110
20	0	3	C	0	1	0	1	0_3C0_101
21	0	3	C	0	1	0	1	0_3C0_101
22	0	3	C	0	1	0	1	0_3C0_101
23	0	3	C	0	1	0	1	0_3C0_101
24	0	3	C	0	1	0	0	0_3C0_100
25	0	3	C	0	1	0	0	0_3C0_100
26	1	3	C	0	1	0	0	1_3C0_100
27	0	3	C	0	1	1	0	0_3C0_110
28	1	3	C	0	1	0	0	1_3C0_100
29	1	3	C	0	1	0	0	1_3C0_100
30	1	3	C	0	1	1	0	1_3C0_110
31	1	3	C	0	1	0	0	1_3C0_100

Radiation stimuli type was recognized as great and thermal condition of the ambient air recognized as cold physiological strain. There is no sultry in January. The weak daily thermal contrast were observed in the first part of month while second part of month has significant daily thermal contrast. Rain was observed five days during month while. There were eight days with snow (Table 2).

Summarized biothermal weather in Dobož in January shows dominant weather conditions represented as -1\_3C0\_000. In January 16 days (52%) have biothermal weather type with cool stress, subtype with great radiation stimuli and cold physiological strain with no sultriness and five different classes, 14 days with weak daily thermal contrast of the air temperature, two rainy days and four snowy days (Chart 1).

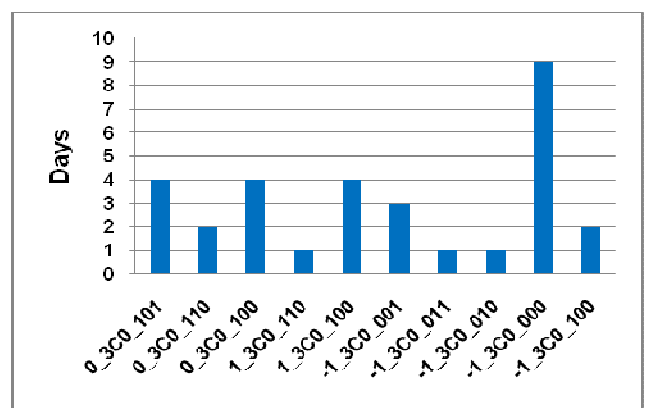


Chart 1. The frequency of bioclimatic classification in Dobož, January 1990

Ten days (32%) show comfortable stress weather type with great radiation stimuli and cold physiological strain with no sultriness, with

significant daily thermal contrast of the air temperature, two rainy days and four snowy days (0\_3C0\_101, 0\_3C0\_110, 0\_3C0\_100). Finally five days (16%) in the end of the month show extreme with warm stress, with great radiation stimuli and cold physiological strain with no sultriness, significant daily thermal contrast of the air temperature, one rainy and without snowy days (1\_3C0\_100, 1\_3C0\_110).

Biothermal condition in July shows dominated hot stress, while nine days show warm stress. There is no thermoneutral weather type. Radiation stimuli type was recognized as great. Thermal condition of the ambient air is different. Represented all subtypes of the air temperature neutral subtype is the most dominant while days with hot and cold strain occurred as well. There is only two days with sultry in July. There is 25 days with significant daily thermal contrast and 5 days with weak daily thermal contrast. There were 7 rainy days.

Table 3. Weather conditions in Doboj, January

day	HL	R'	C	SI	dt	RR	SC	weather
1	2	3	H	1	1	0	0	2_3H1_100
2	2	3	T	0	1	0	0	2_3T0_100
3	2	3	T	0	1	0	0	2_3T0_100
4	2	3	C	0	0	1	0	2_3C0_010
5	2	3	T	0	1	1	0	2_3T0_110
6	1	3	C	0	0	0	0	1_3C0_000
7	1	3	C	0	1	1	0	1_3C0_110
8	1	3	C	0	1	0	0	1_3C0_100
9	2	3	T	0	1	0	0	2_3T0_100
10	2	3	T	0	1	0	0	2_3T0_100
11	1	3	C	0	0	1	0	1_3C0_010
12	2	3	T	0	1	0	0	2_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	1	3	T	0	1	0	0	1_3T0_100
16	2	3	T	0	1	0	0	2_3T0_100
17	2	3	T	0	1	0	0	2_3T0_100
18	1	3	C	0	0	0	0	1_3C0_000
19	1	3	C	0	1	0	0	1_3C0_100
20	2	3	T	0	1	0	0	2_3T0_100
21	2	3	T	0	1	0	0	2_3T0_100
22	2	3	T	0	1	0	0	2_3T0_100
23	2	3	T	0	1	0	0	2_3T0_100
24	2	3	C	0	0	1	0	2_3C0_010
25	1	3	C	0	0	1	0	1_3C0_010
26	1	3	C	0	1	1	0	1_3C0_110
27	2	3	T	0	1	0	0	2_3T0_100
28	2	3	T	0	1	0	0	2_3T0_100
29	2	3	T	0	1	0	0	2_3T0_100
30	2	3	T	0	1	0	0	2_3T0_100
31	2	3	H	1	1	0	0	2_3H1_100

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 very hot 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 significant daily thermal contrast of the air temperature. The other 18 days with very hot stress have great radiation stimuli with thermoneutral physiological strain and no sultriness. Weather classes show 9 days with significant daily thermal contrast of the air temperature and only one rainy day (Table 3).

There is seven days with hot 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 significant 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 significant daily thermal contrast of the air temperature and two rainy days. (Chart 2)

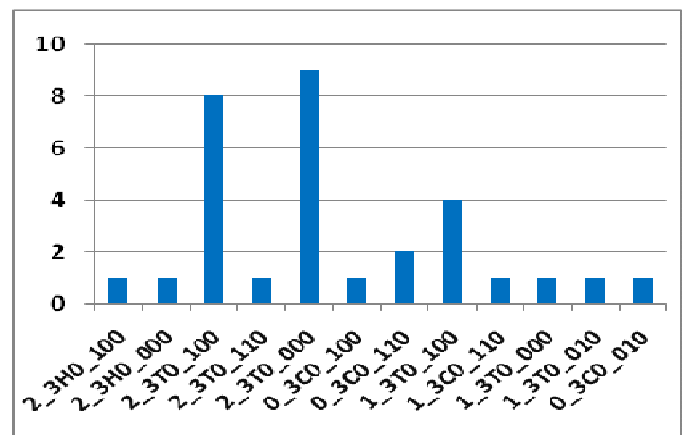


Chart 2. The frequency of bioclimatic classification in Doboj, July 1990

### 3. Conclusion

Bosnia and Herzegovina has 16 spa resorts with thermal mineral waters that have been registered as

a medical facility. Most of all spas are located in the northern part of Republic of Srpska entity. Vručica spa health resort mentioned in this paper is located in the Doboj 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. Dominant weather types in Doboj, analysed in January, are types with cool stress, subtype with great radiation stimuli and cold physiological strain with no sultriness, with weak daily thermal contrast of the air temperature and without participations (-1\_3C0\_000). In July, dominant biothermal weather type is with hot stress, great radiation stimuli with thermoneutral physiological strain, no sultriness intensity, with significant daily thermal contrast of the air temperature and without participation (2\_3T0\_100).

#### References:

- [1] K. Blazejczyk: *Assessment of recreational potential of bioclimate based on the human heat balance*, First International Workshop on Climate Tourism and Recreation, Int J Biometeorology (2001) WP01 (133-152)
- [2] K. Blazejczyk, A. Matzarakis: *Assesment of Bioclimatic Differentiation of Polan Based on the Human Heat Balance*, Geographia Polonica, Spring 2007, vol. 80 No. 1, p. 63-82
- [3] T.Koslovska-Szczesna, B. Krawczyk, K. Blazejczyk.: *The Main Features of Bioclimatic conditions at Polish Health Resorts*, Geographia Polonica, Spring (2004), 77 (1) (45-61)
- [4] C R de Freitas: *Theory Concepts and Methods in Tourism Climate Research*, First International Workshop on Climate Tourism and Recreation, Int J Biometeorology (2001) WP01(5-20)
- [5] M.R. Pecelj, M.Milinčić, M.Pecelj.: *Bioklimatska i ekoklimatska istraživanja-pravci razvoja*, Glasnik Srpskog geografskog društva (2007), 87 (2) (199-210).
- [6] Pecelj M.R, Pecelj M., Mandić D., Pecelj J., Lukić B., Filipović D.: *Informational technology in bioclimate analysis of Višegrad for health spa tourism*, 7th WSEAS International Conference on Engineering Education, ISBN: 978-960-474-202-8 , ISSN: 1792-426X, Corfu Island, Greece , 2010, pp.322-325 .
- [7] Pecelj M., Pecelj M.R., Mandić D., Pecelj J., Milinčić M., Tošić D.: *Informational Technology in Bioclimate Analysis of Banja Luka for Tourism Recreation*, 9th WSEAS International Conference on Telecommunication and Informatics, University of Catania, Sicily, Italy, 2010, pp.35-39.
- [8] Pecelj M., Mandić D., Pecelj M.R., Gojković P., Pecelj J., Lukić B., Šabić D.: *Information technology in study of tourist attractions in Visegrad*, 7th WSEAS International Conference on Eng. Education, Corfu Island, Greece , 2010, pp. 393-397
- [9] Pecelj M.R, Pecelj M., Mandić D., Pecelj J Vujadinović S., Šećerov V., Šabić D., Gajić M., Milinčić M.: *Bioclimatic Assessment of Weather Condition for Recreation in Health Resorts*, 8th WSEAS international conference on Environment, Ecosystems and Development, Athens, Greece , 2010, pp. 211-214.
- [10]Chr. Gutenbrunner, G. Hildebrandt (Hrsg): *Handbuch der Balneologie und medizinischen Klimatologie*, Springer, 1. Auflage, Berlin, Heidelberg, New York, Tokio, 1998. (589-594).