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**(497.11 Zlatibor)**

Original scientific paper

DOI 10.5937/ptp2401045S

Received on: August 10, 2023

Approved for publication on:

February 05, 2024

Pages: 45–56

## INFLUENCE OF BIO-CLIMATIC CONDITIONS OF MOUNT ZLATIBOR ON HEALTH TOURISM

**APSTRACT: Introduction:** Bioclimatic conditions are of great importance for all forms of tourism, especially for health tourism, as they should encompass therapeutic and prophylactic characteristics. Over the last three decades, tourism in Zlatibor has been continuously growing in terms of tourist numbers and the development of tourist infrastructure. This paper presents the bioclimatic and climatic conditions on Mount Zlatibor from the perspective of their impact on tourism. More precisely, it examines their influence on tourist movements on this mountain and their significance for the development of health tourism. **Materials and Methods:** Research data were obtained through the analysis of temperature, air pressure, humidity, insolation, and precipitation levels. Based on these data, physiological equivalent temperature (PET) values and the universal thermal climate index (UTCI) were calculated. **Results:** The obtained results of bioclimatic indices (PET and UTCI) indicate potential stress due to extreme cold in the mornings and evenings from late October to the second decade of March. Pleasant warmth prevails during the summer months in the mornings and evenings. In terms of health, the climate of Zlatibor is suitable for maintaining health, as well as for treating various lung diseases, anemia, heart and blood

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vessel disorders, especially thyroid disorders. Bioclimatic conditions closely correlate with tourist movements on Zlatibor, as evidenced by climate data and the results obtained from PET and UTCI calculations. **Conclusion:** Comparing tourist numbers over a five-year period reveals that bioclimatic conditions significantly influence Zlatibor's peak tourist season, which occurs during the summer months. This period offers the most favorable bioclimatic conditions, attracting the highest number of visitors to the mountain, especially those seeking health and recreational activities.

**Keywords:** *Zlatibor, bioclimatic conditions, health, tourism.*

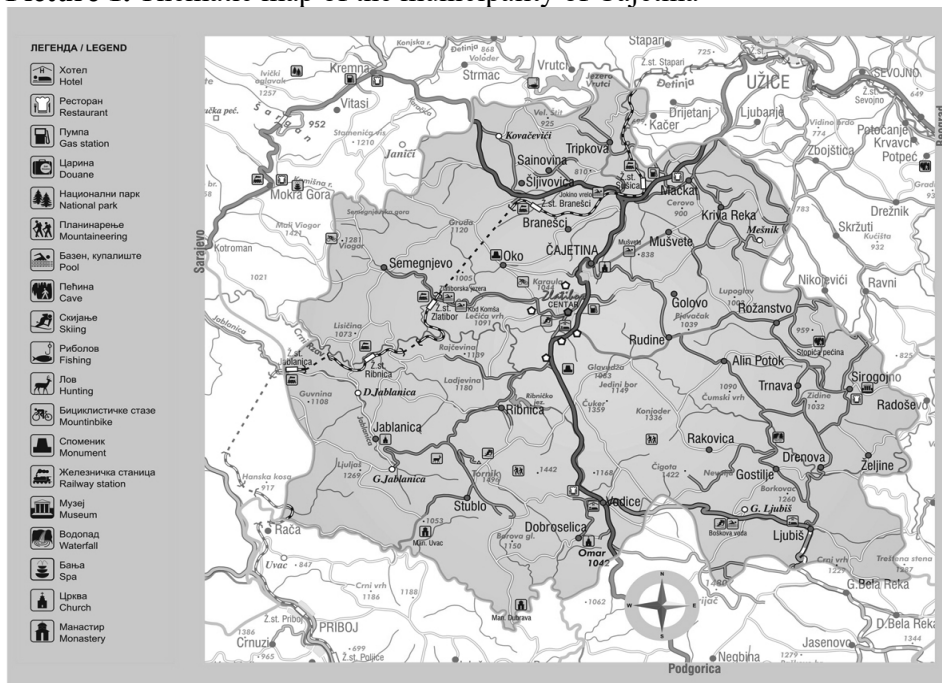
## 1. Introduction

Tourism is an economic branch that experienced rapid development in the second half of the twentieth century. The influence of nature on the human organism has been very significant throughout the history of the development of civilization, and one of the most important natural factors is the climate. As we progressed technologically, we managed to mitigate climate impacts, but we still remained dependent on nature. There is a well-known quote from the ancient philosopher Hippocrates, "The human organism behaves differently in certain periods of atmospheric weather. Mountain Zlatibor, situated in the southwestern part of Serbia, represents one of the jewels of natural beauty and richness of this region. Besides its distinctive cultural heritage and authentic rural legacy, Zlatibor is often explored as a destination in the context of health and medical tourism. What makes this mountain exceptional is its specific bioclimatic profile, which includes a combination of air composition, microclimatic factors, solar radiation, and other elements that influence the health and general well-being of visitors.

This paper aims to analyze how the bioclimatic conditions of Zlatibor affect health and medical tourism, exploring the benefits that this mountain provides for therapeutic purposes. Understanding how natural factors such as clean air, specific flora and fauna, as well as geographical location, affect human health, provides deeper insight into the potential benefit that visitors can derive from staying in Zlatibor. Through the analysis of available data, the research will examine how these bioclimatic conditions are used for therapeutic purposes, including treatments for respiratory diseases, stress recovery, and improvement of overall health conditions. The role of the local community and medical institutions in promoting this specific type of tourism will also be considered, as well as how they have adapted to meet the needs of guests who come in search of health and rejuvenation.

Through this research, we will strive to provide a comprehensive overview of the impact of bioclimatic factors on tourism that significantly influences the health and medical well-being of visitors to the mountain Zlatibor. The year 1893 is considered the beginning of health tourism on Zlatibor, when the king of that time period Aleksandar Obrenović approved the establishment of an air spa on Zlatibor. Later research confirms that Zlatibor's climate has very favorable effects on healthy people and excellent characteristics for the treatment of psychosomatic diseases such as regulating the work of the thyroid gland, metabolic diseases, lung and heart diseases, improving the blood count and the like. Zlatibor is one of the most visited tourist destinations in Serbia. Knowledge of the bioclimatic characteristics of an area can also help the tourism industry by offering alternative facilities to guests in certain parts of the year that can extend the season and the stay of tourists (Stojićević, 2016). The aim of this work is to connect the bioclimatic conditions of Zlatibor as a tourist destination with the impact on health and movement of people.

**Picture 1.** Thematic map of the municipality of Čajetina



Source: Tourist organization Zlatibor

## 2. Bioclimate indexes

Bioclimatic indices PET and UTCI were used as basic methods for obtaining information about the bioclimate of Zlatibor, in the period from 1992 to 2013. The use of the bioclimatic index PET allows a person to experience the thermal component of time on his own example. It is actually an index that describes the thermal environment according to thermal-physiological conditions. It is easier to imagine what a room air temperature of 30°C means thermally than to know that a clear sky, moderate wind and an air temperature of 20°C are expected. Then a person can, from his own experience, determine for himself how to dress and what type of activity would be appropriate for such conditions (Höppe, 1999). Table 1 shows the comfort sensation scale according to the physiological equivalent temperature.

**Table 1.** Classification of the feeling of comfort according to physiological equivalent temperature (PET)

| PET (°C) | The feeling of comfort |
|----------|------------------------|
| < 4      | very cold              |
| 4–8      | cold                   |
| 8–13     | fresh                  |
| 13–18    | pleasantly fresh       |
| 18–23    | pleasant               |
| 23–29    | Pleasantly warm        |
| 29–35    | warm                   |
| 35–41    | hot                    |
| > 41     | very hot               |

Source: Matzarakis & Mayer, (1996)., p 8.

UTCI – Universal Thermal Climate Index represents the ratio of the air temperature of the reference environment that causes the same model responses as real conditions. UTCI can be understood as the air temperature that would lead to the same heat stress as the actual conditions in the conditions of the reference environment.

**Table 2.** UTCI table for measuring heat stress

| UTCI (°C)  | EVALUATION OF PHYSIOLOGICAL STRESS |
|------------|------------------------------------|
| below -40  | Extreme cold stress                |
| -40 to -27 | Very strong cold stress            |
| -27 to -13 | Strong cold stress                 |
| -13 to 0   | Medium cold stress                 |
| 0 to 9     | Pleasantly cold stress             |
| 9 to 26    | No heat stress                     |
| 26 to 32   | Medium warm stress                 |
| 23 to 29   | Pleasantly warm stress             |
| 32 to 38   | Strong warm stress                 |
| 38 to 46   | Very strong warm stress            |
| above 46   | Extreme hot stress                 |

Source: Błażejczyk & Błażejczyk, (2012)., p 70.

Daily data from the meteorological station on Zlatibor for the period from 1992 to 2013 were the basis for calculating the PET and UTCI bioclimatic indices. RayMan software was used to calculate PET, and BioKlima program was used to calculate UTCI (Błażejczyk, 2006). RayMan is a software developed by Professor Andreas Matzarakis (Matzarakis, Rutz & Mayer, 2007).

The research used the example of a bioclimatic leaflet for the mountain Zlatibor. The leaflet was used to obtain data on the annual course of average temperatures, relative humidity, recognition of days with extreme temperature values, precipitation and wind (Stojićević, 2016). Important data on air pollution were collected based on the monitoring of allergenic pollen for all important places in Serbia.

### 3. Research results

The results of the analysis of the climatic elements of Zlatibor point to the therapeutic values of the climate, which gives this mountain the characteristics of a climatic health resort. For the above reason, the analysis of bioclimatic conditions is also necessary.

### **Air temperature**

The most frequent temperatures ranging from 25 °C to 30 °C were recorded in July and August. The coldest days can be observed from the middle of October until the beginning of April. In December and January, over 50% of days have temperatures between -10 °C and 0 °C. Very low temperatures (below -10 °C) are rare and mostly occur in the third decade of January and early February (Republički hidrometeorološki zavod – RHMZ).

### **Air humidity**

The characteristics of air humidity are high variability with an atypical annual cycle. RH in the range of 85 to 95 and over 95% occurs during the winter months, i.e. in December, January and February with values over 50% (RHMZ).

### **Precipitation**

During the observed period, the average number of days with precipitation was 178. Rain can be expected 187 days a year, while days with precipitation above 5 mm can be recorded for 72 days a year. Heavy rainfall is most common in late spring and during the summer months. Snow up to 1 cm high can occur on Zlatibor from the first half of October to the second half of April (RHMZ).

### **Wind**

Wind directions change during the day. Before noon, the southwest wind is dominant, but in the middle of the day, northerly directions become predominant. Wind speeds are between 1 and 3 m/s (RHMZ).

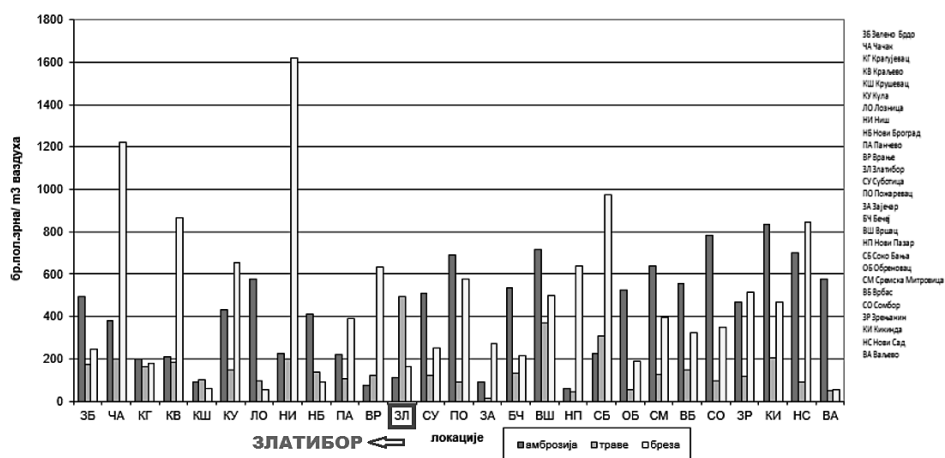
### **Bioclimatic conditions**

The average values of PET on Zlatibor for the decades between 1992 and 2013 show the possibility of extreme cold stress in the morning and evening hours from the end of October until the second decade in March. In the afternoon, there is less stress due to extreme cold. Better conditions for thermal comfort are during spring and autumn. PET values that are pleasant throughout the day are represented from the second half of April, then during May, September and the first half of October. During the summer months (June, July, and August), the morning and evening hours have pleasant thermal conditions, but also the heat stress in the afternoon hours. UTCI has a similar movement during the year as PET. Extreme cold stress is present throughout the day in November, December, January, February, and also occurs in March. From the second decade of April until the end of September, pleasant thermal conditions prevail throughout the day.

### Air pollution

In recent decades, air pollution has become an increasingly important problem for human health. Zlatibor becomes an excellent place to get through the summer months with the most pronounced influence of ambrosia. Evidence for these claims can be found in the results of the monitoring of allergenic pollen, where it is clearly seen that Zlatibor is in the rank of places where the maximum daily concentration of ragweed pollen grains is at the lowest level (diagram 1), and based on the report for the maximum daily concentration of pollen grains at all stations in the Republic of Serbia in 2021 (Environmental Protection Agency)

**Diagram 1.** Maximum daily concentrations of pollen grains at all stations in the Republic of Serbia in 2021.



Source: Annual report on the state of air quality in the Republic of Serbia for 2021. Environmental Protection Agency.

Comparing the total number of tourists on Zlatibor in the period from 2016 to 2020, it can be noted that the largest number of tourists is present during the summer (289,162) and the smallest number during the spring (222,546). These data indicate the connection of climatic factors with the decision of tourists when choosing a tourist season, because it is precisely in the periods with the highest number of visits that the conditions for health tourism and recreation are very favorable. Of course, a more detailed analysis could lead to conclusions that can somewhat disprove the claim that the climate is the main reason for such a large number of tourists in the summer season, given that most employees have the opportunity to take annual vacations at that time, which

is one of the prerequisites for tourist movements (Vuletić, 2022). Comparative bioclimatological analyzes were also made by Błażejczyk during 2021, who, using the example of Zlatibor, came to similar regularities in the tourist movement on this mountain, as in the above statement (Błażejczyk, 2021). Pecelj also claims that during the summer months in the big cities of Serbia, “strong and moderate heat stress” is most present, while in the same period in Zlatibor, “moderate heat stress” dominates (Pecelj, et al., 2017), which is one of the important drivers for tourist movements towards this mountain.

#### **4. Discussion**

The results of this study showed that the used climatological indices reflect the state of climatological elements. The climate of Zlatibor is suitable for maintaining health, as well as for the treatment of various lung diseases, anemia, disorders of the heart and blood vessels, and especially disorders of the thyroid gland, which is why it was declared a climatic health resort (Novaković-Kostić, 2015, p. 50). Bearing in mind that the atmospheric pressure on Zlatibor is extremely favorable, staying on this mountain has a favorable effect on the improvement of the blood count, above all on the increase in the percentage of hemoglobin in the blood and the increase in the number of red blood cells. Considering the above, Zlatibor represents a therapeutic area for all acute and chronic diseases of the respiratory organs, thyroid gland and anemia of all forms. The results of the research conducted by the Ministry of Health of the Republic of Serbia in 2013 indicated an increasing trend of obesity among the population of Serbia (Lešović, Smiljanić & Ševkušić, 2018, p. 8). Therefore, it is no coincidence that the Specialized Hospital for Hyperthyroidism was founded in Zlatibor back in 1964, which in 1997 grew into the Institute for Thyroid Gland and Metabolism. When planning the site for the Institute, many experts were consulted, especially doctors, climatologists and architects. In this regard, the favorable bioclimatic conditions on Zlatibor help the ultimate goal of obesity treatment, which is a permanent reduction of body mass (Lešović, Smiljanić & Ševkušić, 2018, p. 11).

#### **5. Conclusion**

Zlatibor is an exceptionally desirable destination for visitors seeking to preserve and improve their health. The results clearly indicate the benefits provided by the specific bioclimatic conditions of this mountain. Clean air, rich



flora and fauna, as well as beneficial microclimate, have proven to be key factors contributing to the overall well-being of visitors. Specific treatments for respiratory problems, stress reduction, and recovery after illness are just some of the ways these natural resources can be utilized for therapeutic purposes.

It is also important to emphasize the role of the local community and medical institutions in promoting this type of tourism. Their commitment to providing high-quality health services plays a crucial role in building trust among visitors and enabling this type of tourism to thrive.

Mount Zlatibor, with its unique bioclimatic characteristics, represents an exceptional resource for the development of health tourism. Its ability to provide improvements in the physical and mental health of visitors makes it not only an attractive tourist destination but also a key factor in enhancing the overall health of society.

Further research should enable even more effective utilization of Zlatibor's potential in preserving and improving the health of visitors in the future.

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## **UTICAJ BIOKLIMATSKIH USLOVA PLANINE ZLATIBOR NA ZDRAVSTVENI TURIZAM**

**APSTRAKT: Uvod:** Bioklimatski uslovi imaju veliki značaj za sve oblike turizma, a prevashodno za zdravstveni turizam, jer treba da sadrže terapijske i profilaktičke karakteristike. U poslednje tri decenije turizam na Zlatiboru je u stalnom usponu po broju turista i po razvoju turističke infrastrukture. Rad prikazuje bioklimatske i klimatske uslove na planini Zlatibor sa aspekta uticaja na turizam. Odgovori kako klimatski uslovi utiču na turistička kretanja na ovoj planini i u kojoj su meri značajni

za razvoj zdravstvenog turizama predstavljaju glavne teme ovoga rada. **Materijal i metode:** Podaci za istraživanje su dobijeni analizom temperature, vazdušnog pritiska, vlažnosti vazduha, insolacije i količine padavina. Na osnovu tih podataka izračunate su vrednosti fiziološki ekvivalentne temperature (PET) kao i univerzalnog termalnog indeksa (UTCI). **Rezultati:** Dobijeni rezultati bioklimatskih indeksa (PET i UTCI) ukazuju na mogućnost stresa na ekstremnu hladnoću u jutarnjim i večernjim satima od kraja oktobra pa sve do druge dekade u martu. Tokom letnjih meseci prijatne toplotne uslove imaju jutarnji i večernji sati. U zdravstvenom smislu klima Zlatibora je pogodna za održavanje zdravlja, kao i za lečenje različitih plućnih bolesti, anemije, poremećaja srca i krvnih sudova, a naročito poremećaja štitaste žlezde. Na osnovu podataka o klimi i rezultata dobijenih izračunavanjem fiziološki ekvivalentne temperature (PET) i univerzalnog termalnog indeksa (UTCI) bioklimatski uslovi su dovedeni u najbližu vezu sa turističkim kretanjima na Zlatiboru. **Zaključak:** Poređenjem broja turista u petogodišnjem periodu došlo se do zaključka da upravo bioklimatski uslovi u najvećoj meri utiču da letnja sezona bude najposećenija, a samim tim i najprijatnija za sve kategorije turista sa posebnim naglaskom na one turiste koji Zlatibor posećuju iz zdravstvenih i rekreativnih razloga. Ovaj period tokom godine odlikuju najbolji bioklimatski uslovi pa je i broj posetilaca ove planine tada najveći.

**Ključne reči:** Zlatibor, bioklimatski uslovi, zdravlje, turizam.

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