

Assessment of Ohrid's Tourism Potential by Using Temperature Humidity Index and Its Contribution to International Tourism Marketing

İlknur Zeydan¹
Özgür Zeydan

Abstract

Ohrid is an important tourist destination in North Macedonia. Ohrid City is located on the coast of Ohrid Lake. Tourism in Ohrid is not well-developed because of inadequate financial and cultural promotion. Especially, outdoor tourism depends on climate. Using the bioclimatic (thermal) comfort conditions, the true tourism potential of a destination can be evaluated. The purpose of this study is to evaluate the tourism potential of Ohrid by implementing the thermal comfort index. THI was applied for the determination of bioclimatic comfort. Five years (2019-2023) of meteorological data was downloaded from the Visual Crossing website. Monthly average THI scores were calculated. As a result, four different THI classes were revealed: cold, cool, comfortable, and hot. June – September period is determined as the most comfortable season for tourism. Local and governmental authorities, businesses in the tourism sector, and tour operators can use these results for the development of tourism in Ohrid. Seasons and activities may be organized according to the bioclimatic comfort levels. The development of tourism in a region also contributes to international tourism marketing.

Keywords: tourism potential, bioclimatic comfort, temperature humidity index, Ohrid

JEL classification: Z320

Introduction

Tourism is an important sector since it contributes to the economy. Tourism activities are dependent on weather and climate conditions. Unfavorable weather conditions will result in a lower number of tourist arrivals and a loss in tourism revenue (Trajkov, Biljan, and Andreeski 2016). Therefore, it is necessary to evaluate the climate conditions of a destination in terms of tourism for decision-making, investments, planning, and marketing purposes (Gao et al. 2022). The true tourism potential of a certain destination can be assessed by determining the bioclimatic comfort. Bioclimatic (climatic or thermal) comfort is the measure of a person's response to climatic factors (such as temperature, relative humidity, and wind speed) in a certain environment (Cinar, Karakus, and Toy 2023).

Ohrid is a leading tourism destination in North Macedonia. Tourist arrivals and overnight stays constitute one over third of North Macedonia's total (Petrevska and Collins-Kreiner 2020). Petrevska and Collins-Kreiner (2017) reported that tourism is not sufficiently developed in North Macedonia. Several studies examined the tourism development in Ohrid (Petrevska and Collins-Kreiner 2020; Petrevska and Matlievska 2018; Petrevska and Collins-Kreiner 2019) but none of them evaluated the bioclimatic comfort levels of Ohrid. Our paper aims to fill this gap. The purpose of this study is to evaluate the tourism potential of Ohrid (North Macedonia) by implementing the thermal comfort index. The temperature humidity index (THI) was implemented for this purpose. The results of this study will contribute to tourism development in Ohrid. It is aimed at supporting Ohrid, which has an important position in the international tourism market, with scientific studies and to contribute more to the development of tourism through research. This paper is organized as follows. In the literature review, the implementation of the temperature humidity index is given. The study area is described in the next section. The formulation of the temperature humidity index and data acquisition procedure are provided in the methods section. The calculated thermal comfort levels

¹ İlknur Zeydan, Ph.D., Oral and Dental Health Application and Research Center; Özgür Zeydan, Ph.D., Associate Professor, Department of Environmental Engineering, Zonguldak Bülent Ecevit University, Türkiye.

and their implications in tourism are given in the results and discussion. The final section concludes with a summary of findings, limitations, and future research recommendations.

1. LITERATURE REVIEW

In the literature, the temperature humidity index (THI) was implemented in many studies to evaluate the climate comfort of a certain destination. THI calculations were generally used to determine suitable tourism seasons at a destination. For example, Yazdani (2018) analyzed the bioclimatic comfort conditions of the Chaldiran region (Iran) using THI. He stated that 75% of the year is suitable for tourism and June, July, August, and September are the most favorable months. Likewise, Hasanah et al. (2020) determined the comfort period for visiting Borobudur Temple in Indonesia via several thermal comfort indexes including THI. Maftai and Buta (2017) employed THI in the Dobrogea Region (Romania) and reported thermal discomfort from October to May. In another study, Rosu, Mihaila, and Bistricean (2022) implemented THI to evaluate favorable seasons for outdoor activities in the submontane contact area between Sucevița and Slănic Moldova.

THI calculations were also used in tourism development-related studies. A study conducted in Focșani City (Romania) reported that THI scores are correlated with higher tourist activities such as overnight stays and arrivals in accommodation facilities (Ciobotaru et al. 2019). In another study, THI was used to assess bioclimatic comfort levels in Artvin (Türkiye). The authors mentioned that the bioclimatic conditions were not taken into consideration much in the planning of tourism accommodation facilities in Artvin (Özşahin, Kaymaz, and Albayrak 2015).

If bioclimatic comfort conditions are assessed by using long-term meteorological data, it is possible to evaluate changes over time and determine the impacts of climate change. For example, Linsheng, Hu, and Yuxi (2019) examined the impact of climate change on Tibet tourism using THI. Banc et al. (2020) applied THI in 10 major cities in Romania using long-term meteorological data. Comfortable class was the major THI class. They also reported that there was a shift from cold weather conditions to hot and warm weather conditions (Banc et al. 2020). Similarly, Feng et al. (2021) stated an increasing average comfort level in China changed from cold to comfortable.

2. STUDY AREA

Ohrid is an important tourist destination located in the southwestern part of

North Macedonia on the coast of Ohrid Lake (Figure 1). Ohrid is famous for local churches and monasteries. Ohrid is a city of cultural and historical heritage and is included in the UNESCO World Heritage List. Ohrid is known as the “Jerusalem of the Balkans” (Petrevska and Collins-Kreiner 2020). Ohrid also provides recreational activities and the summer festival. The closest tourism markets for Ohrid are Western European countries, Balkan countries, Türkiye, and local population participation. Due to the lack of financial and cultural promotion, tourism in Ohrid is not sufficiently developed. Research showed that Ohrid has a strong seasonality and summer tourist destination (Trajkov, Biljan, and Andreeski 2016).



Figure 1. Map of the study area Source:

<http://www.maphill.com/macedonia/ohrid/ohrid/location-maps/physical-map/>

3. METHODS

The bioclimate comfort conditions were determined by using the Temperature Humidity Index (THI). THI is also known as Thom's thermal discomfort index (Maftei and Buta 2017) or thermo-hygro-metric index (Rosu, Mihaila, and Bistricean 2022). THI can be applicable to open spaces. It uses temperature and relative humidity as inputs (Tseliou et al. 2010). Equation 1 was used to calculate the THI score. The bioclimate comfort classes were evaluated with the help of Table 1 (Ciobotaru et al. 2019). When the THI value is between 15°C and 20°C, it is considered the most comfortable environment. When the THI is lower than 15, people will feel cold; when the THI is greater than 20°C, people will feel hot and sweaty (Yang et al. 2016).

$$THI = T - (0.55 - 0.0055 \times RH) \times (T - 14.5) \quad (1)$$

THI Temperature humidity index (°C)

T Temperature (°C)

RH Relative humidity (%)

Table 1. Temperature Humidity Index classes

THI (°C)	Bioclimatic comfort
$-20 < THI \leq -10$	Excessive cold
$-10 < THI \leq -1.8$	Very cold
$-1.8 < THI \leq +13$	Cold
$+13 < THI \leq +15$	Cool
$+15 < THI \leq +20$	Comfortable
$+20 < THI \leq +26.5$	Hot
$+26.5 < THI \leq +30$	Very hot
$THI > +30$	Sultriness

Source: Ciobotaru et al., 2019, 1013, table 1.

The meteorological data were downloaded from the Visual Crossing website (<https://www.visualcrossing.com/>). The data set covers 5 years of daily observations of temperature and relative humidity from 1.1.2019 to 31.12.2023. Monthly mean values of temperature and relative were

calculated. THI scores were computed for each month from the beginning of 2019 till the end of 2023. All computations were performed on RStudio. Graphs were created using the ggplot2 library in R.

4. RESULTS AND DISCUSSION

Figure 2 depicts the time series of daily average temperature records for Ohrid from 2019 to 2023. During the period of investigation, the mean daily average temperature was calculated as 11.8 °C. The temperatures fluctuated between 25.8 °C and -8.6 °C. The hottest day was recorded on the 2nd of August 2021. On the other hand, the coldest day was determined on the 14th of February 2021. July and August were the hottest months while January and February were the coldest months. Figure 3 demonstrates the time series of daily average relative humidity (%) records for Ohrid between 2019 and 2023. The mean daily average relative humidity was computed as 69.2%. The relative humidity ranged between 94.9% and 30.1%. The highest relative humidity was recorded on the 1st of April 2020. On the other hand, the lowest relative humidity was found on the 8th of January 2020.

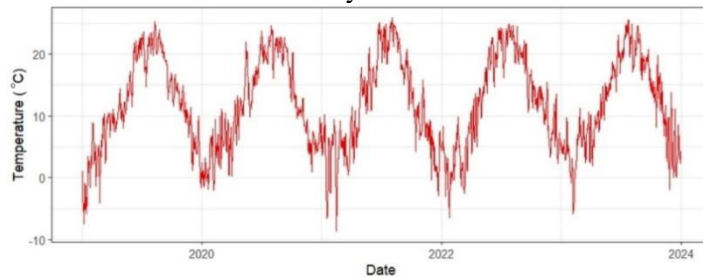


Figure 2. Temperature (°C) of Ohrid (2019-2023)

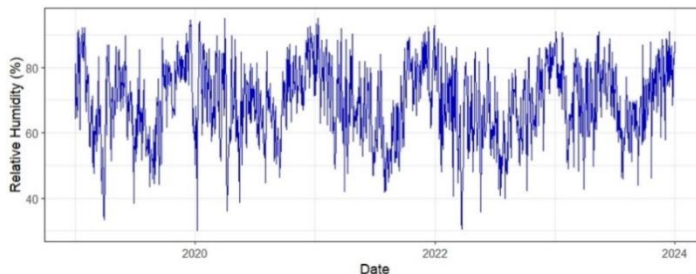


Figure 3. Relative humidity (%) of Ohrid (2019-2023)

The monthly average temperature humidity index value for Ohrid is presented in Figure 4. The five-year monthly THI scores were plotted separately. The graphs of all years were similar to each other. As a result, four different THI classes were revealed: cold, cool, comfortable, and hot. June – September period is determined as the most comfortable season for tourism. Figure 5 depicts the heatmap of THI for each month between 2019 and 2023. Bioclimatic comfort levels were found to be cold from November to April. May and October were determined as cool in three of five years. Four months from June to September are found to be the most comfortable season for tourism. Even though the July and August months were classified as hot, the THI scores were quite close to 20 (upper level of comfortable class). It can be concluded that July and August do not cause much heat-related discomfort for tourists.

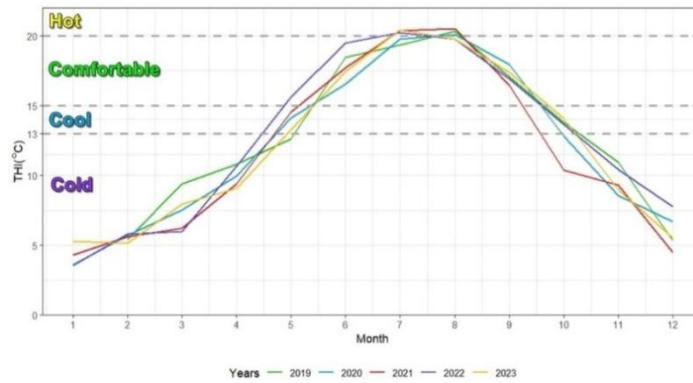


Figure 4. Monthly average temperature humidity index for Ohrid (2019-2023)



Figure 5. Monthly THI values for Ohrid (2019-2023)

This information can be applied to the tourism development in Ohrid. Macedonian Agency for Promotion and Support of Tourism, local authorities, tourism businesses, and tour operators may benefit from the results of this study. New tourism investments can be made in the light of this study. Outdoor tourism activities can be planned according to bioclimatic comfort levels. Tourism businesses can organize their opening seasons and tour operators can increase their travel services by considering the optimum comfort season. Auxiliary service providers of the tourism sector may adjust their schedules for the most convenient season. The results of this study should be kept in mind for tourism marketing.

CONCLUSION, LIMITATIONS AND FUTURE RESEARCH

This study revealed the THI classes for Ohrid. Four different THI classes (cold, cool, comfortable, and hot) were determined as a result of the study. The June – September period was found as the most comfortable season for tourism. The calculated bioclimatic comfort information can be used for tourism development in Ohrid, tourism marketing promotion, and advertising. Because Ohrid is an important location for the international tourism market.

This study has certain limitations. Only 5 years of meteorological data were used, and the results are applicable for the years of 2019-2023. Additionally, results are applicable only to Ohrid and they cannot be generalized to other cities in North Macedonia. It is not possible to assess

the impact of climate change using short-term datasets. Future research implementing long-term meteorological data and detecting trends will help to evaluate the impact of climate change on bioclimatic comfort, tourism development, and tourism marketing.

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