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ANALYSIS OF BIOCLIMATIC INDICATORS IN WHITE DOMINANT AREA. CASE STUDY: THE NORTHERN SECTOR OF THE PARÂNG MOUNTAINS

ANALIZA INDICATORILOR BIOCLIMATICI ÎN SPAȚIUL MONTAN DE DOMINANȚĂ ALBĂ. STUDIU DE CAZ: SECTORUL NORDIC AL MUNȚILOR PARÂNG

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Abstract. The main purpose of the study is to analyze the variability of certain bioclimatic indicators (*the Winter Scharlau Index, the Summer Scharlau index, the Relative Strain Index-RSI*, *the Wind Chill index*) in order to identify the degree of comfort felt by tourists in the white dominant area on the northern side of the Parâng Mountains. The necessity for this study is apparent in the context of the development of mountain tourism and that of winter sports tourism in the Parâng mountain resort in particular. The relevance of the results is also due to the analysis of the climatic parameters (temperature, relative humidity, wind) at two different moments in time during the tourist seasons (winter and summer). The Parâng Mountains feature a large area that favors skiing, which accounted for the tourist refurbishment of the white dominant area in the northern sector as early as 1960-1970. The typical features of the natural landscape and tourist accommodation facilities created in the Parâng mountain resort justify the heavy inflow of tourists from numerous regions in Romania in wintertime.

Key-words: Parâng, white dominant area, bioclimatic indexes, thermal comfort, winter sports.
Cuvinte cheie: Parâng, spațiul montan de dominanță albă, indici bioclimatici, confort termic, sporturi de iarnă

1. INTRODUCTION

An analysis of the thermal bioclimate is of special interest for decision-makers in the public health and the leisure sectors, but also to the population in general (Matzarakis A., Zygmuntowski E., Koch M., 2005, p. 190). The various types of comfort can be assessed by means of an analysis of the variability of bioclimatic indicators, which can be then put to practical use in areas with various economic destinations: agriculture, tourism (mountain resorts or spas etc.), urban and rural habitats. Climate information, of interest for the hospitality industry, must include – in addition to a general overview (average monthly and annual values of

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the climate elements) – information related to the thermal comfort and the factors that influence the weather (Blazejczyk K., Matzarakis A., 2008, p. 1).

In 1996, when celebrating the 100th anniversary of the modern Olympic Games, the World Meteorological Organization selected "Weather and Sports" as the theme of the World Meteorological Day, thus granting sports-applied meteorology an identity of its own (Pezzoli et al., 2000, p. 2).

In the 19th century, the link between sports and tourism developed thanks to the positive perception of sports as a fundamental activity to engage in one's free time; it gained new values, from the simple physical exercice to a competition-based, ludic and health-restoring activity (Di Marco, M., D'Intino, G., Oronzo, S., 2004 quoted by Iancu, Siddu, 2009, p. 64).

Throughout history, travelling for sport is evident, whether it involved journeying to the next village to play a game of football or in recent times (as mountains became an attraction instead of an object of fear) to go skiing (Matley, 1981 quoted by Nicula, 2008, p. 414). Sports have become an important part of leisure tourist activity, which is reflected by the rise in numbers of tourists who choose an active holiday (Iancu, Siddu, 2009, p. 64).

The development of winter sports tourism in the northern sector of the Parâng Mountains requires an analysis of the type of thermal bioclimate, in order to highlight the elements that favor or restrict tourist activity in that region. Although Parâng is a traditional destination for winter leisure activities, it was recently homologated as a mountain resort of national interest, whose status is stipulated in the Government's Decision 1205 of 07/10/2009.

2. METHODS

The analysis of the bioclimatic indicators was conducted using the variation of meteorological parameters during the 1971-2000 time interval, using data supplied by the Parâng weather station. In order to describe thermal comfort during both the cold season and in summer, several meteorological parameters were analyzed (average temperature, relative humidity, wind speed). Operationally speaking, multi-annual sets of data were used - the daily measurements of the above-mentioned parameters – and several bioclimatic indicators were calculated (winter and summer Scharlau indexes, RSI index – *relative strain index*, the Wind-Chill index) with the goal of highlighting the effects of thermal bioclimate on tourists in the analyzed mountain region.

3. RESULTS

3.1. The Winter Scharlau Index reflects the level of human discomfort felt because of skin exposure to the cold. The index derived by Scharlau reflects bioclimatic comfort when air temperature remains positive; the more the temperature decreases, the more intense the physiological sensation of cold becomes (Ionac, Ciulache, 2008, p. 29). The author established a correlation between critical temperatures and the level of humidity; each thermal value is matched by an air humidity value; in wintertime, the human body senses no

physiological discomfort generated by weather getting colder as long as temperature ranges from -5° C to 6° C and humidity stands at 40% or higher. When these critical temperature values - as mentioned by the author - are exceeded, the sensation of cold on the skin is sensed with varying intensity.

The Winter Scharlau index highlights that thermal discomfort caused by the cold is felt in all winter months, with a peak in December and a low in March (Table no. 1). The values of the winter index as calculated for the Parâng mountain resort indicate the normal wintertime conditions typical of mountain regions.

Table no. 1

Winter Scharlau index values as calculated for Parâng

Month	Average temperature	Relative humidity	Winter Scharlau index value	Critical Scharlau temperature	Comfort/ discomfort
November	-2	81	-4.4	2.44	Intense discomfort
December	-3.7	81	-6 .1	2.44	Intense discomfort
January	-5.8	82	-8.3	2.54	Intense discomfort
February	-5.6	86	-8.5	2.94	Intense discomfort
March	-3.1	83	-5.7	2.65	Intense discomfort

(Source: processed data)

In order to be able to estimate the length of time of the winter season, the number of winter days was also calculated; they are predominant in the months of December, January, and February and fewer in March (Fig. 1); one may conclude that winter sports can be played through to mid-March, and if the layer of snow endures, the winter season can last as long as through to late March or even early April.

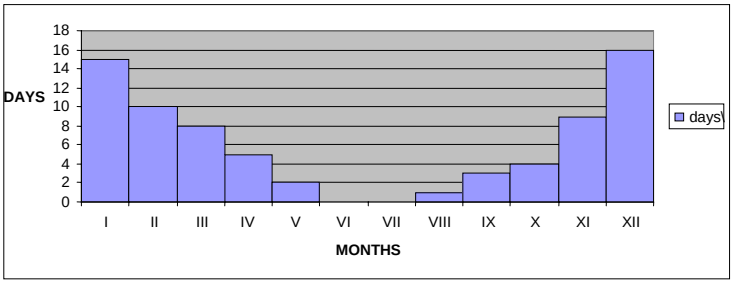

Fig. 1. The average number of winter days at the Parâng weather station (1971-2000)

The importance of winter days for tourist activity is explained by the fact that temperature peaks at no more than 0° C, which favors the preservation of the layer of snow.

It is common knowledge that several outdoors sports activities are strongly influenced by meteorological conditions (Pezzoli et al, 2000, p. 5). The impact of the main climatic parameters on the types of winter sports is synthetically described in Table no. 2.

Table no. 2

The index of meteorological elements' impact on the types of winter sports

Type of sports	Atmospheric pressure	Temperature	Wind	Precipitation	Cloudiness
Alpine skiing	1	4	3	5	4
Cross-country skiing	2	5	4	5	2
Bobsleigh	1	5	3	4	4
Ice skating (outdoors skating rink)	2	5	3	4	1

Legend of the impact index: 1 = low; 2 = mild; 3 = average; 4 = significant; 5 = important.
(Source: Pezzoli et al., 2000, MeteoSport – linea di ricerca in meteorologia applicata allo sport, p. 5)

3.2. The Summer Scharlau index is defined by the same author as indicating the degree of thermal comfort or discomfort in summer biometeorological conditions. K. Scharlau experimentally defined thermal comfort conditions during the warm time of the year as thermal comfort conditions in the warm season in between the limits of temperature (17°-39°C) matched against atmospheric humidity (values ranging from 30 to 100%) and in the absence of wind (Ionac, Ciulache, 2008, p. 32). Exceeding those temperature and humidity values generates a sense of physiological discomfort caused by the excessive heat and humidity.

The values reached by calculating the summer index indicate thermal comfort in the Parâng Mountains as a result of moderate temperatures in the summertime (Table no. 3). The analysis of monthly temperatures' evolution indicates the fact that summers are relatively warm, early springs are cooler and wet and autumns are long and relatively warm and dry. These climatic characteristics favor the development of mountain tourism and especially backpacking tourism in the northern region of the Parâng Mountains. The best time for indulging in backpacking tourism overlaps with the time intervals when temperatures in the analyzed area are higher (May-September) (Fig. 2). One may conclude that tourists in the analyzed mountain region can indulge in summer activities under the best of conditions throughout the warm season.

On a monthly basis, the peaks in the tourist seasons are December – January in winter (the time of best conditions for playing of winter sports, overlapping with

the time of school holidays and the Christmas vacations) and July and August in summer, the hottest months of the year (Fig. 3).

Table no. 3

Summer Sharlau index values as calculated for the Parâng resort

Month	Temperature	Relative humidity	Summer Scharlau index value	Critical Scharlau temperature	Comfort/ Discomfort
June	15	81	4.88	19.88	Well-being
July	17	80	3.09	20.09	Well-being
August	16.5	79	3.81	20.31	Well-being

(Source: processed data)

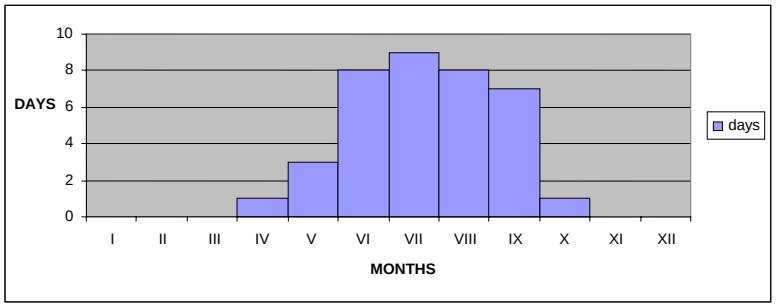

Fig. 2. The average number of summer days at the Parâng weather station (1971-2000) (*Source: The Parâng weather station*)

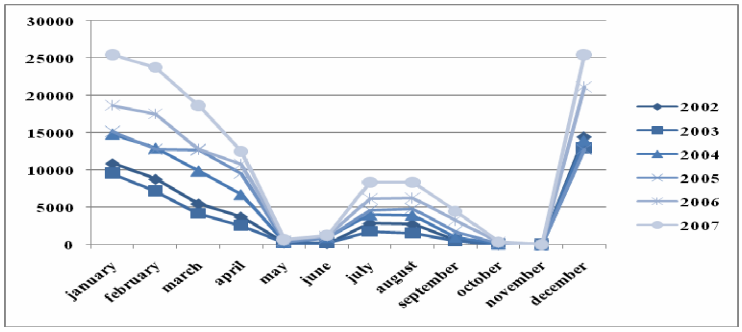

Fig. 3. Monthly evolution of accommodation capacity in service (seat-days) in the Parâng mountain resort during 2002-2007 (*Source: processed data*)

3.3. The Relative Strain Index (RSI) is one of the most relevant bioclimatic indexes; it indicates the real scale of human body heat exchanges under overheating conditions; it indicates not only the intensity of bioclimatic stress due to exposure to heat, but also the potential negative effects of extreme bioclimatic conditions on human psychology (Ionac, Ciulache, 2008, p. 35). Unlike the Summer Scharlau index, RSI values' fluctuation in time and space is more limited,

which better highlights the risk potential caused by overheating in the analyzed region. The results of calculations of the RSI for the Parâng resort indicate summer as the best time of the year for tourism, thermally speaking, as the values are similar to those calculated for the Summer Scharlau index (Table no. 4).

Table no. 4

Relative Strain Index (RSI) values as calculated for the Parâng resort

Month	Maximum temperature	Relative humidity	RSI index	Type of comfort
June	15	81	-0.14	Well-being
July	17	80	-0.09	Well-being
August	16.5	79	-0.1	Well-being

(Source: processed data)

3.4. The Wind Chill Index was calculated in order to highlight the conditions for playing of winter sports; by matching thermal values against the speed of wind, one can subdivide the cold season into shorter periods of time, divided function of the two indexes' values into different types of meteorological weather: cold weather, very cold weather and conditions for freezing. This climate index reflects the combined action of air temperature and wind speed (m/s) on human body heat, that is the intensity of heat energy the human body surface loses by means of various physical processes (radiation, convection, evaporation) (Ionac, Ciulache, p. 41). The Wind-Chill index values calculated for the Parâng massif (Table no. 5) indicate that the difficult months during the year are those in wintertime, with thermal discomfort peaking in January and February, the months when temperature drops to its lowest and wind reaches the highest intensity (7-8 m/s), which leads to very likely conditions for freezing.

Table no. 5

Wind Chill index values calculated for the Parâng resort

Month	Temperature	Wind speed (m/s)	Index value	Type of weather
November	-2	5	-11.2	Very cold
December	-3.7	6	-15.2	Very cold
January	-5.8	8	-21.1	Conditions for freezing
February	-5.6	7	-19.4	Conditions for freezing
March	-3.1	5	-12.6	Very cold

(Source: processed data)

The values resulting from calculating the Wind Chill index in the Parâng resort indicate conclusions similar to those obtained after calculating the Winter Scharlau index, that is that the climate in the northern Parâng Mountains is harsh as a result of very low temperatures and wind intensity, with no thermal comfort and bioclimatic stress reaching maximal values. Under those conditions, the strain placed on the body is heavy, and can only be withstood by young and vigorous

people. However, the conclusion can be reached that these weather conditions offer the premises for proper indulging in winter sports.

For a complex analysis of the favorable conditions for winter sports activities, it is important to have information on the amount and thickness of solid precipitation. The first snow layer is accumulated in the last third of October, and the last layer of snow at the end of the second third of April. In terms of consistency and thickness, the best-quality layer of snow in terms of winter sports-playing is the one during December-March (Table no. 6, Fig. 4).

Table no. 6

Snow layer thickness in the Parâng Mountains (1971-2000)

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average duration of the snow layer (days/year)
Parâng	**42.5**	**56.5**	**51.2**	**13.7**	**0.8**	**0.1**	**0**	**0**	**0**	**0.2**	**5.7**	**21**	**238**

(Source: The Parâng weather station)

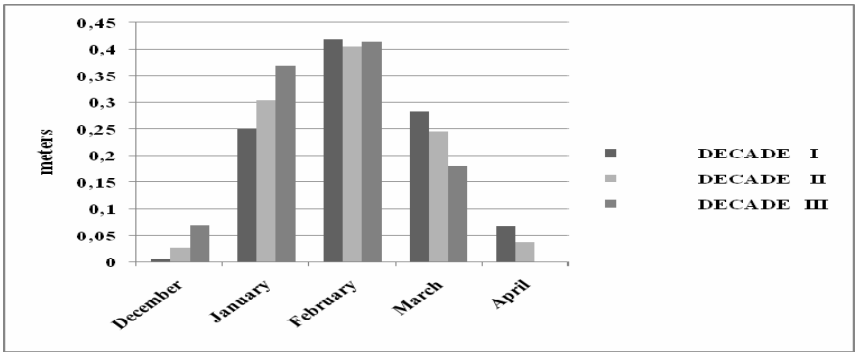

Fig. 4. Snow layer thickness in the Parâng mountains, divided in 10-day groups

The average duration of snowfalls and the average number of days with a snow layer exceeds 200 days a year, or 85% of the total number of winter days per year. These high values in terms of both snow layer thickness and the number of days with snow indicate favorable conditions for winter sports activities throughout the period. Unlike other mountain areas where snow guns are used in order to compensate the shortage of snow, Parâng is one of the few massifs where heavy snowfalls start early in the year (in autumn) as a result of direct exposure to humid air advections, inbound from the ocean (Micu, D., Mărăşoiu, D., 2009, p. 7).

4. CONCLUSIONS

The climate is a dynamic element with special tourist potential. In mountain tourism, natural conditions have a fundamental importance, ensuring the quality of services, integrating the location in the mountain area and offering favourable conditions for practicing winter sports, mostly ski. Also, the types of weather and climate condition can limit tourist activity.

Information on the climate and types of comfort is a present-time necessity for both the local population and for tourists. In this context the analysis of meteorological conditions becomes a particularly important aspect in order to highlight the characteristics of the climate of the residential and/or tourist spaces. The study of the fluctuation of the climate-touristic indicators is a necessary task in assessing the state of physiological and mental comfort, particularly for touristic activity. Holidays spent outdoors, with tourists resorting to playing of sports or indulging in various types of climatotherapy (heliotherapy, spa therapy etc.), are the most suggestive examples that indicate the dependence of the variability of weather and environment conditions. The strong seasonality of mountain tourism is the result of its interrelation with the favorability of thermal conditions and solid precipitation.

By highlighting the qualitative and quantitative features (by calculating the bioclimate indexes) the climate conditions in the area analyzed indicate favourability for tourist activities, playing of winter sports under the best of conditions, and engrossing in various types and forms of tourism in summer (backpacking, recreational caving, ecotourism and cyclo-tourism etc).

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