CORRELATIONS BETWEEN CLIMATIC CONDITIONS AND THE DEVELOPMENT OF WINTER TOURISM IN THE ORIENTAL CARPATHIANS. CASE STUDY: HARGHITA MOUNTAINS

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ABSTRACT. – The suitability of weather conditions for winter tourism development in the Eastern Carpathians. Case Study: Harghita Mountains. In the context of the ongoing global and regional climate change debates, the present study intends to analyze the impact these changes have on winter tourism development in the Harghita Mountains. With a maximum altitude of 2545 m, a complex structure of the underlying surface responsible fo r local climatic particularities, as well as for a wide range of complex and elementary topoclimates, the Romanian alpine zone has a moderate potential for the development of winter sports. Our objectives consist of making correlations between annual average temperatures and the average thickness of snow, between the years 1961 and 2000, in three resorts (Bãile Tuşnad, Bãile Harghita and Homorod). In certain cases, the ski slopes' locations were not correlated with site-specific topoclimate conditions - in such a situation, equally affected are both the users and the owners of the establishment and last but not least, the natural ecosystems they overlap. The study aims to draw attention to development opportunities for winter tourism in the Harghita Mountains area, located west of the Eastern Carpathians. At present, the Harghita Mountains are mainly exploited locally, despite having important winter sports-related assets. From November to April, in Bãile Harghita, Bãile Tuşnad and Bãile Homorod, located in the south-east and south-west of this mountainous area, there is a consistent snow cover on numerous slopes of various inclinations and orientations. The methods that were used in this study aim to determine the average dates of occurrence of the first and last layers of snow and therefore the average annual snow cover interval in the study area. The results show that there is untapped natural potential related to the average and maximum levels of snow thickness and to the number of days with snow-covered ground, especially in Harghita.

Keywords: climate, Harghita Mountains, evolution trend, snow cover.

1. INTRODUCTION

The general geographic features of the Carpathians and the complex structure of the underlying surface are responsible for a series of local characteristics of the climate which, in broad outlines, define a multitude of

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complexe and elementary topoclimats. The Harghita Mountains are no exception to this rule, the region abounding in suitable places for winter sports, as noted by (*Gaceu, 2005*).

The objective of this study is to determine whether or not the western slopes of the Oriental Carpathians are climatologically suitable for winter tourism. As the data is provided by the Miercurea Ciuc and Joseni weather stations, it can be considered valid for the tourist resorts in the Harghita mountainous region (Bãile Harghita, Bãile Tuşnad, Bãile Homorod). A series of local differences can be seen due to slope orientation, western marine air and eastern and north-eastern continental air advection, but also to altitude, landforms, vegetation etc. (*Schreiber, 1980*)

The correlations we found between the various climatic parameters took into account the research conducted by climatologists working for the National Meteorology Administration (ANM). The analysis – based on continuous series of data, provided by 94 weather stations, in service since 1961 – showed increased warming during the past decades (*Clima României, 2008*). By means of pluviometry, we noted a general trend of decrease in annual amounts of precipitation, which is more obvious than in the center of the country, showing a light increase in the North-East and certain southern regions. Seasonally, we identified a strong trend of precipitation increase during autumn (*Busuioc, 2003*).

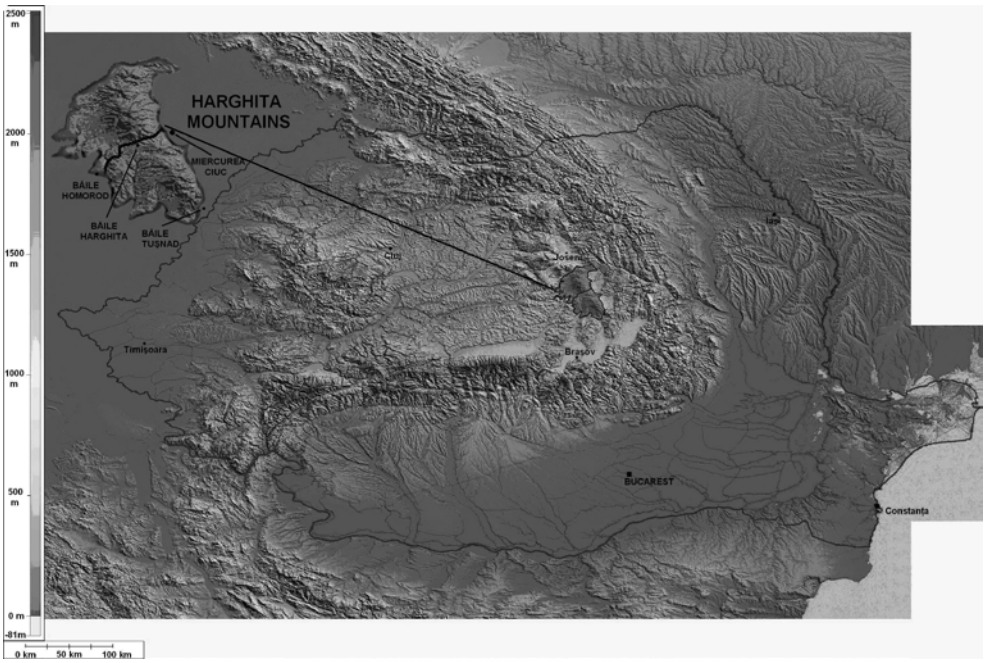


Fig. 1. ***Location of the Harghita Mountains***

Mountainous regions, in general, and the Harghita Mountains, in particular, do not only feature risks associated to the long persistence of the snow

layer, but also those associated to a persistence that is too short, thus limiting the winter sports season. Furthermore, it is not only the thick layers of snow (average and absolute maximum) which are considered, but also the less thick ones, that are particularly interesting in this region. Thickness increases with altitude (Băile Tuşnad - 650 m alt.; Băile Homorod - 750 m alt.; Băile Harghita - 1350 m alt.), thus resulting a fairly broad spectrum of track choices, depending on the slope and the characteristics of the snow.

2. DATA AND METHOD

2.1. Data

We used homogeneous data of average monthly temperature, snow cover and wind speed. The data series were provided by the Miercurea Ciuc weather station and supplemented by other sources (The Meteorological Yearbook 1961-1973). In Romania, as in other regions, the most numerous inhomogeneities in meteorological data sets are found in the data recorded during the nineteenth century and the first half of the twentieth century. The average daily temperature is obtained by the arithmetic mean of air temperatures measured at 00.00, 06.00, 12.00 and 18.00 UTC. For example, the average daily temperature is obtained as follows:

$$m = \frac{t_0 + t_6 + t_{12} + t_{18}}{4} \qquad (1)$$

Thusly, if the station Miercurea Ciuc recorded on January 15th, 1997 the following temperatures: -19.70 C -15.40 C -8.50 C -11.20 C, the average temperature that day is given by:

$$t = \frac{-19{,}7 + (-15{,}4) + (-8{,}5) + (-11{,}2)}{4} = -13{,}7^0 C \qquad (2)$$

For the same purpose, we used the values of wind speed for several speed intervals (0-1, 2-5, 6-10, 11-15; 16-20; 21-24; 25-28; 29 -34; 35-40;> 40 m / s) - mean values for each month and each year -, expressed in numbers of cases and percentages.

Average monthly climate data from October to May were used to identify the general average trends of air temperature, snow and wind speed (A.*Croitoru,2009*).

2.2. Method

To quantify the range of average annual snow cover for the three resorts in the Harghita Mountains, we used a method that employs the average date of the first layer of snow and the average date of the last layer of snow.

These two dates set the snow interval of a region. To determine the average date of occurrence of a weather phenomenon - in this case, the first snow layer –

one must fill in a table of all the dates corresponding to the first layer of snow for each year taken into account. Each date receives a code (the code for January 1st is 1, for January 2nd it is 2 and for December 31st - 365).

The average occurence date of the first snow layer is obtained by summing up the codes for the entire period - 1961-2000 -, and then dividing the result by the number of years taken into account (*Gaceu, 2002*).

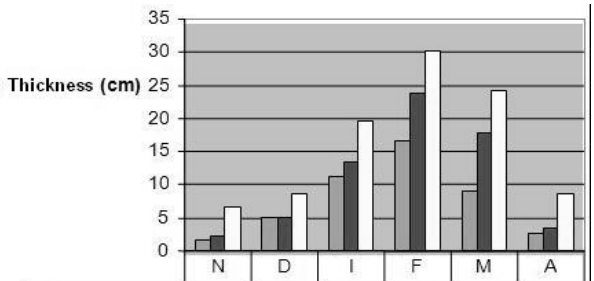
The result represents the code of the average date. The same method is used to obtain the average date of the last layer of snow. Therefore, the average annual snow layer interval is obtained.

3. RESULTS AND DISCUSSION

3.1. The snow layer

In the region we are analyzing, the snow usually lasts from November until April (Bãile Tuşnad, Bãile Homorod) and May (Bãile Harghita). During the month of May, the average thickness of the layer is less than one centimeter.

Note that the dates of snow occurence in the mountains of Harghita are offset from the dates of the first snowfalls. From December to April, the weather - typical mountain climate - will change the average thickness of the snow layer. It varies between 8 cm in December at Bãile Harghita, 5 cm at Bãile Homorod and Bãile Tuşnad and 30 cm at Bãile Harghita in February (Fig. 2). The smallest values may be less than 5 cm, except for the month of February, also adding the risk that the snow is completely absent. Thus, serious problems are generated for tourism activities, especially for winter sports, if the specific infrastructure (snow canons) is not available. The analysis concerning the average thickness of the snow layer is performed in order to find suitable locations for developing the winter sports infrastructure (*Voiculescu, 2007*). In addition, we must also mention the fact that all slopes in the Harghita Mountains (Miklós Csipike, Tófalvi, Kosuth3, Tusnad, Homorod) are located at an altitude of less than 1500 m, in forestry, where the phenomena of snowplows do not occur (Fig. 4).



	N	D	I	F	M	A
Bãile Tusnad	1.5	5	11.3	16.5	9	2.7
Bãile Homorod	2.2	5	13.5	23.8	17.7	3.3
Bãile Harghita	6.7	8.5	19.6	30	24.3	8.6

Fig. 2. ***Average thickness of the snow layer (1961-2000)***

The average dates of occurence of the first and last snow layer set the snow range of a region; however, because of wind, radiation, water and heat factors, snow is not maintained continuously during this interval. Thus, if at Bãile Harghita the average date of occurence of the first snow layer is November 14th and that of the last is April 24th, the average annual interval falls between 14.XI and 24.IV. With the same method we get 27.XI - 12.IV for Bãile Homorod and 02.XII - 07.IV for Tuşnad. Between these dates, the occurence of a snow layer is possible; the average snowfall period is of 161 days at Bãile Harghita, 136 at Bãile Homorod and 126 at Bãile Tuşnad.

3.2. Air temperature

For Miercurea Ciuc, data sets showed no significant changes in temperature (Fig. 3). We insisted on the October – April interval, when the snow layer in the Harghita Mountains has different levels of thickness, and the monthly multi-annual evolution trends feature certain aperiodic variations of air temperature.

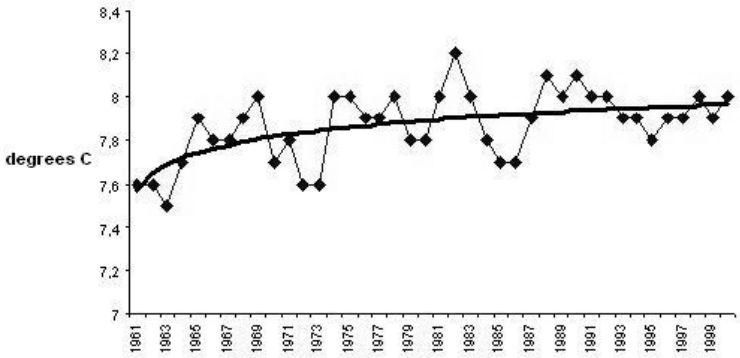


Fig. 3. ***The evolution trend in average annual temperatures at Miercurea Ciuc (1961-2000)***

4. CONCLUSIONS

Firstly, taking into account the data sets that were analyzed for air temperature and the thickness of the snow layer, we can conclude that climatic conditions are suitable for installation of new infrastructure for winter sports on the slopes of southern Harghita mountains. Secondly, it is recommended that the slopes be placed in forested areas – extremely important for strengthening the stability of the snow. Most importantly, the slopes in this area may represent a viable alternative to those in Prahova Valley (Predeal, Sinaia), which are

overflowing on weekends, if we consider the price difference between the two places and the relatively small distance between them (100-150 km).

Fig. 4. ***Snow cover thickness on the Miklós slope (february 2009)***

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