Evaluation of the bioclimate of submontane resorts located between Sucevița and Slănic Moldova based on the THI index

Constantin ROȘU[1], Dumitru MIHĂILĂ[1] and Petruț-Ionel BISTRICEAN[1,2]*
[1]Department of Geography, Ștefan cel Mare University of Suceava, Romania
[2]Regional Meteorological Centre of Moldova, National Meteorological Administration, Suceava, Romania

*Correspondence to: Petruț-Ionel BISTRICEAN. E-mail: petricabistricean@gmail.com.

CC BY 4.0
Vol. 32/2022, 14-28

GEOREVIEW

Published:
online first
28 March 2022

ABSTRACT: The present study aims to evaluate the bioclimatic potential of the submontane region between Sucevița and Slănic Moldova based on the THI thermo-hygrometric index, for which we used monthly data covering the period 1961-2013. From the analysis of this index, we aimed to identify the annual and multiannual regime of bioclimatic features for the targeted study area. The purpose of this study is to highlight the favorable periods of the year, when the comfortable and favorable time for outdoor activities prevails. The information obtained reinforces that there are resorts in the submontane contact area along the alignment between Sucevița and Slănic Moldova has a sedative-indifferent bioclimate, sparing with long periods of the year (from May to September) favorable for outdoor tourism activities: hiking, cycling, mountain biking, Nordic walking.

KEY WORDS: THI index, submontane balneoclimatic resorts in Moldova, bioclimatic comfort.

1. Introduction

The attractiveness of a tourist destination is largely determined by climatic conditions. Climate comfort is taken into account when choosing a tourist destination and especially when planning a stay. Today, the tourism potential of a region also takes into account a series of climatic elements, such as temperature, air humidity, the brightness of the Sun, rainfall, etc. Globally, there is a serious concern about assessing the climatic potential for outdoor tourism activities: hiking, cycling, mountain biking, climbing, Nordic walking or river rafting.

This concern refers to the calculation of bioclimatic indices that highlight the physiological effect of weather and climate on the tourist, but also periods of comfort or bioclimatic discomfort for a certain period of time (a month, a season, a semester or even a year). Bioclimatic indices usually

analyze several meteorological variables: temperature, relative humidity, wind speed etc. These indices have been used in numerous studies, such as those of Tseliou et al. (2010), Ramezani and Palici (2012) or Hassan (2015). Moreover, the interaction between climate and tourism has generated a new branch of climatology, called tourism climatology (Matzarakis 2006, 2010).

Studies undertaken in Romania have focused on assessing bioclimatic conditions (Teodoreanu et al., 1977; Ionac and Ciulache, 2008; Bistricean et al., 2017) and on assessing climatic conditions for tourism activities (Apostol and Gaceu, 2011; Grigore et al., 2015; Lungu et al., 2016; Mihăilă et al. 2018).

In this area of study, we mention the concerns of Bistricean et al. (2017) aimed at climatic and bioclimatic characteristics and balneary potential (mineral springs, salt mines) and provided clarifications regarding the bioclimatic region of Moldova, framing the researched territory to the contact between the sedative-indifferent and the tonic-stimulating bioclimate.

Mihăilă and Bistricean (2018) analyzed the favorable climate for outdoor tourism activities and for health tourism in Bălțătești, Târgu Ocna - Slănic Moldova using TCI, and in 2019, Mihăilă et al. (2019a) performs CTIS for the mentioned resorts. Mihăilă et al. (2019b) studies the thermo-hygrometric peculiarities of the Cacica salt mine microclimate.

Recently, Silişteanu et al. (2020) classified, on an altimetric basis, the resorts on the Suceviţa - Slănic Moldova alignment in the sedative-indifferent level.

The present study aims to evaluate the bioclimatic potential of the submontane region between Sucevita and Slănic Moldova based on the THI index, for which we had gridded data covering the period 1961-2013. From the analysis of this index we aimed to identify the annual and multiannual regime of bioclimatic features for the study area concerned.

The purpose of this study is to highlight the favorable periods of the year, when the comfortable and favorable time for outdoor activities prevails.

The objectives of the study:

- To calculate the monthly, seasonal, semestrial and annual THI values for each resort for the period 1961-2013;
- To determine the annual succession of the characteristics of the weather conditions (highlighted under the phrase: type of weather), respectively of the bioclimate typology (highlighted under the phrase: type of bioclimate) which follow one another within a year;
- comparative analysis on different time intervals (semesters, seasons, months) of the annual regime results of the type of time / type of bioclimate given by THI;
- stating clear conclusions about the characteristics of the weather in relation to man - as a biological individual and with outdoor tourism activities for an average year;
- outlining some coordinates of evolutionary trends (THI) based on climatic data held for the submontane area between Sucevița and Slănic Moldova from 1961-2013.

2. Study area

The researched territory is located in the central eastern part of Romania, at the contact between the Carpathian Mountains, to the west and the Suceava Plateau and the Moldavian Subcarpathians, to the east (Figure 1).

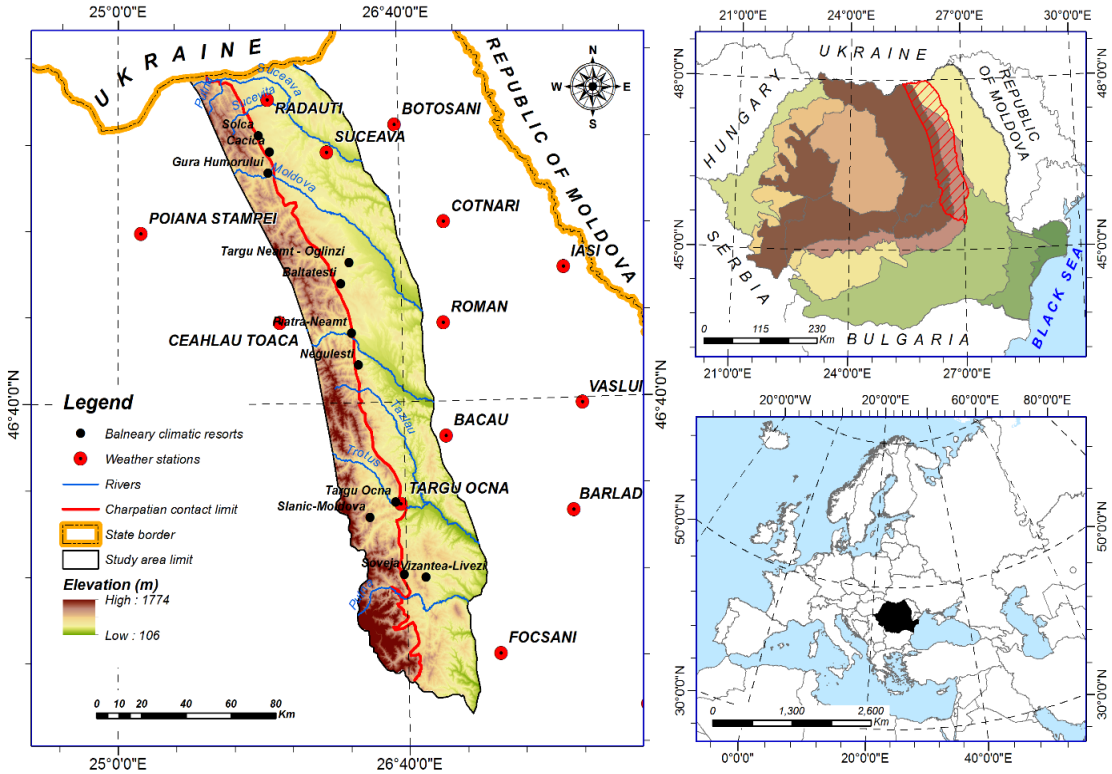

Figure 1 Study area - the submontane contact area between Sucevița and Slănic Moldova.

The entire study area has the N-S orientation, from Sucevița (47° 46´ N; 25° 43´E) to Slănic Moldova (46° 12´ N; 26° 26´ E), these localities being separated at a distance of 180 km (Figure 1).

The land consists of hills and depressions with average altitudes between 250 - 800 m.

The climate of the researched territory is moderate continental temperate, with mild winters (-2.6°C) and cool summers (17.5°C), moderate precipitations (600-700 mm year^{-1}) and with a reduced air dynamics that determine special shelter conditions (Teodoreanu, 1984).

The vegetation formed by deciduous and coniferous species ensures a clean, ozonated and ionized air in the chain of resorts located at the contact with the Eastern Carpathians.

A significant number of mineral springs from the substrate (37, of which 23 are therapeutically exploited) which complete, together with the two salt mines, the list of natural elements with balneoclimatic value.

3. Data and methods

To calculate the thermo-hygrometric index (THI) we used the monthly grid meteorological data from ANM (air temperature, relative humidity) for the period 1961-2013 (Dumitrescu and Bîrsan, 2015).

The database was processed and graphically translated into Excel. The spatial distribution of the THI index was synthesized by specific mapping methods using the ArcGIS v. 10.4 software.
The thermo-hygrometric index (THI) or the thermal stress index is a variant of calculating the Thom discomfort index based on the temperature and relative humidity of the air. It can be applied all year round, but it has the disadvantage that at THI values above 30°C it indicates the existence of hot bioclimates regardless of the temperature value.

Table 1 Value scale of the THI index (°C), type of weather and type of bioclimatic comfort / discomfort, by Bistricean (2020).

THI Index (°C)	Types of time	Types of bioclimate
-20 <THI ≤ - 10	Excessively cold	Bioclimatic discomfort by cooling
-10 <THI ≤ - 1,8	Very cold	
-1,8 <THI ≤ +13	Cold	
+13 <THI ≤ +15	Cool	
+15 <THI ≤ +20	Comfortabil	Bioclimatic comfort
+20 <THI ≤ +26,5	Warm	Bioclimatic discomfort by heating
+26.5 <THI ≤ +30	Very warm	
THI >+30	Heat	

The THI calculation formula proposed by Kyle in 1992 **[1]**:

$$THI\ (^{\circ}C) = Tusc - (0.55 - 0.0055 * RH) * (Tusc - 14.5) \quad \textbf{[1]}$$

where:
Tusc - air temperature in °C measured at the dry thermometer;
RH - relative humidity (%).

4. Results and discussion

4.1. Analysis of the annual regime of meteorological elements that are part of the calculation of THI at the level of the entire studied region, for the interval 1961-2013

First, we analyzed the annual regime of the two meteorological elements that constitute the THI index: temperature and humidity.

From the analysis of the annual regime of temperature and humidity of the air, first of all, it can be observed the inverse proportionality relationship between these two meteorological elements. The low values of air temperature associated with high values of relative humidity correspond to bioclimatic discomfort by cooling (in January, February, March, October, November, December). The summer months are characterized by moderate values of air temperature (15-19°C) and air humidity (76-78 %) specific to a bioclimatic comfort.

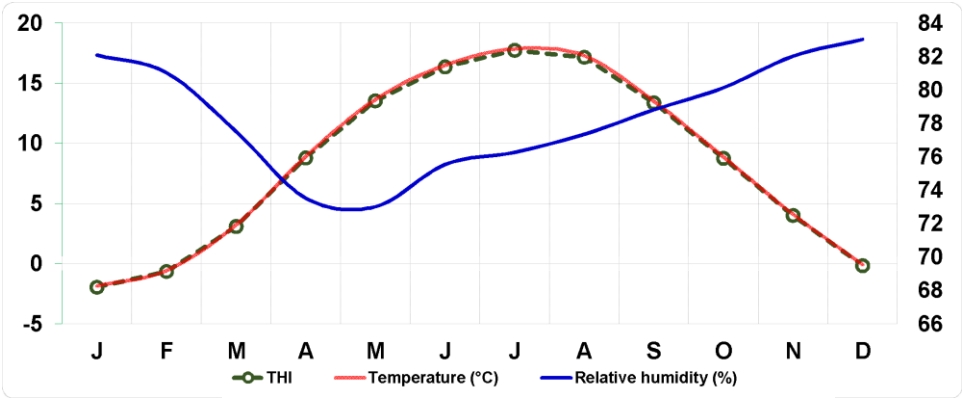

Figure 2 Annual THI regime, air temperature and humidity (1961-2013).

Secondly, there is the sinuous path of air temperature, with an obvious evolution from January (-1.8°C) to July (19°C), and then an involution until December (-0.2°C).

Therefore, an average annual thermal amplitude of 20.8°C is specific to the researched area. The relative humidity of the air has a much narrower level of evolution / involution: from values of 83 % (in January) to a minimum of about 74 % (in April) followed by an upward trend to values of 83 % (in December) and an average annual amplitude of only 10 %. Under these conditions, the THI index overlaps the air temperature graph (Figure 2).

4.2. Temporal and spatial analysis of annual and multiannual values of THI

Although the annual values of the THI index have a low relevance for bioclimatic analyzes, the evolution of this index over the 53 years analyzed highlights some interesting aspects. First of all, the role of geographical location. The northernmost resort, Sucevița, has the lowest values of this index (between 6° C and 9°C), compared to the southernmost resort, Târgu Ocna, where these values are significantly higher (between 8°C and 11°C). Secondly, there is a tendency to increase THI values due to the increase in air temperature (Figure 3).

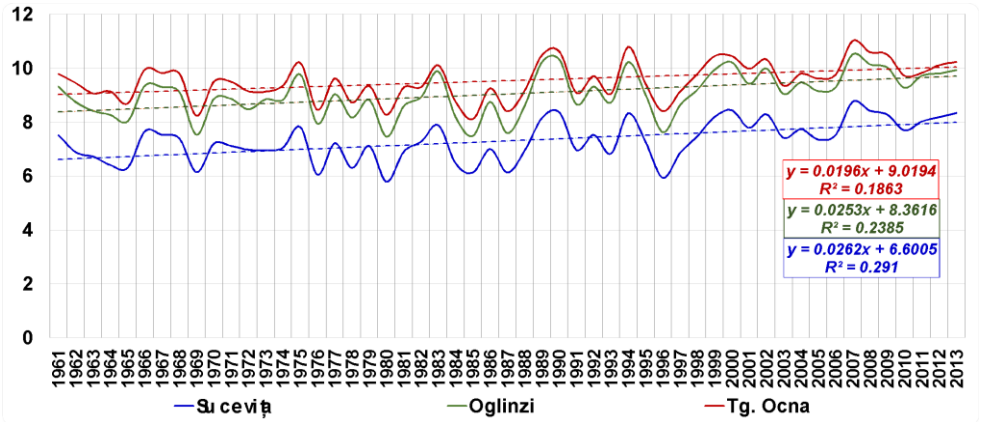

Figure 3 The trend of the evolution of the THI index in the resorts of Sucevița, Oglinzi, Târgu Ocna.

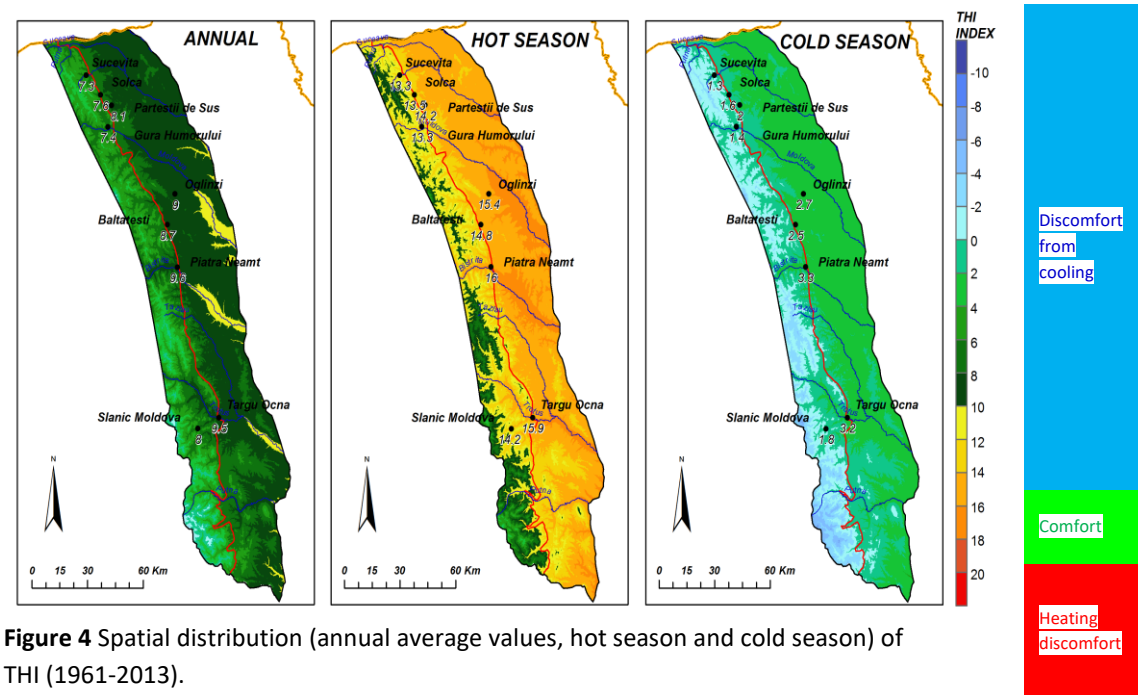

Figure 4 Spatial distribution (annual average values, hot season and cold season) of THI (1961-2013).

The spatial analysis of THI highlights the role of the Carpathians in the western part of the study area, which favors the graphic processes related to the descent of air masses that cross the Eastern Carpathians. Thus, in winter the temperature inversions are weak and the frosts have a low intensity. The heat waves, during the summer, are bearable, and the dryness and drought are not as large as those in the plateau area, to the east of the study region (Moldavian Plateau) (Figure 4).

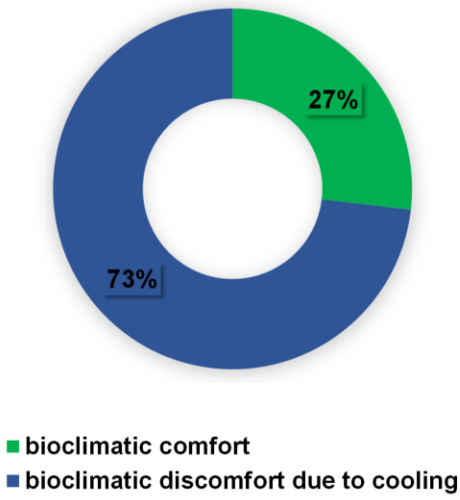

Figure 5 Types of bioclimate.

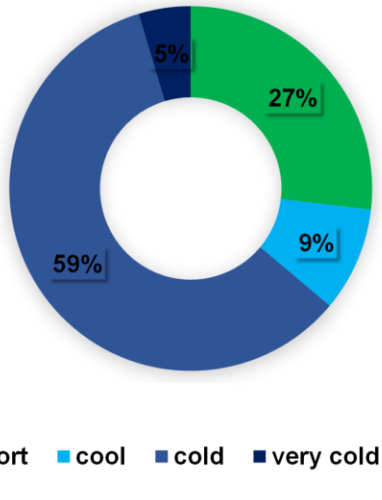

Figure 6 Types of weather.

These climatic characteristics are reflected in the annual values of THI which indicate a bioclimatic comfort (27 %), respectively a bioclimatic discomfort by cooling (73 %), and as types of weather

the cold weather predominates (59 %), comfortable (27 %), cool (9 %) and very cold (5 %) (Figure 5, 6).

4.3. The annual regime of THI divided into semesters

The warm semester is characterized by a predominance of bioclimatic comfort (54 %), due to temperature values between 15°C and 19.9°C and relative humidity ranging between 72 and 76 %. The warm season is characterized by a predominance of bioclimatic comfort (54 %), due to temperature values between 15°C and 19.9°C and relative humidity ranging between 72 and 76 %. Bioclimatic discomfort due to cooling (46 %) corresponds to a type of cool weather (28 %), respectively very cold (18 %) due to lower temperature values in the transition months, April and May and higher relative humidity values (over 80 % in September) - Figure 7.

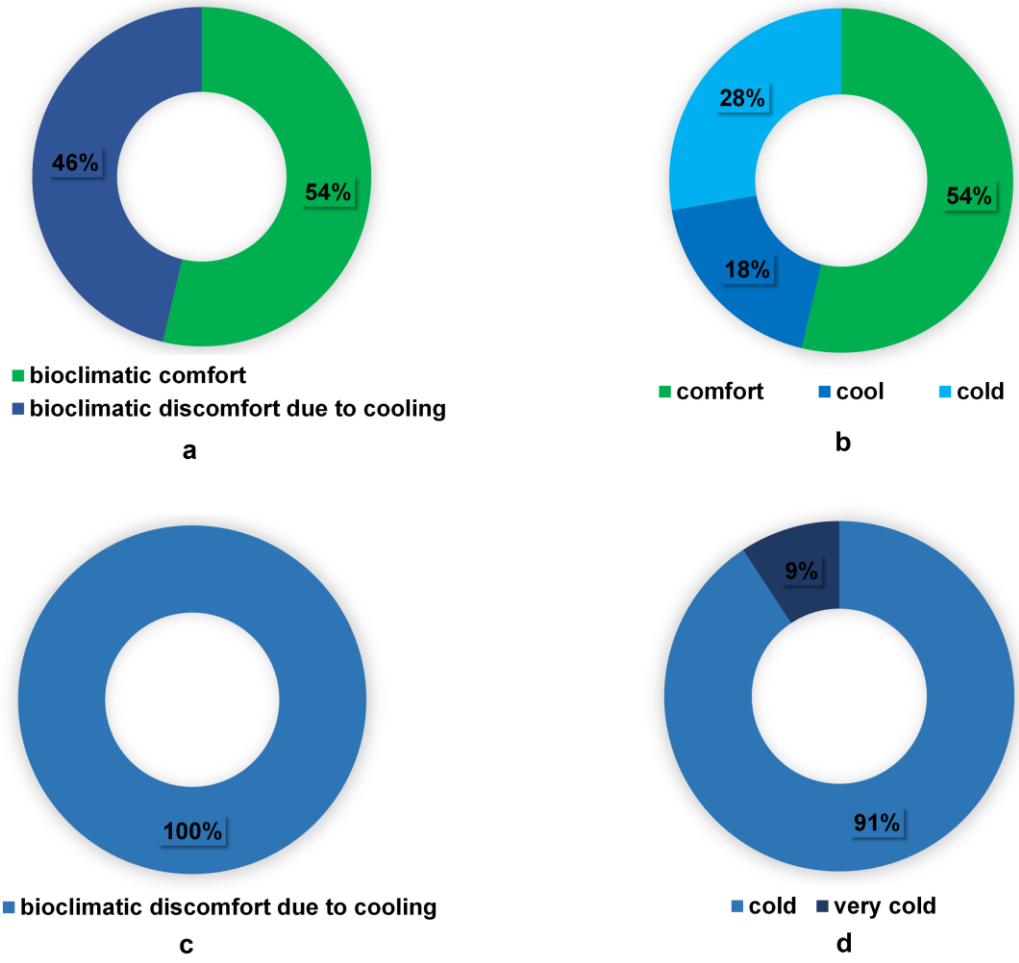

Figure 7 Types of bioclimate: a - the warm semester; c - the cold semester (1961-2013); types of weather: b - warm semester; d - cold semester (1961-2013).

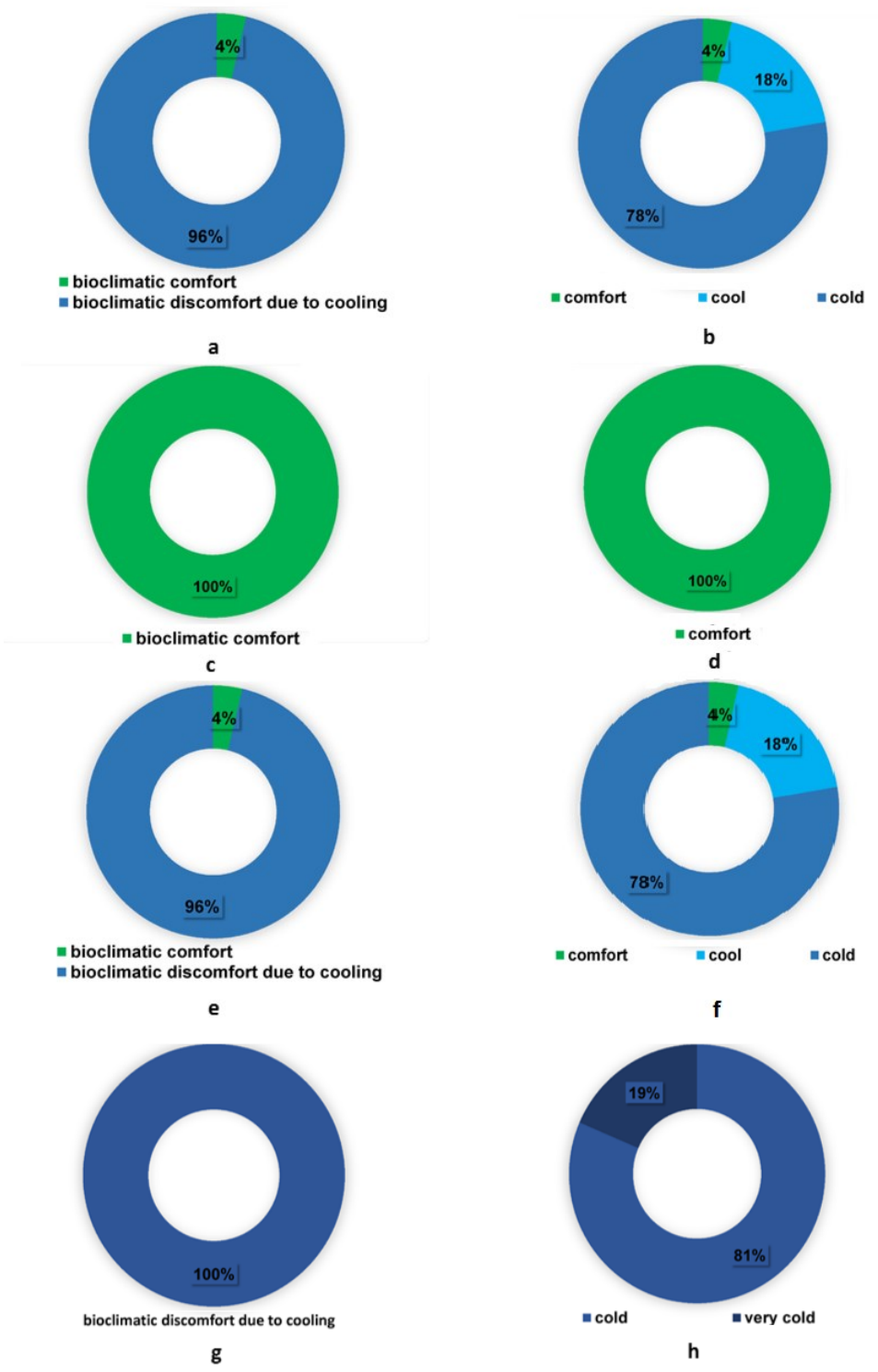

Figure 8 Types of bioclimate: a - spring; c - summer; e - autumn; g - winter (1961-2013); types of weather: b - spring; d - summer; f - autumn; h - winter (1961-2013).

The cold semester is characterized by a discomfort due to cooling that can be easily explained by the values of low average temperatures (-2.8°C ... + 9.9°C) and a high relative humidity (values over 80 %). Cold weather predominates (91 %), followed by very cold weather (9 %), and the dominant bioclimatic comfort/discomfort is cooling discomfort (100 %) (Figure 7).

4.4. The annual regime of THI divided by seasons (1961-2013)

Spring, being a transitional season, with modest values of THI in March and April (between 2°C and 10.3°C), retains most of the characteristics of the cold season, with a predominance of cold (78 %) and cool weather (18 %), and, as a type of bioclimatic comfort/discomfort, the discomfort caused by cooling still reaches very high values (96 %). Only in May it reaches values above 13°-14° and even 15°C in Piatra Neamț, which even indicates bioclimatic comfort.

Summer is the season in which bioclimatic comfort has a maximum share (100 %) with THI values between 15°C and 19.2°C (Figure 8c-d).

In autumn, a situation similar to the spring season is found, with THI values between 3°C and 15°C. September still keeps values close to the bioclimatic comfort threshold (between 13.0° and 14.7°C), so that in the following months, these values will be included only in the range of bioclimatic discomfort due to cooling (3.1°C - 9.9°C) (Figures 8e-f).

Winter is characterized by a bioclimatic discomfort (100 %) due to negative temperatures (values between -0.7°C and -4.6°C) and high values of relative air humidity (values over 80 % in all winter months). The coldest month is January with average negative THI values in all nine resorts. As weather type, cold (81 %) and very cold (19 %) types prevail, respectively the bioclimatic discomfort due to cooling (100 %).

4.5. Annual regime of THI divided by monthly average values (1961-2013)

The multiannual values of the THI index highlight the summer months (June, July and August) with values specific to bioclimatic comfort (15-20°C) (Table 2).

Table 2 Annual regime of THI divided by monthly average values (1961-2013).

Resort/month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
SUCEVIȚA	-2.8	-1.4	2.0	7.6	12.5	15.2	16.6	16.0	12.2	7.7	3.1	-0.9
SOLCA	-2.3	-1.0	2.2	7.9	12.6	15.4	16.7	16.2	12.4	8.0	3.5	-0.5
CACICA	-1.9	-0.9	2.8	8.5	13.3	16.1	17.4	16.8	13.0	8.5	3.7	-0.4
GURA HUMORULUI	-2.6	-1.4	2.0	7.6	12.4	15.2	16.5	16.0	12.2	7.9	3.2	-0.7
OGLINZI	-1.6	-0.4	3.8	9.7	14.5	17.3	18.6	18.0	14.3	9.6	4.7	0.1
BĂLȚĂTEȘTI	-1.6	-0.5	3.4	9.2	13.8	16.6	18.0	17.4	13.7	9.2	4.4	0.2
PIATRA NEAMȚ	-1.1	0.5	4.8	10.3	15.0	17.9	19.2	18.7	15.0	9.9	5.0	0.6
TG OCNA	-1.0	0.5	4.3	10.1	14.8	17.8	19.2	18.6	14.7	9.8	5.0	0.7
SLĂNIC MOLDOVA	-2.3	-1.1	2.7	8.4	13.1	16.0	17.4	16.9	13.1	8.4	3.7	-0.4

THI Index (°C)	Types of weather
-10 <THI ≤ - 1,8	Very cold
-1,8 <THI ≤ +13	Cold
+13 <THI ≤ +15	Cooling
+15 <THI ≤ +20	Comfort
+20 <THI ≤ +26,5	Warm

The months of the transition seasons (March, April, May, respectively, September, October and November) benefit from moderate THI values (Figure 9) between 2°C and 9.9°C, bearable for a series of outdoor activities.

Winter is marked by THI values close to 0°C, but they are also slightly restrictive (-2.8 ... +0.7°C). Although the bioclimatic discomfort due to cooling is now a permanent one, it falls within tolerable limits of the human body.

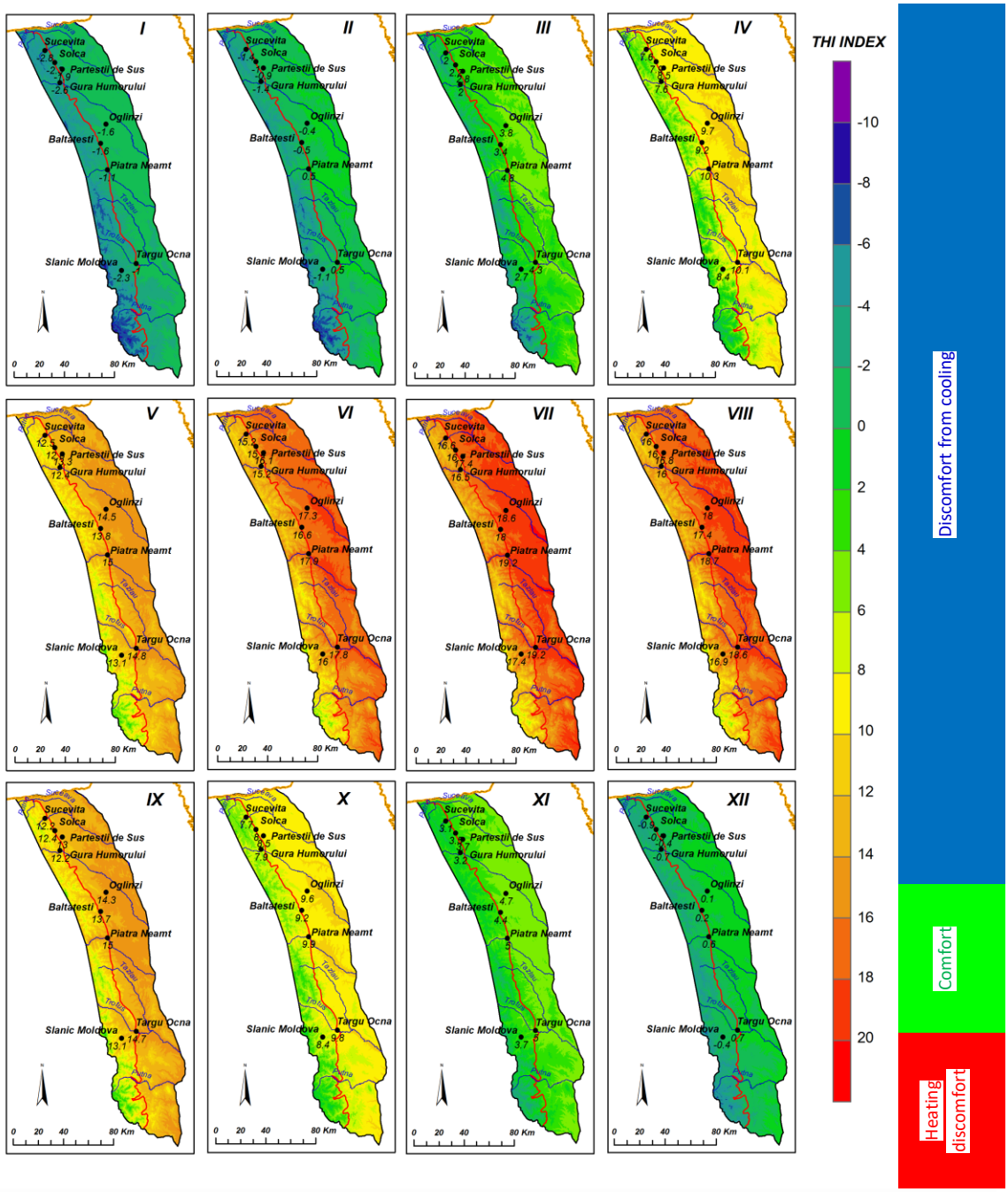

Figure 9 Spatial distribution of THI divided into monthly averages.

4.6. The multiannual inter-monthly regime of THI in Sucevița, Oglinzi and Târgu Ocna

Located at the foot of Obcina Mare, the tourist resort of national interest Sucevița is located in a special natural setting: the gentle peaks (with altitudes between 400-1000 m) around covered with coniferous forests ensure a clean and ozonated air; the rich hydrographic network is collected by the homonymous river that crosses the locality from west to east; the sedative-indifferent bioclimate and the mineral springs complete the natural dowry of the resort. A rich anthropic patrimony is added with monuments included in the UNESCO Patrimony (Sucevița Monastery). The inter-monthly regime of THI in Sucevița highlights some interesting aspects: grouping the months with bioclimatic comfort in the summer season; if in the first part of the analyzed period (1961-1987) these months are grouped 1-2-3 months, in the second part of the interval (1988-2013) the bioclimatic comfort is concentrated on all the 3 summer months.

There are also exceptions: in 1978 and 1984 there was not a month to have bioclimatic comfort, instead in 1994 and 2003 there were 4 consecutive months with bioclimatic comfort. Annual THI values ranged from 6.1°C to 8.8°C (Table 3).

Table 3 The inter-monthly regime of THI in Sucevița (1961-2013).

THI	1	2	3	4	5	6	7	8	9	10	11	12	average	THI	1	2	3	4	5	6	7	8	9	10	11	12	average
1961													7.5	1988													6.9
1962													6.9	1989													8.2
1963													6.7	1990													8.4
1964													6.4	1991													7.0
1965													6.3	1992													7.5
1966													7.7	1993													6.8
1967													7.5	1994													8.3
1968													7.4	1995													7.3
1969													6.1	1996													5.9
1970													7.2	1997													6.9
1971													7.1	1998													7.5
1972													7.0	1999													8.2
1973													7.0	2000													8.4
1974													7.1	2001													7.8
1975													7.8	2002													8.3
1976													6.1	2003													7.4
1977													7.2	2004													7.7
1978													6.3	2005													7.4
1979													7.1	2006													7.5
1980													5.8	2007													8.8
1981													6.9	2008													8.4
1982													7.3	2009													8.3
1983													7.9	2010													7.7
1984													6.5	2011													8.0
1985													6.1	2012													8.2
1986													7.0	2013													8.4
1987													6.1	average	-2.8	-1.4	2.0	7.6	12.5	15.2	16.6	16.0	12.2	7.7	3.1	-0.9	7.3

THI Index (°C)	Types of weather
-10 <THI ≤ - 1,8	Very cold
-1,8 <THI ≤ +13	Cold
+13 <THI ≤ +15	Cooling
+15 <THI ≤ +20	Comfort

The climatic and tourist resort Oglinzi-Târgu Neamț is located in a hilly floor with altitudes between 390-430 m, being bordered to the northwest by the Moldavian Subcarpathians (Pleşului Peak), and to the east it has a wide opening to the Moldavian valley. Chloro-sodium mineral waters, ionized air (over 1180 ions/cm^3, Teodoreanu and Bunescu, 2009) and the

indifferent sedative climate, make this resort a tourist destination with great development potential.

Being located in the center of the study area, Oglinzi resort has higher THI values than Sucevița resort. The months with bioclimatic comfort cover the summer season, but they also extend in the months related to the transition seasons, respectively in May and September. In the second part of the analyzed period (1988-2013) there is discomfort due to heating, in slight degrees, especially in July. Annual THI values range from 7.5° to 10.5°C (Table 4).

Table 4 The inter-monthly regime of THI in Oglinzi (1961-2013).

THI	1	2	3	4	5	6	7	8	9	10	11	12	average	THI	1	2	3	4	5	6	7	8	9	10	11	12	average
1961													9.3	1988													8.6
1962													8.8	1989													10.2
1963													8.4	1990													10.3
1964													8.3	1991													8.7
1965													8.0	1992													9.3
1966													9.4	1993													8.7
1967													9.3	1994													10.2
1968													9.1	1995													9.0
1969													7.5	1996													7.6
1970													8.9	1997													8.6
1971													8.9	1998													9.2
1972													8.5	1999													9.9
1973													8.9	2000													10.2
1974													8.8	2001													9.4
1975													9.8	2002													10.0
1976													7.9	2003													9.1
1977													9.0	2004													9.5
1978													8.2	2005													9.2
1979													8.8	2006													9.3
1980													7.5	2007													10.5
1981													8.6	2008													10.1
1982													8.9	2009													10.0
1983													9.9	2010													9.3
1984													8.2	2011													9.7
1985													7.5	2012													9.8
1986													8.7	2013													9.9
1987													7.6	average	-1.6	-0.4	3.8	9.7	14.5	17.3	18.6	18.0	14.3	9.6	4.7	0.1	9.0

Indicele THI (°C)	Types of weather
-10 <THI ≤ - 1,8	Very cold
-1,8 <THI ≤ +13	Cold
+13 <THI ≤ +15	Cooling
+15 <THI ≤ +20	Comfort
+20 <THI ≤ +26,5	Warm

The tourist resort of national interest Târgu Ocna is located at the contact between the Eastern Carpathians and the Subcarpathians of Moldova, in the west of the Caşin Depression on the Trotuș valley and the Slănic tributary. With an altitude of 260-280 m, the resort falls into the sedative bioclimate. Among the natural curative and health factors we mention Trotuș Salt Mine, mineral springs, ozonated air.

Positioned in the south of the study area, Târgu Ocna resort has a long period of the year with bioclimatic comfort. The THI index falls between the thresholds of bioclimatic comfort (15-20°C) from June to August. There are many situations in which bioclimatic comfort is installed in May (47.1 %), a specific aspect for September (39.6 %).

Table 5 The inter-monthly regime of THI in Targu Ocna (1961-2013).

THI	1	2	3	4	5	6	7	8	9	10	11	12	average	THI	1	2	3	4	5	6	7	8	9	10	11	12	average
1961													9.8	1988													9.2
1962													9.5	1989													10.5
1963													9.1	1990													10.6
1964													9.1	1991													9.1
1965													8.7	1992													9.7
1966													10.0	1993													9.1
1967													9.8	1994													10.8
1968													9.8	1995													9.4
1969													8.2	1996													8.4
1970													9.5	1997													9.1
1971													9.5	1998													9.8
1972													9.1	1999													10.5
1973													9.1	2000													10.5
1974													9.4	2001													10.0
1975													10.2	2002													10.3
1976													8.5	2003													9.4
1977													9.6	2004													9.8
1978													8.7	2005													9.6
1979													9.3	2006													9.8
1980													8.3	2007													11.0
1981													9.3	2008													10.6
1982													9.3	2009													10.5
1983													10.1	2010													9.7
1984													8.8	2011													9.8
1985													8.1	2012													10.1
1986													9.3	2013													10.2
1987													8.4	average	-1.0	0.5	4.3	10.1	14.8	17.8	19.2	18.6	14.7	9.8	5.0	0.7	9.5

THI Index (°C)	Types of weather
-10 <THI ≤ - 1,8	Very cold
-1,8 <THI ≤ +13	Cold
+13 <THI ≤ +15	Cooling
+15 <THI ≤ +20	Comfort
+20 <THI ≤ +26,5	Warm

Bioclimatic discomfort due to heating is present in a higher proportion compared to previous resorts (2.8 %, compared to 1.8 % in Oglinzi and 0 % in Sucevița) (Table 5).

5. Conclusion

The sub-mountainous region between Sucevița and Slănic Moldova has a high balneoclimatic potential: mineral springs, salt mines from Cacica and Târgu Ocna, indifferent sedative bioclimate, forest vegetation that generates clean, ozonated and ionized air.

To detail the bioclimatic characteristics, the analytical approach was based on the thermo-hygrometric index (THI). We used monthly grid data provided by the NMA for the period 1961-2013.

The periods of the year with bioclimatic comfort were identified following the analysis of the annual, seasonal, seasonal and monthly regime for each resort. The summer months stand out, followed by the spring and autumn months in which bioclimatic comfort holds the maximum share of time, and outdoor tourist activities can take place without restrictions: hiking, cycling, mountain biking, Nordic walking.

The trend of value growth of THI over the 53 years analyzed, indicates an improvement of the bioclimatic conditions for the transition seasons and an increase of the favorable period for tourist activities in all nine resorts.

The results of our study can be a starting point in the elaboration of a tourism development strategy of the submontane region between Sucevița and Slănic Moldova.

Acknowledgement

This paper received financial support through the project entitled: „DECIDE - Development through entrepreneurial education and innovative doctoral and postdoctoral research, project code POCU / 380/6/13/125031, project co-financed from the European Social Fund through the Operational Program Human Capital 2014-2020".

References

Apostol, L., Gaceu, O. 2011. The climatic-touristic potential of the Romanian Black Sea coast during summer, established according to the method of Besancenot, Mounier and de Lavenne. Carpathian Journal of Earth and Environmental Sciences, 6(1), 199-206.

Bistricean, P. I., Mihăilă, D., Lazurca, G.-L., 2017. Bioclimatic regionalization of Moldova west of the Prut river. DOI 10.1515/pesd-2017-0004, Present Environment and Sustainable Development, Vol. 11, no. 1, 45-54.

Bistricean, P. I., 2020. Potențialul balneoclimatic al stațiunilor turistice din Moldova. Ștefan cel Mare University Publishing House, Suceava.

Dumitrescu, A., Birsan, M.,V., 2015. ROCADA: a gridded daily climatic dataset over Romania (1961–2013) for nine meteorological variables. Natural Hazards 78(2): 1045–1063. DOI: 10.1007/s11069-015-1757-z.

Hassan, E. M., Vershosaz K., 2005. Analysis and estimation of tourism climatic index (TCI) and temperature-humidity index (THI) in Dezfoul. International Preceedings of Chemical, Biologica land Environmental Engineering (IPCBEE), vol. 85, pp 35-39.

Ionac, N., Ciulache, S., 2008. Atlasul bioclimatic al României. Ars Docendi, Bucharest.

Lungu, M., L., Ilieș, D., C., Josan, I., Ungureanu, M., Prefac, Z., Gaceu, O., Mateescu, R., 2016. The climatic-touristic potential of the romanian Black Sea coast during summer, established according to the indices of Burnet, Clausse-Goerout and Sarramea. Cercetări Marine, 46, 31-47.

Matzarakis, A., 2006. Weather and climate related information for tourism. Tourism and Hospitality Planning and Development, 3:99-115.

Matzarakis, A., 2010. Climate Change: Temporal and spatial dimension of adaptation possibilities at regional and local scale. In: Schott C (cd) Tourism and the implications of Climate Change: Issues and Actions, Emerald Group Publishing. Bridging Tourism Theory and Practice 3:237-259.

Mihăilă, D., Bistricean, P. I. 2018. The suitability of Moldova climate for balneary - climatic tourism and outdoor activities - a study based on the Tourism Climate Index, DOI 10.2478/pesd-2018-0021, Present Environment and Sustainable Development, Vol. 12, no. 1, 263-282.

Mihăilă, D., Bistricean, P.-I., Briciu, A.-E. 2019. Assessment of the climate potential for tourism. Case study: the North-East Development Region of Romania, Theoretical and Applied Climatology, Vol. 137, Issue 1–2, 601–622.

Mihăilă, D., Briciu, A.-E., Costan (Briciu) L.-A. 2019. Preliminary research on the thermo-hygrometric peculiarities of the Cacica salt mine microclimate, Georeview, Vol 29, No 1 (2019), pp. 60-69.

Ramezani, B. G., Palici, M., 2012. Recognition of monthly human bioclimatic comfort with tourism climate index in Ramsar, South-West of Caspian Sea, Iran. AGD Landscape & Environment, 6 (1), 1-14.

Silişteanu, S. C., Mihăilă, D., Dogaru, G., Bistricean, P.I. 2020. Balneoclimatology - where to?, Georeview.

Teodoreanu, E., Niculescu, G., 1977. „Stațiuni balneoclimatice" (map). Atlasul Geografic, pl. VII-7.

Teodoreanu, E., Dacos-Swoboda, M., Voiculescu, C., Enache, L., 1984. Bioclima stațiunilor balneoclimatice din România, Sport-Turism Publishing House, Bucharest.

Teodoreanu, E., Bunescu, I., 2009. The balneary and climatic potential of Oglinzi resort. Present Environment and Sustainable Development, Vol. 3, pp. 107-112.