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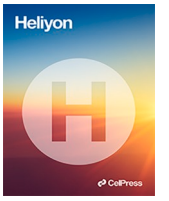

Research article

A bioclimatic evaluation of sustainable tourist activities in western Romania

Dumitru Mihăilă [a], Petruț-Ionel Bistricean [a], Răzvan-Ovidiu Gaceu [b], Elena-Maria Emandi [a], Emilian-Viorel Mihăilă [c], Vasilică-Dănuț Horodnic [a,*]

[a] *Department of Geography, "Ștefan cel Mare" University, Suceava, Romania*
[b] *Department of Geography, Tourism and Territorial Planning, Oradea University, Romania*
[c] *Department of Informatics, "Al. I. Cuza" University, Iași, Romania*

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ABSTRACT

The study analyzes with priority the bioclimatic conditions for tourist activities in two famous tourist areas in western Romania [(Băile Felix–Băile 1 Mai (BF_1 M) – Stâna de Vale – Vlădeasa and, respectively Băile Herculane (BH) - Semenic], from the perspective of the potential of health tourism and in the subsidiary of sports and camping tourism. Such researches are missing for western Romania. The main working tools in the evaluation of the tourist valences of the bioclimate include: the spatio-temporal analysis of the Physiologically Equivalent Temperature (PET) bioclimatic index, of the TCI climate-tourism index and of the climate-tourism schemes (CTIS). PET, TCI and CTIS were calculated and drawn up based on the daily data of the meteorological elements included in their calculation for the period 1961–2019. The bioclimate is analyzed as an element of potential that can increase (through a better evaluation and knowledge) the attractiveness and sustainability of the health tourism in the already established resorts (BF_1 M, BH) and can develop sports and camping tourism in the direction of the two proposed axes (Stâna de Vale – Vlădeasa și Semenic), with the decongestion of the resorts from the base the mountains. The proposed objectives consist inmulti-criteria evaluation, promotion and sustainable exploitation of the bioclimatic (and spa) resources of the six tourist destinations, but it also aims to increase the level of attention and information of all those interested, by promoting the bioclimatic and climate-tourism assets of complementary tourist destinations (Stâna de Vale, Vlădeasa, Semenic). The results obtained from the PET statistics show that between 25 and 39 % of the days of a year are comfortable, and the TCI statistics show that between 54 and 69 % of the days are favorable for the practice of tourism. PET and TCI highlight that from mid-April to mid-October the bioclimatic conditions for health tourism are good at BF_1 M and BH and that, only in the months of December–February the balneoclimatic procedures carried out outside the treatment bases are subject to climatic restrictions. Sports tourism has few temporal restrictions, and camping tourism restricts its duration, from April to October in lowland resorts, to May to September in mountain tourist destinations. CTIS shows that the resorts in western Romania have the most favorable bioclimatic and climate-tourism conditions in Romania.

* Corresponding author.
E-mail addresses: dumitrum@atlas.usv.ro (D. Mihăilă), petricabistricean@gmail.com (P.-I. Bistricean), ogaceu@gmail.com (R.-O. Gaceu), marina@atlas.usv.ro (E.-M. Emandi), emilian955@gmail.com (E.-V. Mihăilă), vasilica.horodnic@usm.ro (V.-D. Horodnic).

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1. Introduction and theoretical background

This paper is necessary because the potential of the bioclimate and climate-tourism has not been analyzed until now through methods and indicators so relevant for any balneoclimatic resort in western Romania. This area was chosen because it has the first three most important resorts with thermal waters in Romania: BF_1 M and BH and because the possibilities of diversifying the tourist offer and complementary types of tourism towards Stâna de Vale – Vlădeasa, respectively Semenic, can constitute a viable alternative that would lead to the reduction of tourist pressure on the spa resources in the three resorts located at low altitude. The innovative nature of the paper consists of combining these complex tools for analyzing the potential of the bioclimate and climate for tourism (including a mapping of the resources and tourist attractions that can be visited by tourists coming for cure/treatment in BF_1 M, respectively BF), from the analysis of PET trends, but also from the proposal of alternatives to balneo-climatic tourism, that diversify the tourist offer of the two areas and that could lead to a sustainable valorization of the spa resources, and to the development of alternative tourist axes around, with the economic-social development of the two regions.

1.1. Climate conditions in terms of tourism, for health, sports and camping tourism

i) *Choosing and accessing the tourist destination is influenced by the climate.* Climate and bioclimate conditions tourism, being at the same time a resource for this sector [1,2]. The relationships between weather, climate and tourism are important, multiple, complex and nuanced [3,4]. Weather, climate-tourism image and air quality influence the perception and decision of individuals and groups, related to tourist destinations [5–10]. Preferred and experienced weather conditions influence the choice of tourist destination [11, 12]. People travel to various destinations experiencing weather conditions, varying, from ideal, which create favorable conditions for tourism activity, to unfavorable, which act as limiting agents [13,14].

ii) The spa resources, complemented by the bioclimatic ones, increase the tourist attractiveness and constitute a premise for the diversification of the tourist offer.

Health tourism includes spa and wellness tourism [15]. Balneoclimatic resorts have as their main attraction mineralized thermal waters, treatment and relaxation bases, specific bioclimate, air quality, aeroionization, landscape, plus a matrix of other elements with a role of attraction for tourists. Prophylaxis, spa treatment are integrated with physiotherapy and rehabilitation medicine and involve a specific protocol, based on the study and practical application of physical parameters (heat, light, electricity, etc.) offered by natural therapeutic factors (climate, mineral waters, mud), combined with physical exercise [16]. Spas meet the requirements of treatment-oriented tourists who already have certain medical conditions, as well as healthy, wellness tourists, interested in maintaining or improving their well-being [17]. Geographical areas with spa and geothermal resources have a high tourist potential and a special attractiveness, wherever they are located, arousing the interest of researchers to assess them and propose solutions to manage their offer [18]. The attractiveness of areas, with mineral and thermal resources, increases proportionally with the availability and diversity of health tourism services, especially for the elderly [19]. The bioclimate of each resort has, as well, a big potential to attract tourists [20]. The physiological effort of the acclimatization process of tourists in a certain resort is recommended to be very low, in order for that resort to increase its attractiveness [21].The bioclimate at BF_1 M and BH is relaxing. The tourists who will come to the two resorts will not have adaptation problems, the bioclimatic stress being minimal.

iii) Contrasting tourist seasonality – a problem to be solved by judicious use of bioclimate resources.

Tourist seasonality is proof of the conditioning of the tourist sector by the climate, the seasonal concentration in tourist flows being a problem for which solutions are also sought [22] at BF_1 M, respectively BH. The mountain peaks of the Apuseni and Semenic Mountains can offer the alternative.

The balancing of tourist flows between the two seasons (warm and cold) that was also noted in other tourist areas [23] could be done in the current climate context by developing opportunities for outdoor, sports and camping tourism. An alternative to health tourism, for people who are not in therapy and treatment, but visit these resorts for curative and prophylactic purposes, is outdoor tourism, which involves relaxation, hiking, field therapy, and, complementary to them, sports tourism (gymnastics, tennis, sledding, skiing, etc.) and camping tourism.

An alternative to the heat of the warm season at BF_1 M and BH is hiking the mountain trails and camping at Stâna de Vale, Vlădeasa and Semenic. Camping, which is the largest sub-sector of outdoor tourism [24,25], involving accommodation and recreation in nature, is dependent on the climatic conditions which, from May to October are favorable in the Apuseni Mountains and in the Banat Mountains. Exposure to meteorological conditions is high and relevant for camping tourism in the context of the mountain floors of the Apuseni Mountains and the Semenic Mountains, but not as demanding as, for example, in Northern Europe [26]. Camping tourism with its multiple economic-social valences and determining weather-climatic conditions, is better researched in Western and Northern European countries [12,26,27,28,29,30,31,32,33], North America and very little in Romania.

Winter sports can be practiced in conditions of prepared slopes in Stâna de Vale, Vlădeasa and Semenic. In these tourist destinations, the snow resources for the skiing activity are good, but it must be taken into account that the changing climate parameters may negatively affect the entire skiing activity in the future [34]. Climate change also requires new strategies in the targeted resorts, to maintain or extend the duration of the ski season in a unitary approach, that includes all interested parties in this type of tourism [35].

iv) Judiciously exploited bioclimatic resources bring major economic advantages to the regions where high-profile tourist resorts are located.

Health tourism has a complementary to main role in generating multiplier effects on other components of the regional or local economic subsystem [36]. At BF_1 M and BH, in line with the change in the tourist profile after 1989, a slight shift from balneoclimatic tourism to wellness tourism can be observed, which is gaining ground. On this profile, Oradea appeared as a resort. The phenomenon has been observed in all its complexity in other tourist regions as well [37].

Tourism operators have an ambivalent relationship with weather and bioclimate resources. They are greatly advantaged by the favorable weather conditions for various types of tourism, such as health or sports tourism, the latter being mainly carried out outdoors [38–42].

Therefore, the integrated flow of monitoring actions - analysis - knowledge - promotion - valorization of bioclimatic resources in the case of the six tourist destinations will raise the economic level of the two geographical areas where the destinations are located.

1.2. The theoretical-applicative framework of the addressed research direction

Research in the field of climate conditioning in tourism can go in several directions. One direction analyzes the relationship between tourist flows and climatic conditions [43–46]. A second direction addresses the preferences and behavior of tourists in relation to the climate [11,47]. A third direction also addressed in the present study is represented by the use of the main climate elements (temperature, humidity, wind direction and speed etc.), bioclimatic indices (cold and heat stress, thermal comfort etc.) [48,49] and climate-tourists of medium complexity – TCI [50–55] or of high complexity - CTIS [56–58], in highlighting the climate-tourist offer of the resorts included in the present study.

PET has been applied in many countries, regions, localities or tourist resorts to evaluate human thermal comfort [59] for Valencia, Spain [60]; in Italian Alpine cities [61]; in Iran [62]; in Tehran [10]; for Xi'an, China etc.). Among the studies that use this index in the analysis of tourist potential from various natural or administrative entities around Romania, we can mention those belonging to Ref. [63] (for health tourism in Austria) [64]; (for the Vojvodina region of Serbia) [65–69]; (for regions, localities or the entire territory of Hungary) [48,70,71]; (for localities and islands in Greece) [72]; (for Odessa in Ukraine) [73,74]; (for Bursa and Uludağ in Turkey) [74]; (for the territory of Austria and a number of resorts in the Austrian Alps) [20]; (for five resorts in the Moldova region of Romania) [75]; for the southern coastal region of the Caspian Sea. The PET and TCI indices have influences including on the financial aspects of tourism in different destinations [76].

The Tourism Climate Index (TCI) is one of the most widely used indices that model climate information for use in tourism purposes. The TCI was proposed by Ref. [77] and uses a combination of seven climatic and bioclimatic parameters, but neglects human thermo-physiology, human comfort and discomfort, important factors for tourists and their degree of satisfaction during vacations [1]. PET, as bioclimatic index, completes the biometeorological deficiencies of TCI, giving additional information about the energy balance of the human body, about its state of comfort or discomfort, but the TCI as a climate-tourism index presents the advantage that it clearly reproduces the relationships established between the weather/climate element and the groups of tourists who arrive in a certain area. The two indices complement each other.

Some authors [51] used TCI to analyze the sustainability of tourism and the influence of climate change on it, in 40 cities in Iran [50,53,54]. assessed the impact of climate resources on tourism seasonality in China [55]. calculated the TCI for 39 meteorological stations, in order to identify the most suitable time and territories for practicing tourism activities in the province of İzmir in Turkey [24,25]. combined TCI and HCI (Holiday Climate Index) for tourism operationalization of 11 national parks in the United States of America. TCI has been used with good results so far, in only one study in Romania by Ref. [52].

CTIS renders at ten-day temporal resolution, climatic and bioclimatic information for tourism purposes [78,79], based on relevant and validated thresholds of bioclimatic indices or climatic elements, of importance and real impact in tourism and on their frequency of production. CTIS can adapt to analysis for different types of tourism through their thermal, physical and aesthetic components [80]. CTIS have been applied worldwide for countries, regions, coastal, urban or mountainous destinations and in different climatic conditions as for example: in Greece (Crete – [78]; Thesalonica – [48]), Taiwan [6], Croatia [79,81], Australia [82], Turkey [73], Iran [83, 84], Austria [74], Ukraine [72], Luxembourg [85], Algeria [56], Romania [20], Spain [86], China [87], Poland [57,58].

The activity in the field of health, sports and camping tourism is subject to a changing climatic reality and will have to adapt to it through rigorous planning [3,88–90]. Sports and camping tourism could become a viable, complementary, decongestant, alternative for tourism in BF_1 M and BH.

The objectives of this study (the first of this kind to be carried out for the resorts in western Romania) consist in: 1) the precise identification, based on the PET, of the periods of the year when tourist activities, depending on their typology, can be carried out in favorable bioclimatic conditions; 2) the promotion through TCI and CTIS of the climate-tourism assets that favor health, sports and camping tourism from the two tourist areas, but also the valorization of the tourist attractions in their surroundings; 3) encouraging the sustainable valorization in the perspective of the trends of the climate and bioclimate), of the balneoclimatic resources that have made some of these resorts famous, but also the emergence of new directions of tourist development, for the decongestion of tourism from the BF_1 M and BH resorts and directing tourist flows to a greater extent to Stâna de Vale – Vlădeasa, respectively Semenic. The study substantiates the role played by climate and bioclimate in tourist activities in the studied tourist destinations.

2. Materials and methods

2.1. Methods and means

The development algorithm of this study was based on *i)* the argumentation by means of PET of the bioclimatic peculiarities of the six analyzed tourist destinations, followed by *ii)* the highlighting of the time conditions relevant for tourism, supported by the calculation and analysis of the TCI. These indices are finally linked, sectorally or entirely in *iii)* CTIS, which reproduce in the most synthetic, complex and relevant form, the multivalent relationships between the climate-bioclimatic matrix and various types of tourism activities.

The PET index was calculated, based on daily data (average air temperature, relative humidity, cloudiness and average wind speed), with the RayMan 1.2 program proposed by Matzarakis https://www.urbanclimate.net/rayman/. In addition to the mentioned meteorological elements for PET calculation, we used time series of solar radiation and series of adjacent information on clothing, personal data on subjects (age, sex, height, weight) and on human activity [91]. In our study we considered the subjects (tourists, locals) to be men/women, aged 35 years, 1.75 m tall, with an average weight of approx. 80 kg.

The PET values were related to the scale proposed by Ref. [92] and which can be consulted in Table 1.

A more detailed description of the PET bioclimatic index calculations and the interpretation of its value scale, is given by Mihăilă et al. in the study of resorts from the region of Moldova, Romania, in 2019 [20].

TCI values were related to the scale proposed by Ref. [77] and which can be consulted in Table 3.

To determine TCI, we first calculated the five indicators included in its formula (1):

$$TCI = 2[(4*CID) + CIA + (2*P) + (2*S) + W] \quad (1)$$

CID (Daytime Comfort Index) is a sub-index for the calculation of which, one needs mean of daily temperature maxima (°C) and mean of daily relative humidity minima (%). CIA (Daily Comfort Index) is calculated on the basis of mean daily temperature (°C) and mean daily relative humidity (%). P represents mean monthly sum of precipitation (mm), S means daily duration of sunshine (hours) and W average daily wind speed (ms^{-1}). Each of the five indicators was given points from 5 to 0: 5 points show that the indicator provides ideal conditions for tourism activities, while 0 points indicate very restrictive conditions, impossible (according to Ref. [77]).

The climate-tourism schemes were drawn up with the help of the CTIS program developed by Ref. [93]. 14 components were used: 1) three thermal components: cold stress (induced by PET values < 8 °C); thermal comfort (18 °C < PET <29 °C), heat stress (PET >35 °C); 2) four aesthetic components (foggy days with humidity >93 %, sunny days with cloud cover <4/8, days with snow layer thickness >1 cm, days with snow layer thickness >20 cm); 3) seven physical components: (dry days - dehydrating - vapor tension between 0 and 7.4 hPa, normal days - hygrically balanced - vapor tension between 7.5 and 11.6 hPa, humid days – hydrating - vapor tension >11.6 hPa, dry days with precipitation <1 mm, light, short rainy days with precipitation <5 mm, rainy days with precipitation >5 mm and windy days with wind speed >8 ms-1) [48,68,78,94–96]. ArcGIS 10.8 was used to design the maps, and the bean plot and boxplot graphs were made using the Python program. PET (and TCI) trend analysis was performed using the parametric Mann-Kendal test and the non-parametric method of Sen [97], to determine the magnitude of change. Data processing was performed using the MAKESENS Excel model, developed by the staff of the Finnish Meteorological Institute [98]. Significance levels α for the Sen slope were between 0.001 and 0.1.

2.2. Data

In order to calculate the PET, TCI and CTIS generation, the daily time series of air temperature (minimum, average, maximum), relative humidity (minimum, average, maximum), water vapor pressure, cloudiness, duration of sunshine, atmospheric precipitation, wind speed, snow layer thickness, from the interval 1961–2019 from the meteorological stations Oradea, Băile Herculane, Stâna de Vale, Vlădeasa and Semenic.

The 25k topographic map from 1984 and SRTM80 m, respectively satellite images from the years 2019–2020 taken with the help of the Google Earth Pro program were used to create Figs. 1–3. To create Fig. 4, the CLC data set from 2018 downloaded free of charge

Table 1
Ranges of the physiologically equivalent temperature (PET) for different grades of thermal perception by human beings and physiological stress on human beings; internal heat production: 80 W, heat transfer resistance of clothing: 0.9 clo [92].

PET (°C)	Thermal perception	Grade of physiological stress
<4.1	Very cold	Extreme cold stress
4.1–8.0	Cold	Strong cold stress
8.1–13.0	Cool	Moderate cold stress
13.1–18.0	*Slightly cool*	*Slight cold stress*
18.1–23.0	*Comfortable*	*No thermal stress*
23.1–29.0	*Slightly warm*	*Slight heat stress*
29.1–35.0	Warm	Moderate heat stress
35.1–41.0	Hot	Strong heat stress
>41.0	Very hot	Extreme heat stress

Table 2
The synthetic parameters of PET (°C) for the two targeted tourist areas and for the 3 complementary tourist destinations in the interval 1961–2019. Share (in %) of daily average PET values on different value ranges (between <-10 °C and >41 °C).

The resort	BH_1 M	Stâna de Vale	Vlădeasa	BH	Semenic
PET AVERAGE	12.24	4.08	3.54	13.94	4.36
PET MAX	43.80	33.30	35.90	47.50	39.20
PET MIN	−21.90	−28.40	−28.90	−24.30	−27.90
PET%					
<-10	2.8	10.1	12.1	1.2	11.4
−10–0.0	18.0	28.7	28.8	14.8	27.4
0.1–4.0	10.2	10.9	10.6	10.8	10.4
4.1–8.0	9.2	11.0	11.1	10.1	10.4
8.1–13.0	11.2	15.0	14.1	11.4	14.0
13.1–18.0	*11.9*	*14.4*	*13.0*	*12.3*	*13.5*
18.1–23.0	*12.6*	*7.4*	*7.0*	*12.2*	*7.9*
23.1–29.0	*14.1*	*2.3*	*2.8*	*13.0*	*3.9*
29.1–35.0	7.9	0.2	0.5	9.6	0.9
35.1–41.0	2.0	0.0	0.0	4.1	0.1
>41	0.1	0.0	0.0	0.7	0.0

Table 3
The synthetic parameters of TCI scores for the two targeted tourist areas and for the 3 proposed axial tourist extensions for the period 1961–2019. Share (%) of daily average TCI values on different value ranges (ranged between <9 units indicating impossible days for tourism and 90–100 units, representing ideal days for tourism).

The resort		Băile Felix-1 Mai	Stâna de Vale	Vlădeasa	Herculane	Semenic
TCI AVERAGE		61.19	52.57	50.63	60.10	53.70
PET MAX		100.00	100.00	100.00	100.00	99.00
PET MIN		0.00	0.00	−3.00	8.00	8.00
Description of the impact of TCI scores on tourist activities		***TCI %***				
<9	Impossible	0.0	0.1	0.1	0.0	0.0
10–19	Extremely unfavorable	0.5	0.4	0.9	0.1	0.6
20–29	Very unfavorable	4.8	4.2	5.8	2.7	4.5
30–39	Unfavorable	7.7	12.3	15.0	8.5	12.7
40–49	Marginal	18.3	28.7	30.1	21.3	27.0
50–59	Acceptable	19.5	26.9	24.4	22.5	24.2
60–69	Good	13.4	13.7	11.7	14.1	13.5
70–79	Very good	17.3	9.6	8.1	14.5	11.4
80–89	Excellent	8.2	2.7	2.4	8.2	3.6
90–100	Ideal	10.2	1.4	1.5	8.2	2.4

from the Copernicus Land Monitoring Service portal was used (https://land.copernicus.eu/). For the analysis of tourist statistical information we used the TEMPO-Online database of the National Institute of Statistics (NIS), Tourism section.

2.3. Study area

The study is focused on the first analysis of the climate-tourism potential of the two tourist areas in western Romania whose spa resources have been known and exploited for a long time (at BH since 102 AD). During the summer season some of the researched resorts (BF_1 M and BH) are overcrowded. For some of the tourists who come to relax, heal and be treated in these resorts, the managers of tourist activities should think of programs and finance specific arrangements through which they can direct tourist flows to the multitude of objectives and tourist attractions around them, for a few days of their stay. The BF_1 M resorts represent the largest grouping of balneoclimatic resorts in Romania. They are located in the west of Romania at an altitude of 140–150 m, at the foot of the Șomleului Hill, 8 km from the municipality of Oradea (Fig. 1).

The Stâna de Vale spa resort is located at 83 km from BF_1 M, on the western slope of the Bihor Mountains (Apuseni Mountains), at 1100 m altitude. From Stâna de Vale you can walk to Vlădeasa on a route whose length is 21.4 km. Vlădeasa weather station is located close to the peak of the same name whose altitude is 1836 m. The BH station is located in the southwest of Romania, on the Cerna river valley, at an altitude of 160 m between the Mehedinți and Cernei Mountains (Fig. 1). From BH to the climatic tourist resort of Semenic, located in the Semenic Mountains at 1420 m altitude, it is 92 km.

According to Ref. [99] the thermal waters from BF_1 M belong to the hyperthermal category, they are above 38 °C, and those from BH have a temperature between 35.5 °C and 43.8 °C [100]. The bioclimate is demanding with relaxing nuances in the case of BF_1 M and relaxing with stimulating nuances in the case of BH. At Stâna de Vale, Vlădeasa and Semenic, the bioclimate is tonic with an increasing degree of stimulation as the altitude increases, the healthy and trained ones easily adapting to its conditions.

The surroundings of the BF_1 M and BH resorts present a multitude of tourist attractions (Figs. 2 and 3).

Near the BF_1 M resorts is the city of Oradea, which recently received the status of a balneoclimatic resort. It is a large city in

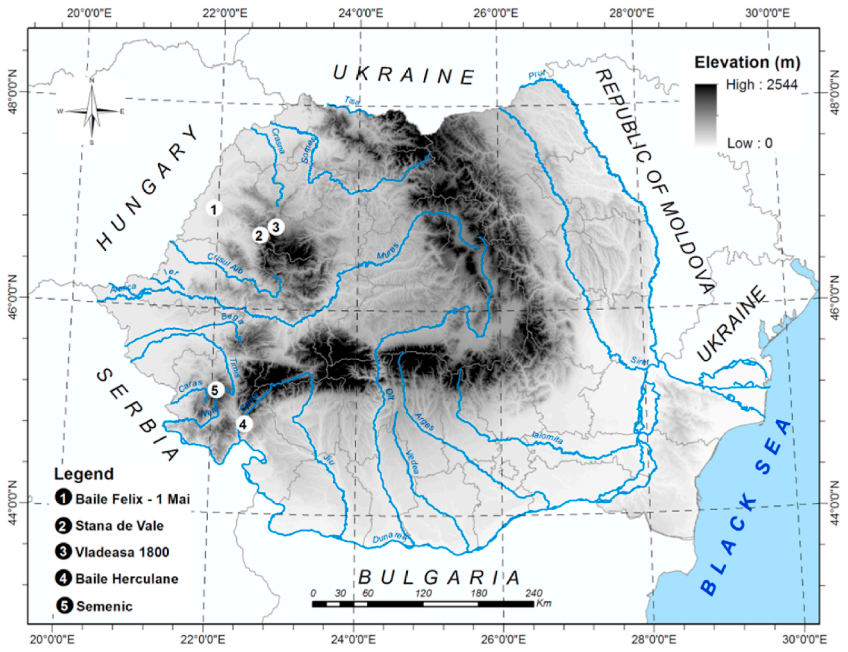

Fig. 1. Location of the tourist resorts BF_1 M, BH and alternative tourist destinations (Stâna de Vale – Vlădeasa and Semenic) on the territory of Romania.

Romania, 183.105 inhabitants at the 2021 national census, who has more than 15 first-rate tourist attractions (Fig. 2a). The historical and cultural heritage sites require at least three days to visit. Other tourist attractions in the vicinity of BF_1 M are Băile Tinca, the balneoclimatic resort of Stâna de Vale, the Vlădeasa massif and mountain peak, many famous caves, mineral and thermal springs, etc. The resorts presents numerous opportunities for relaxation, leisure and beauty and spa treatment, The hotels and the treatment centers offer many of these facilities (Fig. 2b).

The BH tourist resort is located in the south-western extremity of the Domogled Natural Park - Valea Cernei, in the immediate vicinity of the Mehedinți Plateau Geopark and very close to the Semenic-Cheile Carașului National Park, respectively to the Cheile Nerei - Beușnița and Portile de Fier natural parks (Fig. 3). The resort benefits from an unique landscape given by the limestone steepness of Domogled, preserves Roman remains, numerous touristic buildings from the Austrian, interwar and communist periods (Fig. 3a), and near it are the famous Cauldrons of the Danube and the Portile de Fier I dam (Fig. 3b).

In BF_1 M, human pressure on land use is high. Buildings are raised chaotically, not respecting elementary rules of arrangement. The non-irrigated arable lands still hold 36.1 % of the surface of a square with a side of 10 km that has the resort in its center. Next in weight are deciduous forests with 26.9 % and pastures with almost 13 %. The tourist infrastructure would still have room for expansion, but the thermal water reserves are overexploited, having long passed the stage of their sustainable use (Fig. 4).

In BH, the deciduous forests around the resort hold 47.6 % and the mixed forests 27.6 %. This aspect greatly improves the bioclimatic characteristics of the resort and creates the appearance of the existence of some possibilities to expand the tourist infrastructure at the expense of the forest or meadows (which own 5.2 %). In reality, there are very few buildable lands, the geomorphological framework of the Cerna river valley creating a spectacular landscape, but extremely restrictive for construction. Due to the extremely steep slopes and the very narrow valley, the possibilities of inserting new elements of tourist infrastructure are very limited. In the tourist resorts or on the mountain peaks where the types of tourism analyzed show a great potential for development, forest lands hold dominant shares (85.9 % in Stâna de Vale, 74.1 % in Vlădeasa and 86.6 % in Semenic) followed by meadows and grassland (10.6 % in Stâna de Vale, 19.2 % in Vlădeasa and 10.7 % in Semenic) (Fig. 4). In these last places, the natural vegetation has been very little modified by human interventions over time.

3. Results

3.1. The touristic importance of the researched resorts

In the tourist resorts BF_1 M and BH, the social tourism practiced before 1989 (as in Hungary) is currently continued in a more attenuated form through the National Health Center of Romania. Social tourism still attracts a large number of retirees with relatively modest incomes and keeps in operation, but in a stagnant form, a good part of the tourist infrastructure from BF_1 M, Stâna de Vale and BH. A part of the infrastructure has been modernized or is in a long and arduous process of modernization, especially in BH, where many buildings with a tourist destination are heritage buildings from the time of the Austro-Hungarian Empire or the Romanian royalty. A small number of tourism capacities are non-functional and have acquired the status of tourism-residential waste.

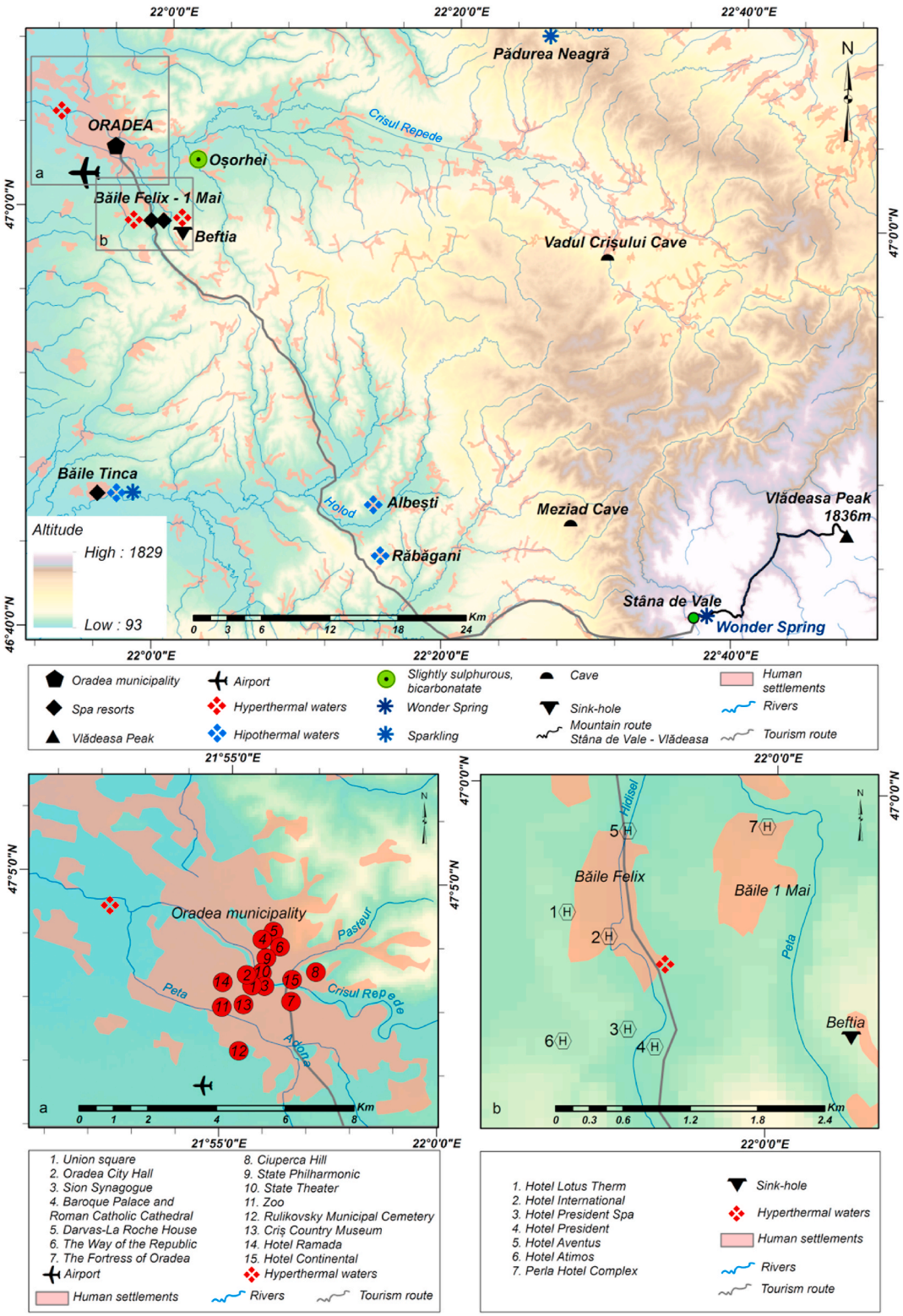

Fig. 2. Tourist map of BF_1 M resorts and surroundings (in a - the tourist attractions of Oradea are highlighted and in b there is information about the most representative tourist accommodation units in BF_1 M.

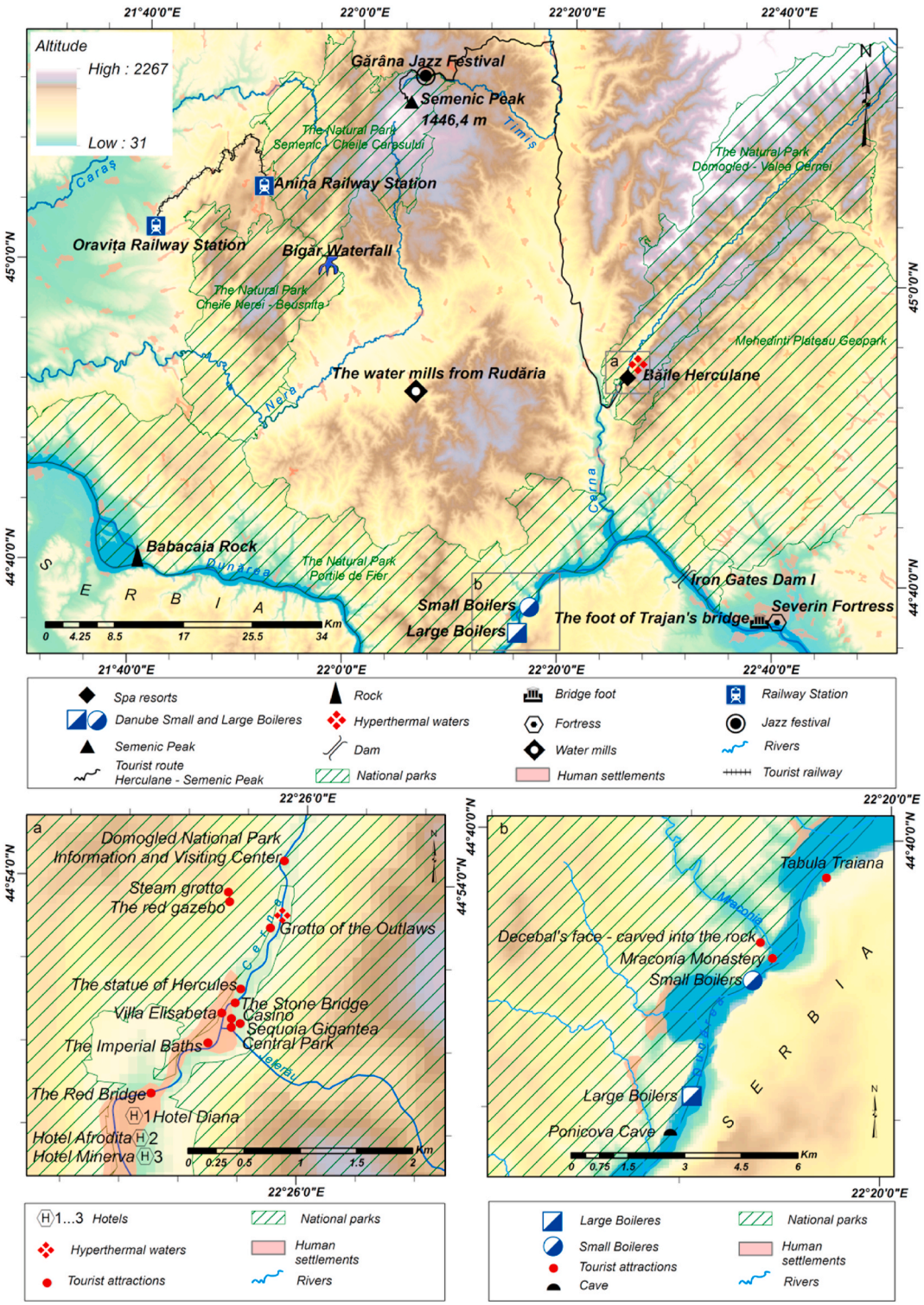

Fig. 3. Tourist map of the BH resort and its surroundings (in a the tourist attractions and accommodation facilities in BH are highlighted; in b the tourist sights of the Danube Boilers are detailed).

Architectural modernism seems that it will be imposed at BF_1 M, while at BH, Roman, Byzantine, Neoclassical, French Renaissance, Moorish, Austrian Baroque, Rococo etc. architectural styles are dominant, but the landscape also includes hotel buildings of large sizes, intended for mass tourism, from the communist period.

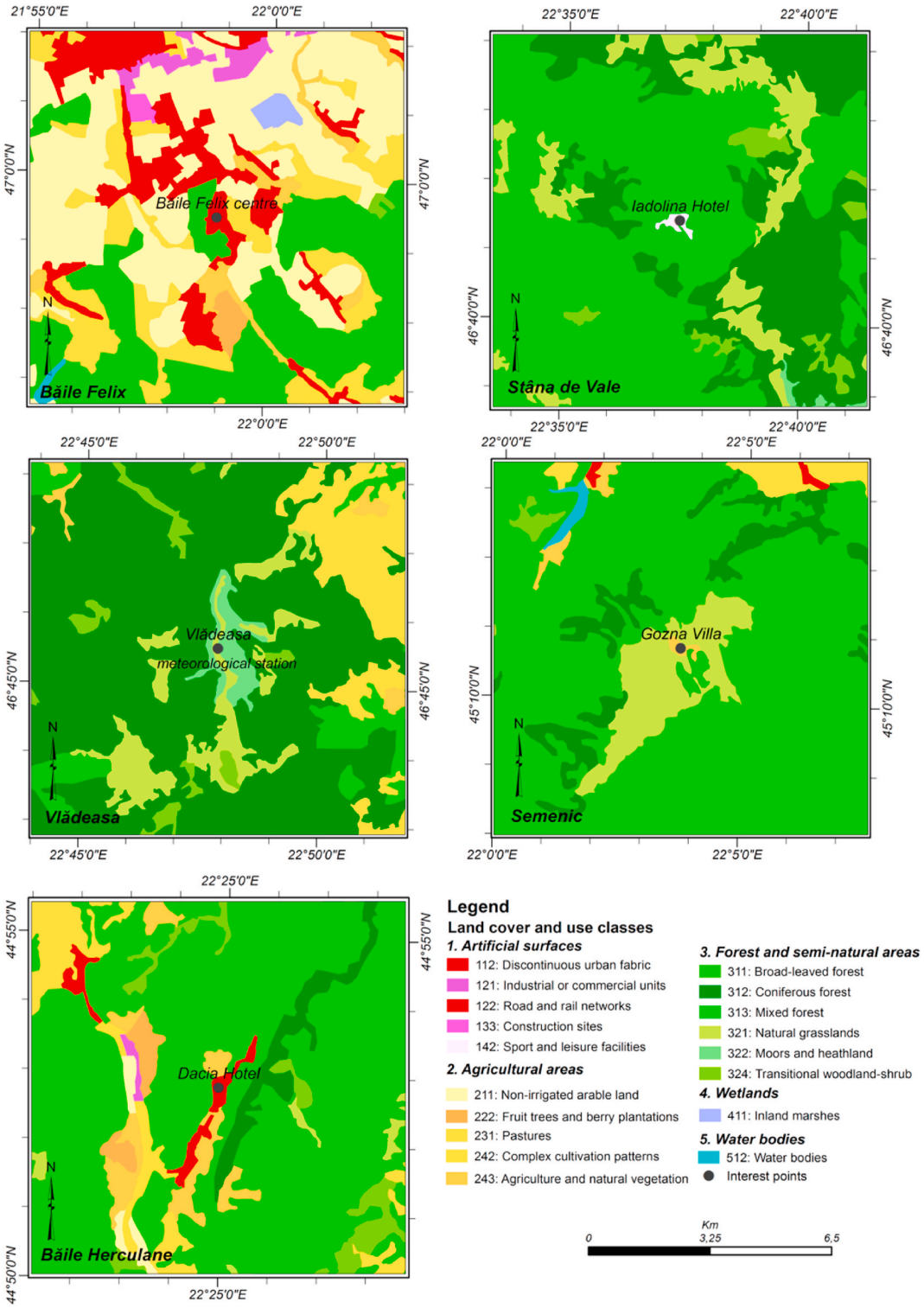

Fig. 4. Land use in the vicinity of BF_1 M, BH resorts and their complementary tourist destinations (the center of each map coincides with the center of the resort or extension, which is located in the center of squares with a side of 10 km).

The accommodation infrastructure of the BF_1 M resorts consisted in 1990 of 29 units, in 2021 of 124 units, and of the BH resort, increased from 23 units in 1990, to 74 units in 2021. The accommodation infrastructure regressed to Stâna de Vale from 8 units in 1990, to two in 2021, and on Vlădeasa it increased from one unit in 1990, to 4 units in 2021. The Semenic resort experienced a slight

increase from 6 units in 1990, to 16 in 2021. From the tourist accommodation infrastructure, the hotels are more representative: 21 at BF_1 M (15 3-star, 5 4-star, one 5-star) and 16 at BH (one 2-star hotel, 14 3-star and one 4-star). Most hotels have treatment centers and spas. The total accommodation capacity in 2021 rose to 8122 places at BF_1 M, to 4874 places at BH, 117 at Stâna de Vale, 141 at Vlădeasa and 638 at Semenic. The situation in 2019 (before the first pandemic wave) shows that a number of 224,336 tourists stayed at BF_1 M (993,364 nights of accommodation), and at BH, a number of 159,367 tourists (in 573,685 nights of accommodation). The annual flow of tourists shows great disproportions between the summer months (of the warm season) and the winter months (of the cold season). For example, in the month of August, on average, 131,675 overnight stays were registered at BF_1 M, and in January 25,426 overnight stays (ratio 4.8:_1). At BH, the average statistics (2010–2021) indicate 77,424 overnight stays in August and 11,863 overnight stays in January (ratio 6.6:_1). More detailed information on the statistical indicators related to the accommodation base and tourist flows can be found in the supplementary material attached to the basic study (SM – section 3.1). It is absolutely necessary that these imbalanced reports be mitigated by measures to extend the tourist season, including actions to better manage the local bio-climate/topoclimate. In the middle of the tourist season, BF_1 M and BH can constitute two generators and supporters of tourist flows for the surroundings. The occupancy rate of the accommodation capacity at BF_1 M and BF can be increased by improving the climatic services outside the peak tourist season, so that the two resorts improve their economic-financial indicators, especially in the spring and autumn months. It is very important that the satisfaction level of tourists visiting BF_1 M and BF, in relation to the management of tourism services rises to the very high potential given by the balneoclimatic resources and other natural resources of these resorts and surroundings.

3.2. *Analysis of bioclimatic features by means of PET*

The PET index was calculated at diurnal temporal resolution for the three base resorts (BF _1 M, BH) and for the 3 complementary tourist destinations (Stâna de Vale, Vlădeasa și Semenic), in the interval 1961–2019 (59 years). The evaluation of the bioclimatic effects was carried out by referring to the PET scale in Table 1.

From the analysis of the PET synthesis in Table 2, we can note that, based on multi-annual average values, the BH resort has the PET value (13.9 °C) within the value range that indicates a slight discomfort due to cooling, a normal value for a climate with sub-

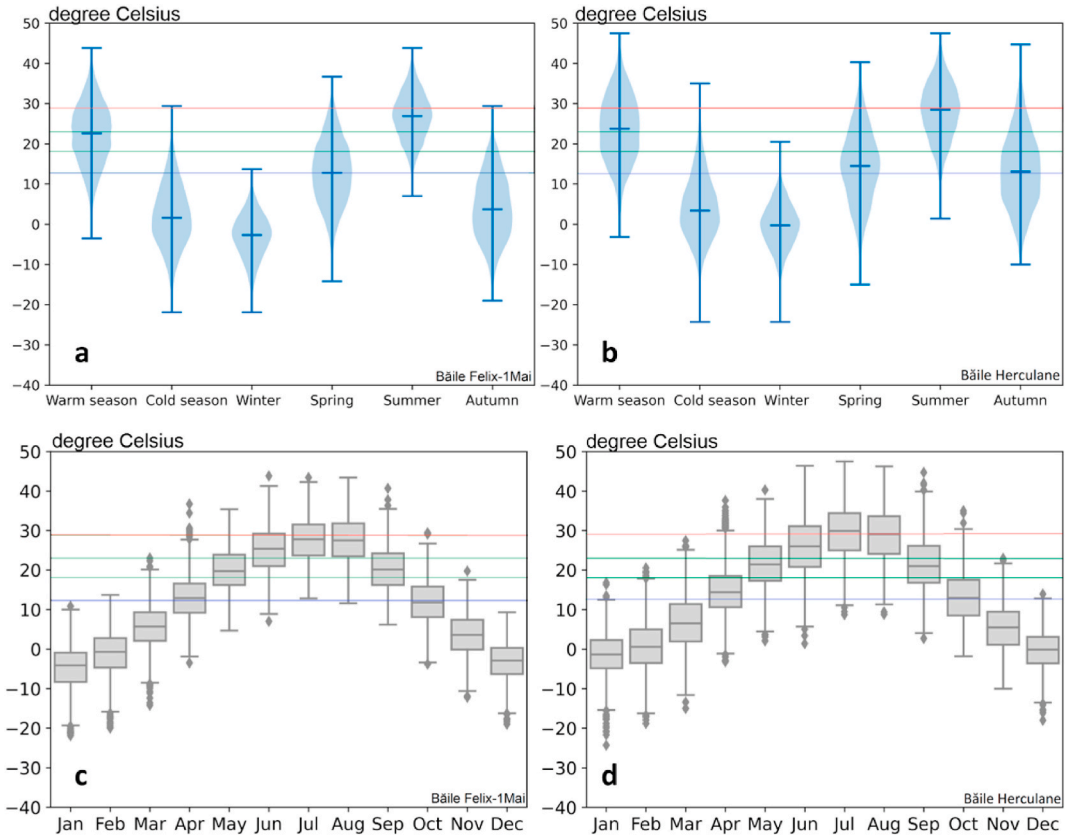

Fig. 5. The parameters of the value distribution by seasons and seasons of the frequency of days with different values of PET at BF_1 M (a) and BH (b) rendered by bean plot type graphs; parameters of the value distribution per month of the frequency of days with different values of PET at BF_1 M (c) and BH (d) rendered by boxplot type graphs (1961–2019); the blue, green and red horizontal lines on the graphs represent PET value thresholds, consistent with those in Table 2.

Mediterranean influences and a relaxing bioclimate with tonic and stimulating shades. At BF_1 M, the average value of PET (12.2 °C) indicates a moderate thermal discomfort through cooling, against the background of the weakening of Mediterranean influences at the latitude of this station, and the strengthening of oceanic influences. Stâna de Vale, Semenic and Vlădeasa are positioned, by their altitudes and due to the bioclimatic stratification, in the field of strong and very strong cold thermal stress.

The average annual share of days with bioclimatic comfort or with thermal discomfort (through cooling/heating), easily tolerable, is 38.6 % at BF_1 M, 37.5 % at BH, dropping to 24.1 % at Stâna de Vale, 22.8 % at Vlădeasa and 25.3 % in Semenic. In the resorts located below 300 m, tourists will enjoy the thermal comfort, in almost 40 % of the days of a year. Thermal discomfort through cooling in varying degrees, is specific in 51.4 % of days at BF_1 M, 48.3 % at BH, holding much higher percentages at Stâna de Vale (75.7 %), Vlădeasa (76.7 %) and Semenic (73.6 %). In the resorts located below 300 m, during the period of thermal discomfort, tourists can take full advantage of the spa facilities and spas and practice a multitude of outdoor activities (walking or cycling through the resorts and the surrounding forests, gymnastics, individual and team sports, visits to various tourist attractions, etc.). During these periods, business and scientific tourism find ideal conditions at BF_1 M and BH.

In the mountain resorts, the moist and cool, clean, oxygenated and aeroionized air - during the warm season, to which is added the layer of snow during the cold season, constitute first-rate attractions for tourists staying in the resorts at the base of the mountain, and visiting them. Summer camping and winter sports have ideal conditions to practice.

Thermal discomfort in different degrees of stress due to heating has annual weights of 10 % in BF_1 M, 14.4 % in BH and much lower in Stâna de Vale (0.2 %), Vlădeasa (0.5 %) and Semenic (1.0 %). The minimum PET values indicate the possibility of producing episodes of time with extreme stress, due to the cold, especially in the resorts of the mountain floor (Stâna de Vale, Vlădeasa and Semenic) and, in a much reduced proportion (even for the BF_1 M and BH resorts), of severe and moderate heat stress episodes.

From the analysis of Fig. 5a and b we can see that most days in the warm season of the year have PET values positioned in the comfort range and do not raise restrictions on tourism activities. The early days of the warm season are frequently marked by cooling discomfort, the late ones as well, and, in the middle of the season, there are many days marked by heating discomfort At BH, the days with cooling discomfort are less numerous, and those with heating discomfort are more numerous than at BF_1 M. In the cold season and especially in winter, the discomfort marked by the cooling of the air gives the bioclimatic normality. Half of the spring and summer days are comfortable. The other half is marked by discomfort through cooling and heating respectively, with small differences between the two resorts. In autumn at BH, the comfortable time holds about ½ (half) of the number of days, but at BF_1 M, the comfortable time is reduced to ¼ (a quarter) of the number of days.

Analyzing the situation by month (Fig. 5c), we note, for BF_1 M, that from mid-April to mid-October, the days with comfort are dominant. In July and August, the number of days with discomfort due to heating, holds approximately 40, respectively 30 % of the total number of days of these months. The high values of air temperature and solar radiation during middays, generate this situation. Outdoor exits can take a short break during tropical or hot midday air temperature hours. In mountain resorts, days with comfortable weather reach their maximum frequency in summer, and afternoons are mostly comfortable (SM – section 3.2).

The months of May and September are the most suitable for outdoor activities, and the months between November and March are the most restrictive. At BF (Fig. 5d), the analysis carried out shows that from April (when 75 % of days are comfortable) to October

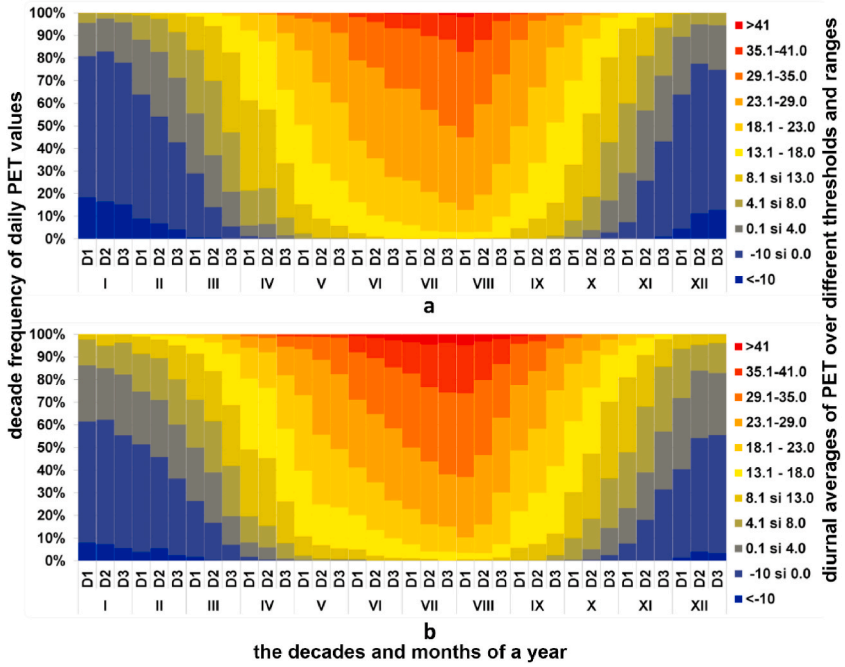

Fig. 6. The monthly and 10-day interval frequency (%) of the number of days with different values of PET in BF_1 M a și BH b (1961–2019).

(when 50 % of days are comfortable) thermal comfort, with a number of exceptions, is dominant. The exceptions refer to the fact that in June, 55 % of days with discomfort due to heating are recorded, in August, 50 %, and in June, around 15 %). The afternoons of these days are marked by periods of tropical or even hot and drizzly weather.

Detailing the situation at the level of decades (Fig. 6a and b), we can notice the annual alternation of the types of discomfort (by cooling – in the days of the cold season, and by heating – in the days of the warm season). In the middle of the cold season and winter, the days with thermal discomfort through cooling, become dominant, and in the middle of the warm season and summer, the days with thermal discomfort through heating, become dominant. Comfortable weather does not appear in the statistics in the winter, it is greatly compressed in the summer, and it gains a greater weight in the transitional seasons. Knowing the decadal weights of PET on different value steps and having the appreciation of their bioclimatic impact, tourists who opt for the BF_1 M, BH resorts will choose, according to their personal bioclimatic requirements, the scheduling of their stay, in the period of the year that suits them best. From March to November inclusively, by scheduling the stay based on bioclimatic statistics and weather forecasts, tourists can make the most of the weather they want during their stay.

3.3. *Analysis of climate favorability for outdoor tourism and sports activities through TCI*

TCI, as a climate-tourism index, shows us that, in BF_1 M, 68.6 % of the analyzed days, and in BH, 67.5 % of the same days, met conditions from acceptable to ideal for tourist activities. In Stâna de Vale, their percentage dropped to 54.3 %, in Vlădeasa to 48.1 %, and in Semenic it was 55.1 % (Table 3).

The climate-tourist potential of BF_1 M, BH resorts, outlined on the basis of daily TCI values, is high, and that of the mountain resorts is of average value. Acceptable conditions for tourism are specific, including in all decades of the winter months, in proportions between 10-15 and 25–30 % of their number of days.

From the second decade of March, to the first decade of November inclusively, more than 50 % of the days have TCI scores that rise above the threshold of 50, indicating favorable conditions for practicing outdoor tourist activities. Very good conditions for tourism occur from the first decade of March to the first decade of November, and excellent and ideal conditions, from the third decade of March to the first decade of November. During the summer, in both resorts, we do not identify statistically, days with restrictions for

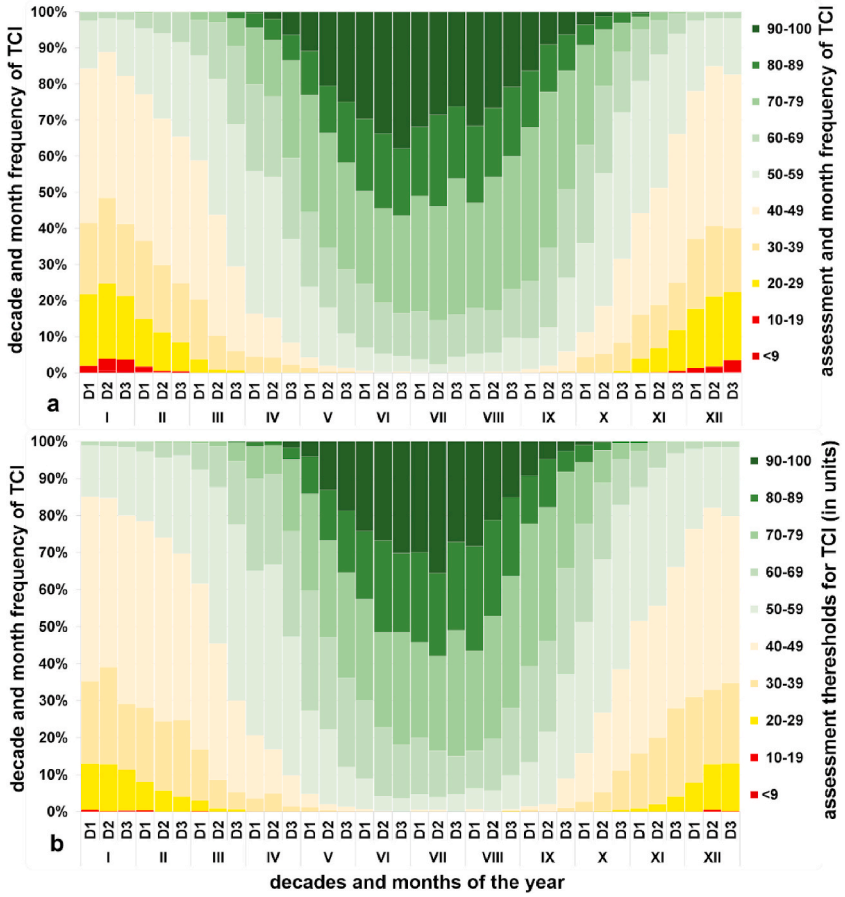

Fig. 7. The monthly and 10-day interval frequency (%) of the number of days with different values of TCI in BF_1 M a și BH b (1961–2019).

tourism, and in the months of May and September, we identify. In all the decades of April and October, the days favorable for the practice of tourism are dominant. In the last two decades of March and the first decade of November, favorable days for tourism prevail (Fig. 7a and b).

The proportion of days with TCI scores below 49 units, dominates from the second decade of November to the first decade of March. In this interval, extremely unfavorable or impossible days for tourism also occur, but their frequency is low (below 5 %/decade). In the mountain resorts, the days with favorable conditions for tourism, diminish their weight in favor of those with restrictive conditions for tourism (Fig. 8a, b and 8c).

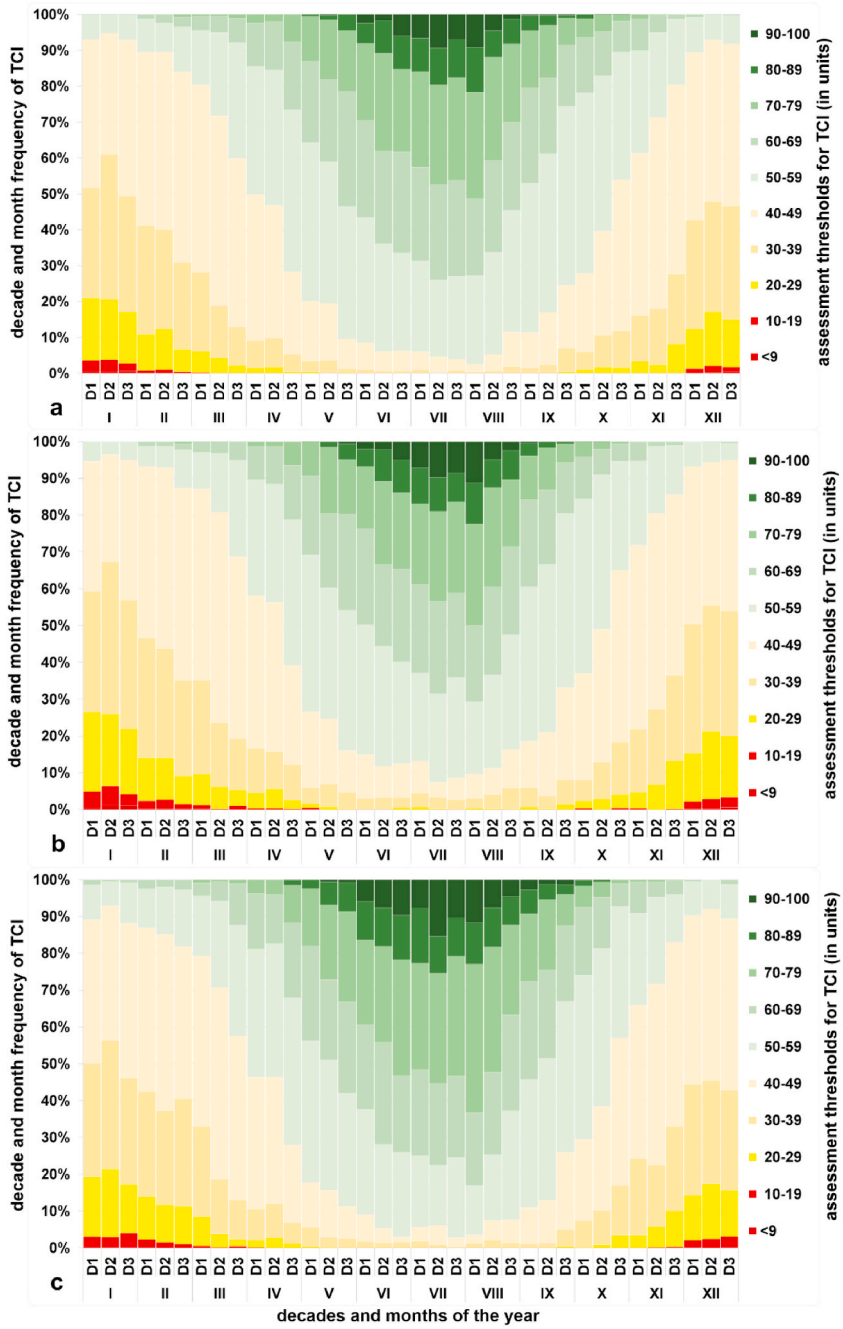

Fig. 8. The monthly and 10-day interval frequency (%) of the number of days with different values of TCI in Stâna de Vale a, Vlădeasa b și Semenic c (1961–2019).

3.4. Analysis of climate favorability for spa, outdoor and sports tourism activities through CTIS

CTIS is a synthetic, multi-criteria assessment tool, at a time resolution of 10 days (1/2 half of the average duration of a balneoclimatic stay), of the climatic elements and phenomena that really matter in tourism, for most forms and types of tourism, with even more so, for balneoclimatic, sports and camping tourism.

From the point of view of cold stress, manifested when the PET values are <8 °C, we note for BF_1 M that, from the third decade of March to the third decade of October, there are no significant restrictions. At BH, the unconditional interval of cold stress is longer by a decade, including the first decade of November, due to the influence of the Mediterranean cyclonic circulation. Heat stress (PET >35 °C) does not have a real impact at the decade level, manifesting in clusters of hours in the afternoons of some days in the summer months, with a somewhat higher power and frequency at BH, due to the more southerly geographical position. This parameter does not restrict tourist activity in the three resorts. Thermal comfort (13 °C > PET <29 °C) lasts at BF_1 M, from the second decade of April (at BH from the first decade of this month) until the second decade of November inclusively. The days with these PET values are most numerous in the months of May and September (Fig. 9a and b).

Dehydrating days for the respiratory tract do not have a frequency that imposes them as a negative determining factor for the comfort of tourists, from the third decade of March to the second decade of November. Normal days from the hygric point of view are specific to the decades of the spring and autumn months, the parameter in question diminishing its characteristics at BH compared to BF_1 M. Hydrating days do not cause respiratory problems, from the second decade of October to the first decade of May at BF_1 M (respectively the last decade of April at BH). Foggy days have a low frequency in the three resorts, giving excellent and ideal conditions for practicing the activities scheduled in any decade of the year. The degree of sunshine is acceptable, good and very good in almost all decades of the year in BH (the exception is the second decade of February). At BF_1 M, from the second decade of November to the third decade of January, the conditions for tourism given by this parameter are marginal.

The reduced decadal frequency of drier days (with precipitation below 1 mm), indicates good to very good conditions for both seasons and all decades, for the practice of any form of tourism. Days with precipitation below 5 mm are even less frequent, giving very good and excellent conditions for tourism, and days with precipitation above 5 mm are even less restrictive in terms of tourism, due to their very low decadal frequency. Such days, by their reduced frequency, make the conditions ideal for tourism in most decades of the year. Windy days do not pose problems for tourism. The snow layer analyzed only for the BH resort (but also for the mountain resorts - in SM – section 3.3) is deposited on the topographic surface, from the third decade of November to the third decade of March, but the conditions for skiing (layer of snow >20 cm) really meet only in the first decade of January. At Stâna de Vale and on Semenic, skiing can be practiced from December to March, inclusive.

3.5. Evolutionary trends of bioclimatic features with relevance for tourism activities

PET trends clearly show the value growth, with good statistical assurance over the period 1961–2019 (Table 4).

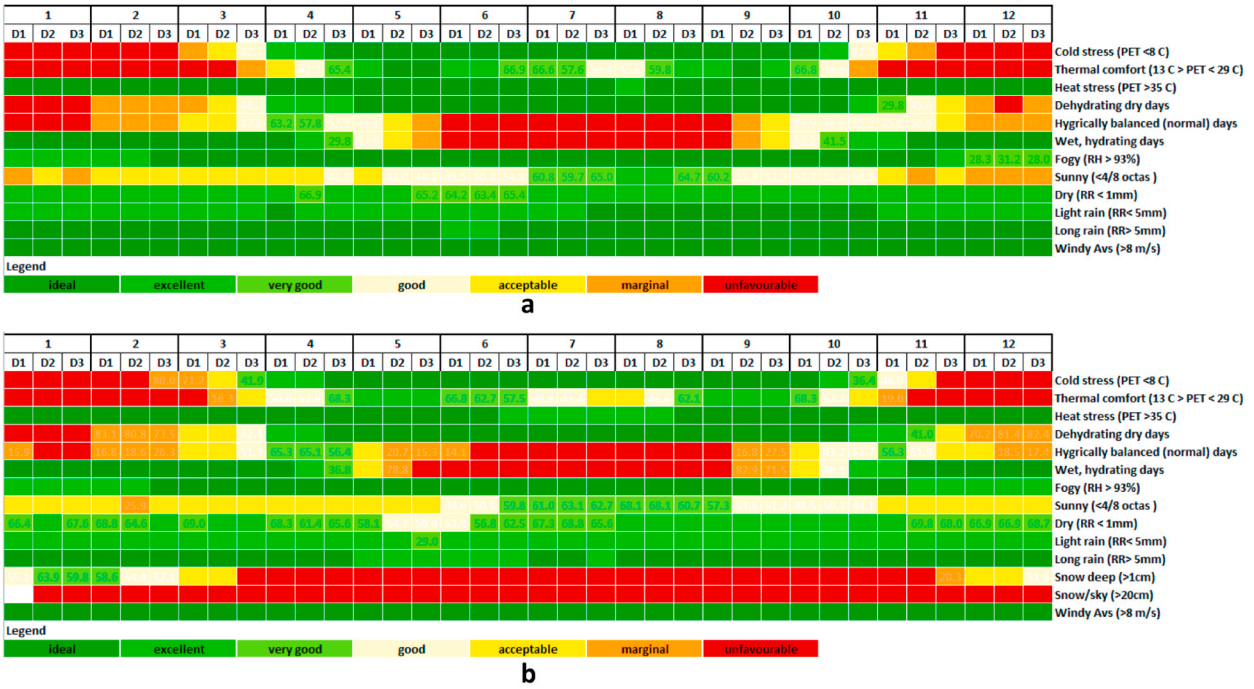

Fig. 9. Climate-tourist scheme for the resorts BF_1 M a and BH b made in accordance with the climate data for the period 1961–2019.

Table 4
Evolutionary trends of the PET index (°C/decade) for the interval 1961–2019 calculated and highlighted using Mann-Kendall tests.

	Time series	Annual	Winter	Spring	Summer	Autumn	Oct–Mar	Apr–Sep
	Signific.	***		***	***			***
BF_1 M	Q	0.3	0.1	0.4	0.7	0.1	0.1	0.5
Stâna de Vale	Signific.	***	**	***	***		**	***
	Q	0.4	0.4	0.5	0.6	0.1	0.2	0.5
Vlădeasa	Signific.	***	**	***	***		**	***
	Q	0.4	0.4	0.5	0.6	0.1	0.2	0.5
BH	Signific.	***	***	***	***	***	***	***
	Q	1.3	1.3	1.5	1.7	0.9	1.2	1.5
Semenic	Signific.	***	**	**	***		**	***
	Q	0.4	0.5	0.4	0.7	0.2	0.3	0.5

	Time series	Ian	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BF_1 M	Signific.				**	**	***	***	***				
	Q	0.2	0.1	0.2	0.5	0.6	0.6	0.7	0.9	0.1	0.0	0.1	0.3
Stâna de Vale	Signific.	*	*	*	**	***	*	***	***				+
	Q	0.5	0.5	0.4	0.5	0.6	0.4	0.8	0.7	0.1	0.0	0.3	0.3
Vlădeasa	Signific.	*	*	*	**	***	*	***	***				+
	Q	0.5	0.5	0.4	0.5	0.6	0.4	0.8	0.7	0.1	0.0	0.3	0.3
BH	Signific.	***	***	***	***	***	***	***	***	***	***	***	***
	Q	1.3	1.5	1.7	1.5	1.7	2.0	1.8	1.8	1.1	1.2	1.2	1.1
Semenic	Signific.	*	+	+	*	*	**	***	***				*
	Q	0.6	0.4	0.4	0.6	0.6	0.7	0.8	0.7	0.2	0.3	0.2	0.4

The level of statistical significance α was between (0.001 and 0.1). Statistical significance at the α = 0.001 level was marked with ***, α = 0.01 significance with **, α = 0.05 with * and α = 0.1 with +. The Sen slope values are denoted by the symbol Q (Table 4).

The most representative PET increase, in terms of value and with the highest degree of statistical significance during the 59 years analyzed, is in the case of the BH resort. PET values increased at BH for all temporal entities analyzed, but for the summer months the increase was between 1.8 and 2.0 °C/decade.

The PET trend in the summer and spring months impose the positive trends of the warm season and the annual ones. And during the winters, the PET value increase was manifested, even if it was more attenuated in terms of value, and at lower levels of statistical significance. For autumn as a season, and the autumn months taken separately (with the exception of BH where the increase in PET is clearly outlined as a value and as a degree of insurance) PET trends are increasing, but they have not yet gained statistical assurance. This aspect can be explained by the fact that in most of the studies carried out on the topic of trends of climate elements for stations in Romania during autumn and the months of this season, no climate element clearly and significantly outlined its trend [101–103]. As a result, a complex index like PET, whose calculation includes elements such as temperature, humidity, wind, cloudiness, did not outline a clear trend supported by a relevant statistical significance, for the autumn season.

Certainly, in the three basic resorts (BF_1 M and BH) and in their complementary tourist destinations (Stâna de Vale resort, Vlădeasa and Semenic resort), maintaining the positive evolutionary trends of PET will result in an increase in climatic favorability for spring tourism, then winters and probably autumns.

The TCI trends for the 1961–2019 period are more difficult to outline, given the fact that the calculation of this index includes 7 climate sub-indices whose cumulative trends do not align in a certain constancy and logic (SM – section 3.4).

4. Discussions

The BF1M grouping of resorts is located within the exciting-demanding bioclimatic floor [104], but the relaxing time type, through high annual frequency, gives, according to our observations, relaxing nuances to the bioclimate. The BF resort has a tonic-stimulating climate [104], but in reality, according to our observations and of [105], it benefits from a relaxing bioclimate with frequent tonic-stimulating interferences. The relaxing bioclimate given by the predominantly oceanic (BF_1 M) and predominantly Mediterranean (BH) westerly air advection, coupled with the foehnal circulation (BH), the generally low altitudes (BF_1 M; BH), the presence of large areas of forest vegetation, parks and the effect of geomorphological shelter (BH), lead to the extension of the tourist season in the three resorts at almost the entire year. The multiannual values of the PET and the indices that define the CTIS for BF_1 M and BH, indicate a larger annual expansion by about 20 % of the time with bioclimatic comfort, and a more favorable climate for tourist activities than established by Ref. [20] for the balneoclimatic resorts in the north-east of Romania. According to Ref. [106], BH and BF_1 M resorts have among the most favorable bioclimates for tourism and health tourism. At BF_1 M and BH, the relaxing bioclimate does not restrict aerotherapeutic procedures, and in combination with the use of heliotherapy, silvotherapy, aeroionotherapy etc., mineral and thermal waters, favor the treatment of cardiovascular, digestive, neurological, hepato-biliary, renal and urinary, metabolic conditions and nutritional [104,107].

According to the daily values of PET, thermal comfort is close to 40 % of the days of a year at BF_1 M and BF, decreasing to almost 25 % in mountain resorts. Daily values of TCI show that almost 70 % of the days of a year have acceptable to ideal conditions for tourism at BF_1 M and BH, their percentage dropping to approx. 55 % in mountain resorts. The two tourist areas have overall,

according to CTIS, the most favorable bioclimatic and climatic conditions for tourism from the entire Romania, an aspect that emerged on different indicators and following previous studies [104–106].

The importance of the three resorts would increase with the scientific valorization of balneoclimatic resources and through an adequate infrastructure. The managers of tourism activities should put more emphasis on the human resource in the medical field and the facilities of treatment bases. The progress in the tourist activity in the six tourist destinations could be more visible if there were real elements of coordination between all the actors involved in them: researchers whose views should be taken into account, administrators, hotel managers, local, county and regional or national administration. Applying only a part of the 14 categories of actions proposed by Ref. [105] could lead to a real progress of health and sports tourism in the three resorts. Special attention should be paid to reducing the overexploitation of spa resources, an aspect noted by Ref. [100] and by Ref. [108]. Extending the type of time with bioclimatic comfort by another 3-4 decades in the months of April–March and October–November, through specific topoclimatic and microclimatic arrangements, would lead to increasing the absorption capacity of tourist flows and increasing the tourist attractiveness of the three resorts. Considering the PET trends from 1961 to 2019, we can anticipate that the period of the year with comfort will naturally lengthen during autumns and springs, but investments in the field of ensuring high-level climate services should not be neglected.

The creation of complex and attractive tourist packages could forward and direct some of the tourists who come to relax at BF_1 M and BH, in visiting the many tourist attractions in the surroundings, with the return, in the evening, to the three resorts. The tourist packages could be completed with trips from one day to 3–5 days to Stâna de Vale - Vlădeasa and Semenic. Field cure, hiking, outdoor gymnastics, sledding and skiing, tent camping in summer, would make tourists take full advantage of the beautiful mountainland-scapes, the clean water of the mountain springs, the air non-toxic, oxygenated and ionized. The congestion in BF_1 M and BH would decrease, and the mountain resorts would receive a substantial financial incentive, which would amplify tourist activities. All this accumulation of actions could be part of the development of sustainable tourism for the two tourist areas that specifically have an obvious complementarity between the low, plain resorts (BF_1 M), or on the valleys at the foot of the mountain (BH), and the medium mountain ones (Stâna de Vale, Semenic), and higher altitude (Vlădeasa) from western Romania.

There are, of course, also a series of organizational, economic and technical limitations of this approach, but which can be overcome through consensus, financial allocations and innovative and environmentally friendly technical solutions [109].

5. Conclusions

The present study opens multiple directions of future approach regarding the climato-therapeutic valorization of the bioclimate, the topoclimatic arrangement of the approached resorts, or the reduction of the effects of natural risks that manifest themselves in their perimeter.

i) After summarizing the results of PET, we noticed that the most favorable period of the year for tourist activities related to health tourism and tourist activities adjacent to it (spent outdoors) owns 38–39 % of days at BF_1 M, BH and 23–25 % at Stâna de Vale, Semenic and Vlădeasa. *ia)* This period is included at BF_1 M between the third decade of April and the first decade of October. In BH this period falls between the first decade of April and the second decade of October. In these intervals, in the specified resorts, the frequency of days with thermal comfort exceeds 50 %. We recommend that, in the first decade of August (for BF_1 M) and between the first decade of July - and the second decade of August (in BH), to reorganize tourist activities in the time interval 11–16, because the stress due to heat is more pronounced. *ib)* From the second decade of February to April, respectively from October to November (at BF_1 M) the number of days with thermal comfort is high enough to favor without great restrictions balneoclimatic procedures such as field cure, open-air medical gymnastics, silvotherapy, aeroionotherapy, aerotherapy, heliotherapy, contrast hydrothermotherapy. Between the second decade of February and the third decade of April and the third decade of October to the month of November (at BH) the number of days without bioclimatic restrictions relevant to tourism is also dominant. *ic)* In the months December–February, some of the balneoclimatic procedures carried out outside the treatment bases are subject to restrictions, or should be carried out with certain precautions.

ii) The daily values of TCI show us a degree of favorability for tourism of 68–69 % in BF_1 M and BF and of 54–55 % in Stâna de Vale, Semenic and Vlădeasa. At BF, the statistical data highlight the best conditions for practicing any form of tourism and the lowest climatic restrictiveness for tourism of the six analyzed tourist destinations. CTIS at the decadal level indicates that, from the second and third decade of March to the first and second decade of November, heat stress is almost absent or manifests to a reduced degree. Pulmonary stress is manifested by hydration from the second and third decades of May to the second and third decades of September, but can be easily controlled by adapting the tourist program and a higher consumption of water. Persistent fog, cloudiness with high values, rainy or windy days, are rare in the matrix of weather conditions, but dry days with precipitation below 1 mm hold approx. 2/3 of the days of the year. The bioclimatic features of the three resorts, the dominant time types, favor health and sports tourism, and those of the mountain resorts favor sports and camping tourism.

iii) Bioclimate trends indicate an improvement over time in the bioclimatic features of the transitional seasons and winter and other forms of cultural, religious, business tourism, etc. can be practiced without restrictions all year round. Through small adjustments made in the managerial act, the resources of health, sports and camping tourism can be used more judiciously. Midsummer can be the interval in which the resorts with high tourist appeal (BF_1 M and BH) can be places of departure/return of tourists to/from the nearby mountain resorts (Stâna de Vale, Vlădeasa, Semenic) and to/from the tourist attractions in the vicinity (caves, avenues, gorges, reserves etc.). In winter, one can combine the benefits offered by the balneoclimatic resorts at the base of the mountains (BF_1 M și BH) with those of the climatic resorts located on the mountain peaks where the forested

slopes and snowy mountain peaks offer offer conditions for practicing winter sports, but also represent ideal viewpoints and relaxation (Stâna de Vale, Vlădeasa, Semenic).

The transfer of information from this study in a format accessible to those involved, will certainly have the effect of boosting balneoclimatic, sports and camping tourism from the six destinations included in the two researched tourist areas.

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Ethics approval and consent to participate

Not applicable.

Data availability statement

All the data analysis results obtained during this study are openly available for access through Figshare repository: https://doi.org/10.6084/m9.figshare.21900762.v5. Any additional information required to reanalyze the data reported in this work is available from the lead contact upon request.

CRediT authorship contribution statement

Dumitru Mihăilă: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. **Petruț-Ionel Bistricean:** Validation, Software, Methodology, Investigation, Data curation. **Răzvan-Ovidiu Gaceu:** Writing – original draft, Investigation. **Elena-Maria Emandi:** Investigation, Formal analysis. **Emilian-Viorel Mihăilă:** Software, Data curation. **Vasilică-Dănuț Horodnic:** Writing – review & editing, Software, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e29510.

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