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Climatic Suitability for Outdoor Tourism in Romania's Big Cities

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Abstract: This research aims to assess the climatic temporal suitability over the year and identify the appropriate season for open-air tourism in ten Romanian cities. It was evaluated using the Enhanced Tourism Climatic Index on a temporal scale of one day and then aggregated to 10 days over 61 years (1961–2021). Daily mean and maximum temperature, mean and minimum relative humidity, wind speed, precipitation, and sunshine hours were employed in the investigation. The Mann–Kendall test and Sen's slope were used for trend detection in the frequency, season duration, and first/last suitable day during the year for outdoor tourism. Acceptable or better weather conditions usually begin in the last part of April and end in mid-October, with *Good* or better conditions lasting between 260 and 310 days/year. The trend shows a shift of *Good* conditions earlier in the year (0.3–9.0 days/decade), resulting in a longer season duration (0.8–13.0 days/decade) for open-air activities. The trend is statistically significant mainly for the extra-Carpathian regions. Big differences in open-air events number during the climatically suitable season have been identified among the cities considered (2–19 events/year). This study is useful for better planning open-air events and activities for tourism and recreation.

Keywords: Enhanced Tourism Climatic Index (ETCI); climatic temporal suitability; open-air tourism; climatic change; Mann–Kendall test; Sen's slope

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1. Introduction

The tourism and travel industries are among the most important global economic sectors [1], strongly influenced by climate and weather [2]. In Europe, it plays a substantial role in fostering growth and employment within the European Union (EU), fostering developmental initiatives and socio-economic cohesion. Notably, Europe maintains its preeminence as the foremost global tourist destination, attracting the highest volume of international travellers, covering 51% of the total global arrivals amounting to 582 million tourists and accounting for 41% of the worldwide tourism receipts [3,4].

In a world where climatic changes pose real threats to everyday life, the tourism industry is not less vulnerable. It is well known that global climate changes can easily alter the distribution of climate assets among tourism destinations, with implications for tourism travel patterns, demand, and seasonality. Moreover, there are considerable implications for the competitive relationships between destinations, respectively, for the tourism companies' long-term profitability due to changes in the length and quality of the tourism [2]. How society adapts to climate change represents a crucial point in downsizing the adverse impacts or, on the contrary, in preparing to take advantage of beneficial changes in climate, whether these are human-caused or natural, depending or not on the amount and rate of change [5,6]. The intricate relationship between tourism and climate has always played a vital role in influencing travel patterns. With a growing emphasis on sustainability and economic development, it becomes essential to rethink how tourism can be planned and promoted, especially concerning meteorological conditions.

The Tourism Climatic Index (TCI) was first developed by Mieczkowski in 1985 [7]. It refers to general tourism activities such as sightseeing and similar light outdoor activities [8]. It is a comprehensive index calculated based on five meteorological variables (air temperature, precipitation, humidity, wind speed, and sunshine hours) and two other sub-indices, resulting in a numerical score that reflects the overall climate comfort of each city (destination).

Developed almost 40 years ago, TCI has important advantages over other climate indices, such as its longevity, widespread use, and comprehensiveness to cover the interactions among different climate variables [9]. It is the most widely used method to quantify climate suitability for tourism [10]. Even though it is employed mainly in the Northern Hemisphere [10], numerous other studies evaluate climate conditions for tourism suitability worldwide [1,10–21].

By its complexity in terms of many variables used for its calculation, we consider TCI can still be a helpful tool, especially in its enhanced version [9], for tourism planners since it provides a quantitative measure of a specific destination. Recently, at the EU level, taking into account seasonality, geographical patterns, and regional typologies such as coastal and urban areas, the analysis shows that a 1% increase in TCI leads to a 0.57% increase in the monthly regional number of bed nights, a term used in the hospitality industry to measure occupancy. However, the magnitude of the impact varies depending on the specific tourism typology [3].

Only a few studies focused on TCIs in Romania, mainly covering small areas. In particular, only three papers identified using TCI focused on Eastern Romania: the seaside region [22], the eastern region of the country [23], and the Danube Delta [9]. The last one used an enhanced version of the TCI (ETCI) to evaluate the potential extension of the tourism season in the Danube Delta, the largest protected area in Europe [9].

Other papers focused on diverse climate indices, such as the Temperature-Humidity Index (THI) and Simmer Summer Index (SSI) for three cities with diverse sizes (Constanța, Focsani, and Sinaia) over the period 2000–2012 [24] or only on Focsani city [25]. The results highlight the relationships between visitor numbers, overnight stays, bioclimatic comfort in Sinaia and Constanța, and the bioclimatic discomfort in urban areas, particularly in Constanța. Another research analyzed Net Effective Temperature (NET) in comparison with THI in characterizing the thermal comfort conditions in Romania during the warm season (May–September) [26]. Physiologically Equivalent Temperature index (PET) was also used to assess the conditions in the North-East Region of Romania over the interval 1961–2015 [27]. Some papers were developed based on the Holiday Climate Index (HCI) [28,29].

As global climates evolve under climate change conditions, destinations can use the ETCI to adapt their strategies, ensuring they remain economically viable and sustainable. The ETCI can act as a beacon, guiding these adaptation strategies. Even though Mieczkowski's index was not created to explore or evaluate the impacts of climate change on tourist comfort, it can also be used for this purpose [30–32]. However, other significant factors also affect tourism [8], and tourists react differently to numerous cumulative climatic variables [9,19,33,34].

Regarding the study area, the lack of information and inconsistency in the analysis of climate resources for tourism included in the evaluation of Romania's potential for natural tourism served as the impetus for the current study. By creating a statistically sound, quantitative analysis of what the climate offers tourists in Romanian cities, we aim to advance this strategy and improve this approach. The paper aims to highlight the climatic suitability for organizing open-air recreational events (contests, festivals, fairs, etc) in each of the ten selected cities of Romania, according to ETCI. Furthermore, a comparison between the recent period (2012–2021) and the long mid-term period (1961–2021) was made to examine how the climatic changes are reflected in this index. This approach is in line with the European Agenda for Tourism 2030 [35], which aims to maintain the EU's status as a leading tourist destination by launching in 2022 a roadmap to achieve a twin (green and digital) transition and promote resilience in tourism. The initiative focuses on a transition pathway that highlights the links inherent in making tourism more environmentally friendly and in implementing ongoing legislative initiatives relating to environmental protection and climate neutrality [3].

For this paper, we propose a novel approach to assess the temporal climatic suitability and detect the maximum length of the season with favorable climatic conditions for outdoor tourism. This could further encourage the distribution of the tourists incoming through the entire season and diminish the pressure during the peak season. This goal is among the newest and more innovative ones, as most of the studies done until now have focused on destination suitability for tourism, not more on time frame suitability. Within this research, we shifted the focus from merely assessing the destination's best suitability to identifying specific periods when climatic conditions are favorable for tourism and how long this period can be during the year. This subtle shift has profound implications for economic development and sustainability, especially in the tourism sector: understanding the best periods for tourism allows sector planners to strategically promote tourism for the entire suitable season detected. Such targeted promotions can result in consistent economic benefits throughout the year. The innovative use of the ETCI, especially with its emphasis on time frame suitability, offers a promising bridge between economic development and sustainability. A harmonious balance can be struck by ensuring destinations are frequented during their climatically suitable periods, allowing the environment and the local economy to flourish.

2. Materials and Methods

2.1. Study Area

Located in Southeast Europe, on the northwestern shore of the Black Sea, Romania extends about 9° longitude and approximately 5° latitude and covers more than 237,000 km^2 (Figure 1, Table 1). It generally benefits from a temperate continental climate, but some regional yet substantially important influences induce several other sub-climate zones. Thus, the moist air masses originating over the Atlantic Ocean generate in the western and central (intra-Carpathian) regions more humid conditions than they are in the eastern and southern parts of the country (extra-Carpathian regions), where the influences over the climate are extreme continental. This leads to specific bioclimatic conditions: milder and wetter in the intra-Carpathian regions and hotter/colder and dryer in the extra-Carpathian regions. One of the most critical factors that contribute to dividing the climatic conditions between the two categories of regions is the presence of the Carpathian Mountains, which act as a natural barrier in the transportation of the moist, western air masses towards Eastern Europe [36].

The mean multi-annual temperature differs from sub-zero values in the mountains and is more than 11.0 °C in the southern regions and the coastline. Extreme temperatures hit more than 40 °C during summer and below −20 °C in wintertime. It is worth mentioning that the largest ranges of daily and annual temperatures are specific to the eastern and southern parts of Romania. The multi-annual precipitation exceeds 500 mm in the intra-Carpathian regions, whereas it is between 300 and 700 mm in the extra-Carpathian area [37]. In the mountains, observations revealed values higher than 1000 mm [38].

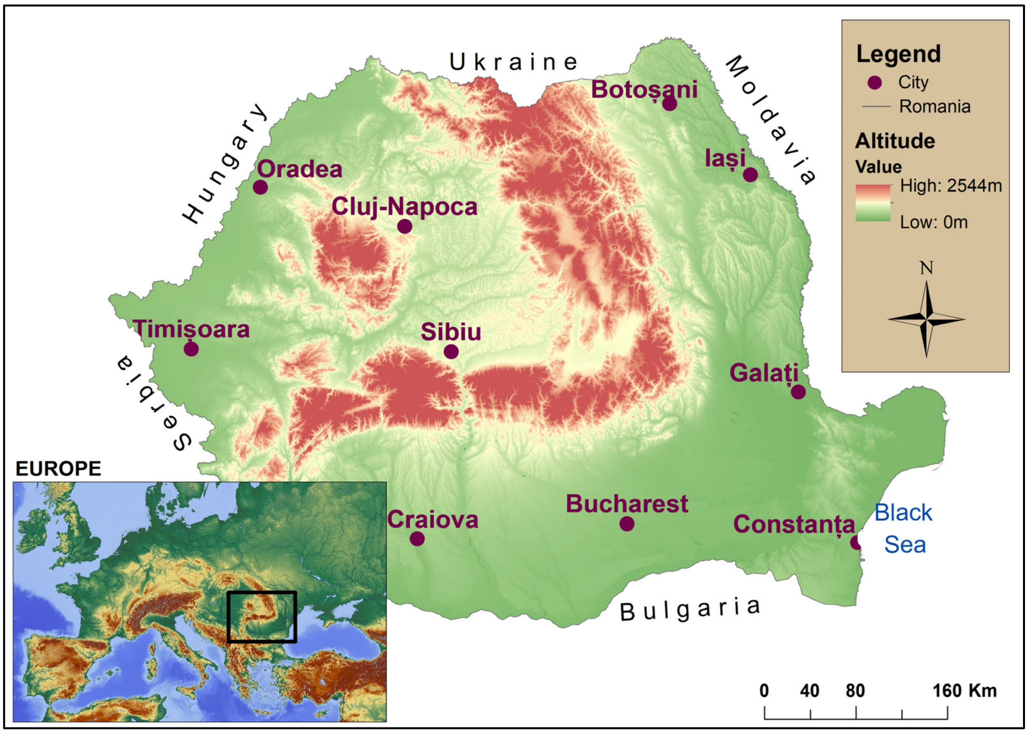

Figure 1. Topography and weather stations considered (Europe map is downloaded from [39]).

Table 1. Geographical coordinates and mean multi-annual values (1971–2021) of main climatic parameters in locations considered [40,41].

Weather Station *	Lat (N)	Long (E)	Elev (m)	T (°C)	RH (%)	PP (mm)	SS (h)	W (m/s)
Botosani	47°44′08″	26°38′40″	161	9.6	71.7	534.5	5.6	3.6
Bucharest-Băneasa	44°31′00″	26°05′00″	90	10.9	69.0	573.7	5.7	3.2
Cluj-Napoca	46°46′39″	23°34′17″	410	8.4	75.3	578.4	5.4	3.1
Constanța	44°12′49″	28°38′41″	13	11.6	71.3	394.4	6.2	4.9
Craiova	47°18′36″	23°52′00″	192	11.1	69.2	560.7	6.2	3.4
Galați	45°28′23″	28°01′56″	71	10.8	69.7	455.4	5.8	4.1
Iași	47°10′15″	27°37′42″	102	9.7	70.7	523.5	5.7	3.6
Oradea	47°02′10″	21°53′51″	136	10.3	72.4	551.4	5.8	3.7
Sibiu	45°47′21″	24°05′28″	444	7.9	71.8	706.1	5.1	3.4
Timișoara	45°46′17″	21°15′35″	86	10.9	68.9	566.9	5.8	3.6
Romania Max	48°14′09″	29°39′34″	2544					
Romania Min	43°37′12″	20°15′44″	0					

* Weather stations are listed alphabetically.

Regarding climate changes in Romania, most studies conducted so far focused on air temperature and precipitation and indicated significant increases in air temperature (mean and extreme temperature indices) and mainly no significant change in precipitation, except for the frequency of heavy precipitation and very heavy precipitation days, which significantly increased [36,37,42–46]. Other studies claim that wind speed significantly decreased in most analyzed locations while sunshine hours significantly increased, especially in spring and summer [46]. Mixed trends for relative humidity and a general decreasing trend in cloud cover have also been detected [47].

2.2. Data Used

A good spatial coverage for the whole country is provided by the 10 selected cities that are representative of each climatic region of Romania. They are different in size from mid to large cities. Their location is presented in Figure 1, and their geographical coordinates and elevation are presented in Table 1. We consider that they also well illustrate the weather conditions in the low-rise building areas of the cities since all weather stations considered are inside the built-up area of the considered cities (except for the Craiova weather station, which is located 200 m away from the built-up area limit).

To obtain the ETCI datasets for all the analyzed cities, historical sets of daily and sub-daily climate data covering 61 years (1961–2021) were employed. The original meteorological parameters used were daily average and maximum data for 2 m air temperature (*TG*, *TX*) (°C), daily average and minimum relative humidity (*RH*, *RHmin*) (%), daily sum of precipitation (*R*) (mm), daily sunshine hours (*SS*) (h) and daily wind speed at 10m height (v_{10}) (km/h).

The climatic data for the current study was extracted from four main databases. Still, the data homogeneity is ensured by the same raw source: the SYNOP messages issued by the weather stations mentioned above and, where possible, by random checking performed for common periods. More precisely, the main data sets (1961–2016) were provided by the Romanian National Meteorological Administration (NMA). To obtain a more recent perspective, the 2017–2021 data sets, as well as the missing values from the previous period, were freely downloaded from online databases as follows: *TG* and *TX* values for 1961–2016 were extracted from the database of the European Climate Assessment and Dataset project (ECA&D) (non-blend data) [38,48] and from *Meteomanz* [49]. The values for the *v10*, *RH*, and *SS* over the recent short period (2017–2021) were extracted from *Meteomanz* [49] and *Reliable Prognosis 5 Days* [50] databases. Because *RHmin* values are not available from the national database over the long-term period, the values for the period 1961–2016 were reconstructed based on the regression equation established between the daily maximum and minimum *RH* calculated for the last five years considered and available from *Reliable Prognosis 5 Days* database (hourly values) [50]. The wind speed (*W*) was converted from 10 m to 1.2 m using the formula for wind speed extrapolation available online [40,51].

The open-air recreational events considered in the present study were selected based on their longevity in the last ten years of the analyzed period (2012–2021). For open-air recreational events, we considered various types, such as cultural, artistic, and sports festivals, fairs, concerts, or city days. Several events have been organized over more than 20 years; some others are pretty new, but we have considered just those organized for at least five years. Some events changed their dates from one year to another, and it was difficult to find the event days for previous years. The events' names, duration, and more detailed information are presented in Supplementary Information (Table S1). Where available, the event dates were written in the document mentioned above for the last year available. The study does not aim to focus on these events but only to offer a broader perspective of how many days are covered by recreational open-air events in the ten big cities of Romania during the suitable period and how they are distributed throughout the year so to consider better planning them based on the climatic factors.

2.3. Analytical Procedures

For ETCI calculation, different authors presented some limitations of the original formula of the TCI and proposed some adjustments [8,18,52–55]. This study employed an enhanced version of the TCI (ETCI) [9] instead of its basic form as in formula (1). The original reclassification method proposed by Mieczkowski was kept as a general approach. Each variable value was reclassified into values from 1 to 5 [7], except for precipitation values, for which we applied an adjustment, and values from −2 to 5 were associated with each value. Several modifications compared to the original version of the index have been made to adequately reflect Romania's climate, the actual duration of vacations, and the features of the open-air events. Thus, three main adjustments have been made:

i. The index was calculated on a daily scale and then aggregated on 10/11-day periods; each month was divided into three periods (decades): from day 1 to day 10, from day 11 to day 20, and from day 21 to the last day of each month (28, 29, 30, or 31).

ii. Instead of the daytime and daily comfort index (*CId* and *CIa*), daytime and daily Effective Temperature (*TEd* and *TEa)* was employed because *TE* evaluates the common influence of air temperature, relative humidity, and wind speed. The index establishes a relationship between the identical state of the human body's thermoregulatory capacity (warm and cold perception) and the differing temperature and humidity of the surrounding environment [40,56]. *TE* general description, advantages, and formula were presented in detail in [40], but for this research, its calculation was tailored [9] to successfully replace *CId* and *CIa* in the original TCI formula [7]. Thus, *TEd* aims to detect the index's maximum value, calculated based on *TX*, *RHmin*, and their corresponding wind speed, *W*, during the daytime. In contrast, *TEa* was calculated based on daily mean values of the same variables (*TG*, *RH*, and *W*).

iii. Daily sums of precipitation higher than 10 mm (heavy precipitation days) and 20 mm (very heavy precipitation days) were given a higher weight in the precipitation reclassification data since it can generate severe disturbance of the open-air tourism and recreation activities. Thus, heavy precipitation days received scores of -1 and very heavy precipitation days of -2 for precipitation.

We kept the temporal scale of daily and sub-daily data and outlined 10-day periods (decades) for the final classification of climate adequacy for open-air events;

The ETCI was calculated using the following formula:

$$ETCI = 2(4TEd + TEa + 2R + 2S + W) \quad (1)$$

where *TEd* is the daytime Effective Temperature, derived from daily *TX* and corresponding *RH* and *W*, *TEa* is the daily Effective Temperature calculated based on *TG*, *RH*, and *W*; *R* is the precipitation; *S* is the number of sunshine hours; and *W* is the wind speed. The values after reclassification were used.

The same ETCI approach has been successfully used in a recent study focused on the Danube Delta in southeastern Romania [9].

For the present paper, we considered as suitable periods for open-air tourism and recreational events and activities only those monthly decades with an average multi-annual rate of the ETCI score of at least 5, corresponding to comfort classes from *Acceptable* to *Ideal* (Table 2).

Table 2. ETCI comfort classes (modified after [9]).

ETCI Score	Rating	Comfort Class	Favorability
90–100	9	Ideal	Suitable for outdoor tourism and open-air events
80–89	8	Excellent	
70–79	7	Very Good	
60–69	6	Good	
50–59	5	Acceptable	
40–49	4	Marginal	Unsuitable for outdoor tourism and open-air events
30–39	3	Unfavorable	
20–29	2	Very unfavorable	
10–19	1	Extremely unfavorable	
<10	0	Impossible	

Although the ETCI score was calculated for each day and then aggregated for each monthly decade of the year, for this analysis, we focused only on the suitability classes from *Acceptable* to *Ideal*, which were considered the most appropriate for outdoor recreational and tourism activities.

A few features were identified for the detailed analysis: *first date* (*FD*) and *last date* (*LD*) of occurrence, *duration of occurrence period* (*DOP*), and *frequency of days* specific to a given suitability class (*FO*). Initially, we detected the first and the last date of occurrence in a year (season) of each suitability class. Thus, for each class and each year, we identified the *FD* and the *LD* as per calendar day number. Based on the results obtained, we then calculated the *DOP* as the number of consecutive days between the *FD* and *LD* of each suitability class in a year, regardless of whether all the days belonged to the same class. The *FO* during the *DOP* was calculated as the number of days belonging to the specified suitability class during the period detected between the *FD* and *LD* of each year. A similar approach was recently employed for the analysis and trend detection in a few biometeorological indices for the same cities [40].

The trends were detected based on daily values obtained. Furthermore, the values were averaged for each parameter and each suitability class over the analysis period (1961–2021) for a synthetic analysis.

Climatological values/data, especially when derived from datasets longer than 30 years, could not be of much interest to practitioners, as the mean values over an extended period, especially under the present climate change conditions, could consistently differ from "present conditions". With this study, we also aimed to check how the existing events are distributed over climatically suitable periods of the year in the cities considered. Since the data for such events are available mainly over the last 10 years of the analyzed period, to put into agreement the climate data with the outdoor event data and to make this study more useful to stakeholders, we calculated the mean values of the same climatic parameters for the last ten years (2012–2021). Additionally, this analysis provides more actual climate features that could be of more interest to tourism event planners and other tourism practitioners, local authorities, and tourists over the lengthy period (1961–2021).

All the trend detection and slope calculations have been performed using the XLSTAT PREMIUM 2020.5.1. version software. For trend detection, we employed the Mann–Kendall test [57–59], and the magnitude of the trend (the slope) was calculated by employing Sen's slope method [60]. Both methods are appropriate and widely used to detect changes in climate variables [13,20,32,61]. The significance level was chosen to be 0.05.

The charts were developed in Microsoft Excel 365 for each location, and the spatial distributions of trend-type representations were mapped using ArcMap10.2 software.

3. Results

3.1. Duration of the Season

Throughout the year, according to average values calculated for the ETCI score for each decade, four cities present *Acceptable* or better conditions from the second decade of March. The remaining locations indicated the beginning of the season during the third decade of March, except for Constanța, which displays open-air suitability later, from the first decade of April. This delay may be explained by the city's location on the Black Sea's western coastline, where the water body nearby greatly influences the climatic conditions. The favorable conditions last until the first decade of November except for Botosani city, where they end in the third decade of October. The peak season from a climatic perspective, considering the dominant frequency of *Very Good*, *Excellent*, and/or *Ideal* conditions, starts in the second decade of May in most cities selected and finishes in the second or the third decade of September. The peak season extends by one decade at the beginning and end of the season in the cities located in lower altitudes and plain regions (Bucharest, Craiova, and Timișoara). In contrast, in cities located at higher altitudes and surrounded by the Carpathian Mountains in Central Romania (Cluj-Napoca and Sibiu), the climatic peak season begins later, in the third decade of May and ends earlier compared to the cities mentioned above (Figure 2, left and Table S1).

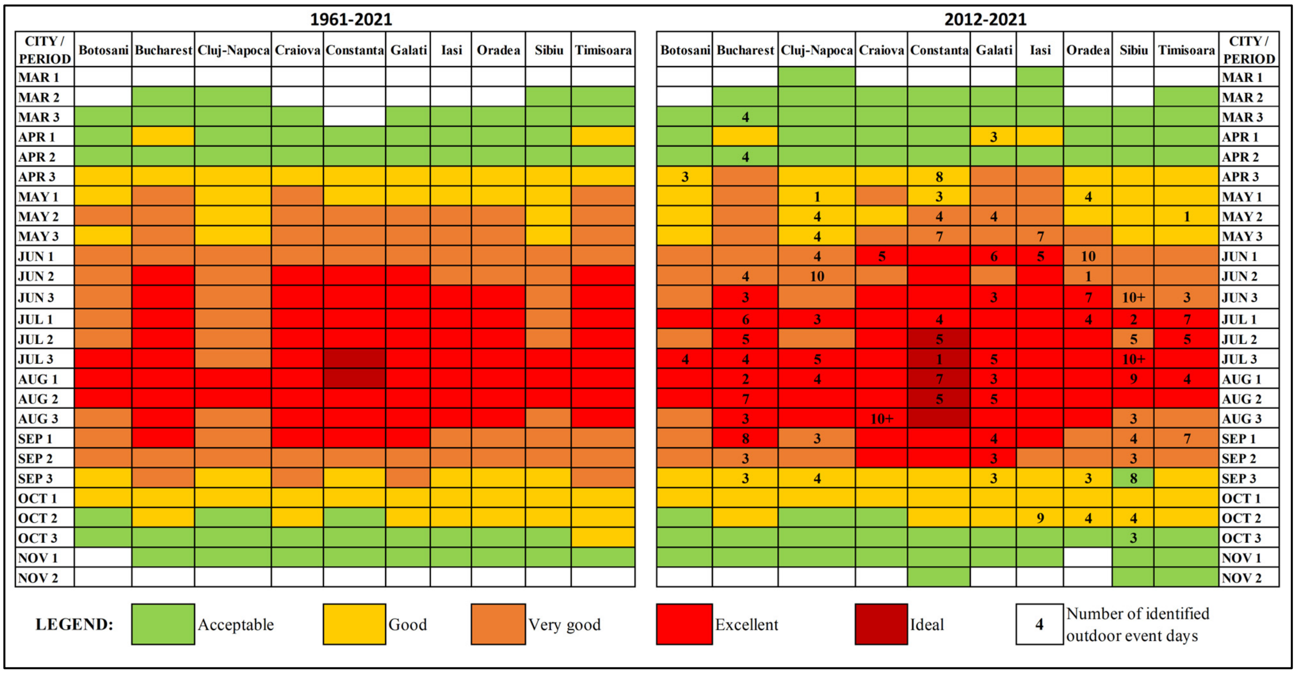

Figure 2. Annual climatic suitability distribution according to the average ETCI score/class for each monthly decade.

Over the shorter and more recent period (2012–2021), dominant *Acceptable* or better conditions for open-air recreational and tourism activities were detected for most cities from the second decade of March or even the first one for Cluj-Napoca and Iași. They lasted until the first decade of November, or later for three cities (Constanța, Sibiu, and Timișoara) (Figure 2). Compared to the long period, *Very Good* or higher suitability conditions can begin one decade earlier in eastern cities (Galați or Iași) or up to three decades later in central and western cities (Oradea, Sibiu, and Timișoara). Also, a shortage of the upper suitability conditions was detected at the end of the season. Thus, *Good* conditions characterized most locations except for Sibiu, where *Acceptable* conditions were dominant for the last decade of September. The *Ideal* conditions were present only in Constanța, and their average of only two decades over the long period grew to five decades in the recent period (Figure 2).

3.2. Frequency Analysis of the Suitability Classes

Generally, an inverted "bell curve" shape is observed in the distribution of comfort classes throughout the year, with the most favorable classes for outdoor tourism and recreational activities prevalent during the summer months. However, a peculiar characteristic is noted in this distribution during the second decade of April in all analyzed locations. Although one would expect the number of days with *Acceptable* or superior conditions to continue increasing, they decreased slightly compared to the preceding decade. There is a notable significant number of days with *Marginal* or inferior conditions, with slight variations from one station to another (over 18% in each case) (Figure 3 and Table S2a).

The *Ideal* conditions for outdoor tourism over the 61 years were detected starting from the first decade of May, mainly in the southern cities (Constanța, Bucharest, Craiova, and Galați), till the second decade of September. In general, a higher frequency was identified for the days with *Excellent* conditions in all cities, starting with the first decade of May and lasting until the last decade of September, with the peak between the beginning of July and the second decade of August. *Acceptable* and *Good* conditions are mostly common during the mid-spring or mid-autumn (April and October). The rest of the year, from the first or second decade of November (depending on the city) until the first or even the second decade of March, is characterized by *Impossible* to *Marginal* conditions (Figure 3 and Table S2a).

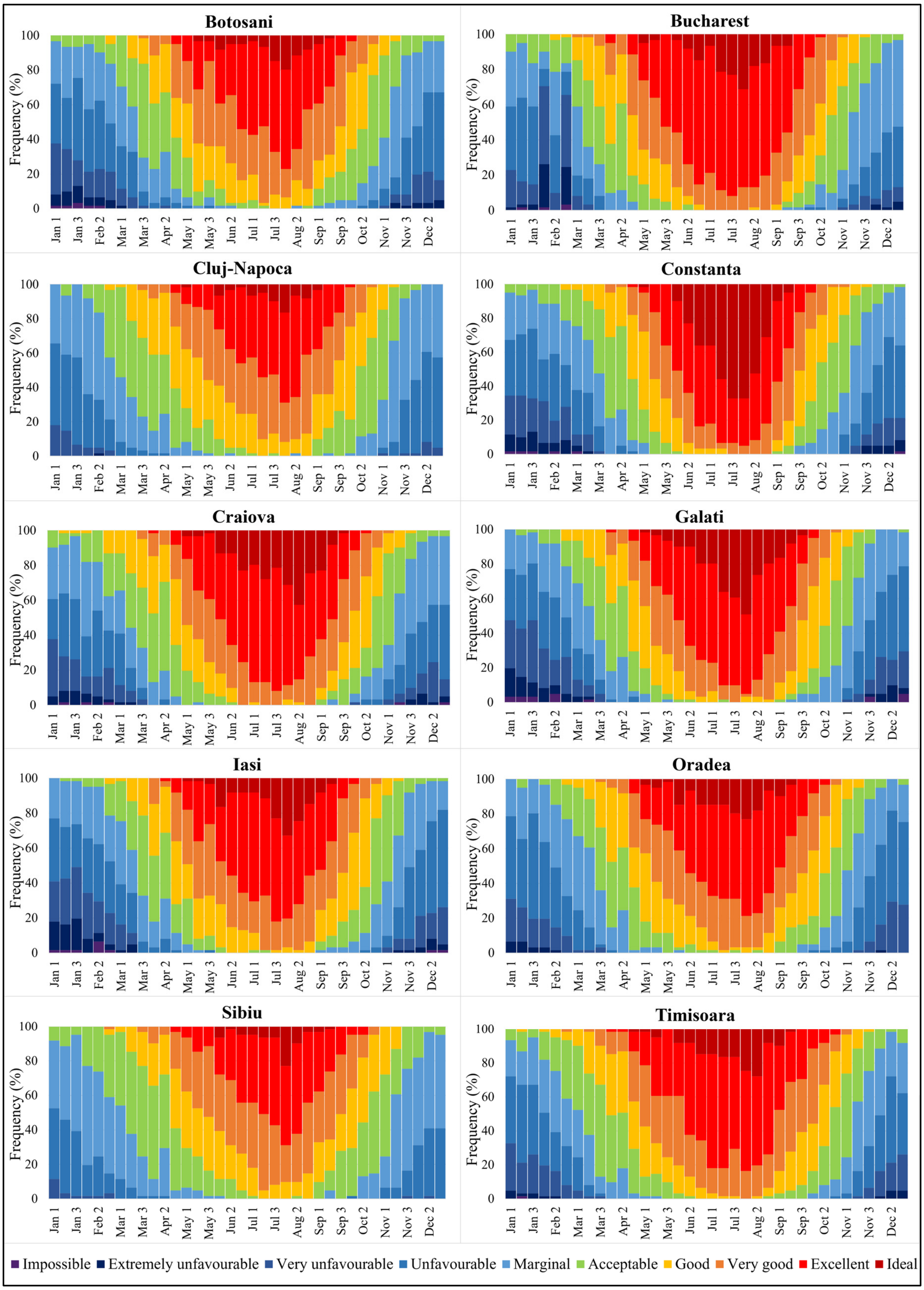

Figure 3. Frequency of each suitability class by monthly decades over the period 1961–2021 for each location considered.

Over the past ten years, the inverted "bell curve" shape in the distribution of *FO* has still been present. However, it is not clearly defined, displaying significant fluctuations for the same comfort class from one decade to another. Furthermore, an increase in *FO* is noted for the *Ideal*, *Excellent*, and *Very Good* comfort classes. Consequently, for decades with low frequencies of lower conditions from early April to October, or even in the middle of summer, a decrease or disappearance is observed, with slight variations between stations (Figure 4 and Table S2b).

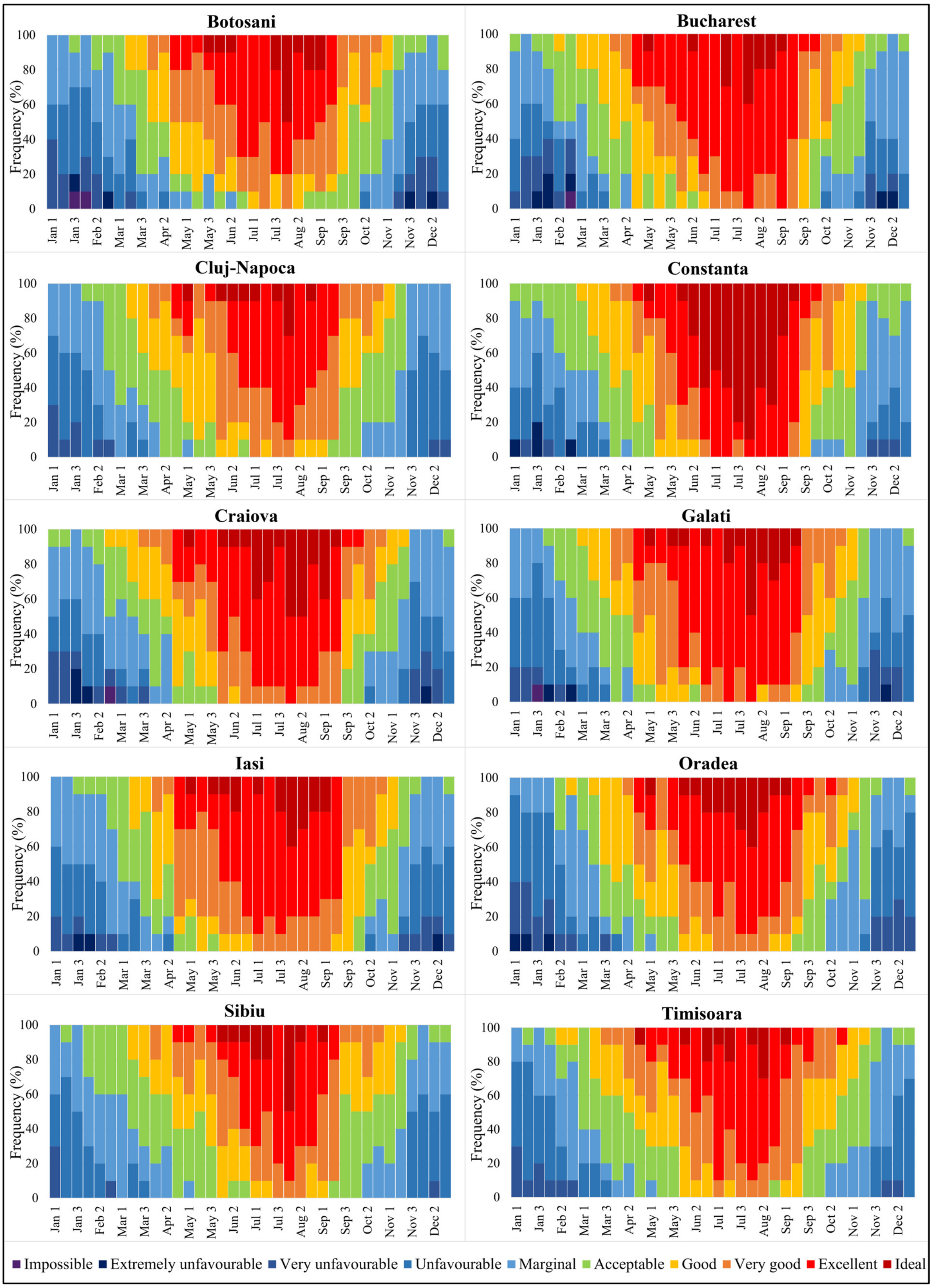

Figure 4. Frequency of each suitability class by monthly decades over the period 2012–2021 for each location considered.

For instance, in Bucharest, over the 61 years analyzed, the *Neutral* class is present in all three decades of April with frequency ranging from 5% to 11%, but it completely disappears in the last ten years for the first and third decades. Additionally, the *Acceptable* conditions class, covering 7% of the second decade of May over the 61 years, disappears entirely in the last ten years. The first decades of August and September, consistently characterized by *Very Good* and *Good* conditions throughout the extended period, were replaced by *Ideal* and *Excellent* conditions in recent years. The *Ideal* class has been lacking for some decades, and it differs from city to city. However, a general increase in *FO* was detected for the *Ideal* conditions during those decades where they are prevailing. At Constanța, they increased to 80% and 90% for the third decade of July and the first decade of August, compared to the overall analyzed period of 67%. Moreover, in the cities of Cluj-Napoca, Sibiu, and Oradea, the frequency of the *Ideal* class in the last ten years is nearly double compared to its value for the entire series of years (Figure 4 and Table S2b).

3.3. Analysis of Parameters

Examining the *FO* over the entire period considered, it is evident that its average for the five analyzed comfort classes ranges between 31 and 67 days per year. Notably, there are variations across cities and within different comfort classes. The *Ideal* class consistently exhibits the highest *FO* (over 50 days/year) in most cities. In comparison, only Cluj-Napoca and Sibiu maintain the *FO* of the *Ideal* conditions under 50 days/year, where most days are attributed to the *Acceptable* class. Furthermore, the class associated with *Good* thermal sensations spans from 42 days/year (Iași) to 51 days/year (Sibiu), the *Very good* conditions range from 34 days/year (Oradea and Galați) to 40 days/year (Cluj-Napoca), and the *Excellent* class varies from 31 days/year (Constanța) to 54 days/year (Bucharest) (Table 3 and Figure 5, up).

Table 3. Mean values of parameters considered: frequency of occurrence (FO), duration of the season (DOP), first day (FD), and last day of occurrence (LD) for each suitability class.

Average	Comfort Class/City	Botosani	Bucharest	Cluj-Napoca	Constanța	Craiova	Galați	Iași	Oradea	Sibiu	Timișoara
FO	Acceptable	53.1	49.6	59.2	49.0	47.7	46.9	47.8	49.1	62.4	54.2
	Good	44.3	44.8	50.1	49.0	45.3	44.3	41.8	46.4	51.4	50.2
	Very Good	35.5	37.7	40.0	37.8	36.3	33.9	35.5	33.9	37.6	38.9
	Excellent	38.5	54.2	39.9	30.8	41.9	39.4	41.3	40.5	43.9	48.3
	Ideal	51.7	62.7	39.9	66.0	66.5	64.0	55.0	56.8	40.8	56.8
DOP	Acceptable	343.8	349.2	337.7	345.4	343.7	332.54	334.3	336.0	350.1	348.4
	Good	295.3	310.2	272.0	300.8	297.8	264.8	277.0	282.1	296.9	305.4
	Very Good	216.5	235.2	213.7	215.8	232.3	211.4	215.5	211.2	220.0	230.6
	Excellent	181.3	203.5	168.2	168.3	191.1	175.0	177.6	175.5	178.1	185.7
	Ideal	147.2	162.4	127.3	131.7	153.9	141.2	142.7	143.4	137.0	151.2
FD	Acceptable	12.4	11.0	15.7	11.8	14.3	17.8	18.5	15.9	9.0	8.7
	Good	37.6	33.8	49.1	37.9	36.1	58.0	49.8	44.9	37.0	31.9
	Very Good	82.7	71.8	82.2	88.6	71.2	86.9	83.3	84.8	81.3	74.8
	Excellent	107.1	93.1	112.3	117.1	100.1	110.2	109.0	110.4	109.7	103.3
	Ideal	122.0	113.3	135.5	136.6	119.2	127.8	125.0	126.6	130.7	120.5
LD	Acceptable	356.1	360.1	353.3	357.2	358.0	350.3	352.8	352.0	359.1	357.1
	Good	333.0	344.0	321.1	338.7	333.9	322.8	326.8	327.0	334.0	337.3
	Very Good	299.2	307.0	295.8	338.7	303.5	298.2	298.9	296.0	301.3	305.4
	Excellent	288.5	296.6	280.6	285.5	291.2	285.2	286.6	285.9	287.8	289.1
	Ideal	269.2	275.7	262.7	268.4	273.0	269.0	267.7	270.0	267.7	271.7

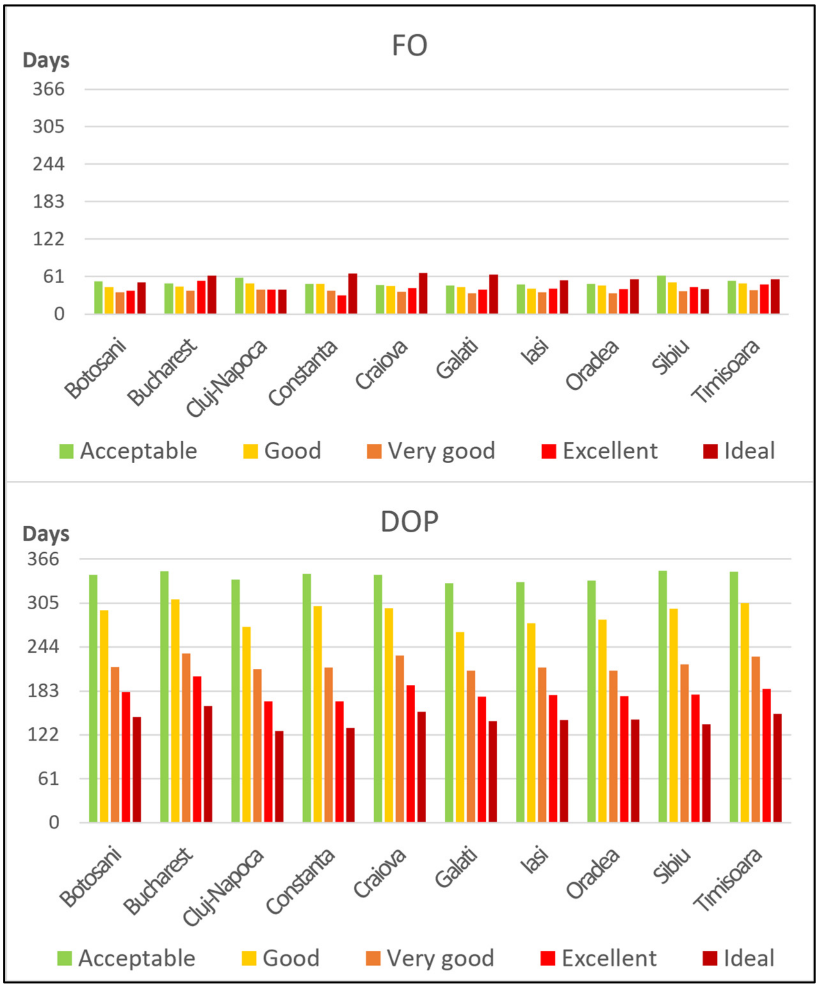

Figure 5. FO (**up**) and DOP (**down**) mean values for each suitability class and each location considered.

The length of the *DOP* also depends on the comfort class, but the *Acceptable* class has the most extended duration; such days are noticed almost all year round (between 330 days/year at Galați and 350 days/year at Sibiu), followed by *Good* conditions (between 265 days/year at Galați and 310 days/year at Bucharest). The *Excellent* conditions have a duration ranging from 168 days/year (Constanța and Cluj-Napoca) to 203 days/year (Bucharest), respectively, and *Very Good* conditions between 211 (Galați) and 235 (Bucharest) days/year, which are specific to the late spring/early autumn and summer seasons. The shortest duration is attributed to the *Ideal* class, extending to 130 days/year at Cluj-Napoca and 160/year at Bucharest (Figure 5, down and Table 3).

The earliest occurrences of *FD* are noted in the *Acceptable* class, from early January, ranging from the 9th (Timișoara and Sibiu) to the 19th day of the year (Iași). Conditions classified as *Good* indicated considerable variability among different stations, with *FD* observed in February, starting from 3 February (day 34) in Bucharest and extending to 27 February (day 58) in Galați. *Very Good* conditions emerge in March, spanning from 10 March (day 70) in Craiova to 29 March (day 89) in Constanța, while *Excellent* conditions are present between 2 April (day 93) in Bucharest and 26 April (day 117) in Constanța. *Ideal* conditions were identified between 22 April (day 113) in Bucharest and 17 May (day 137) in Constanța (Table 3 and Figure 6, up).

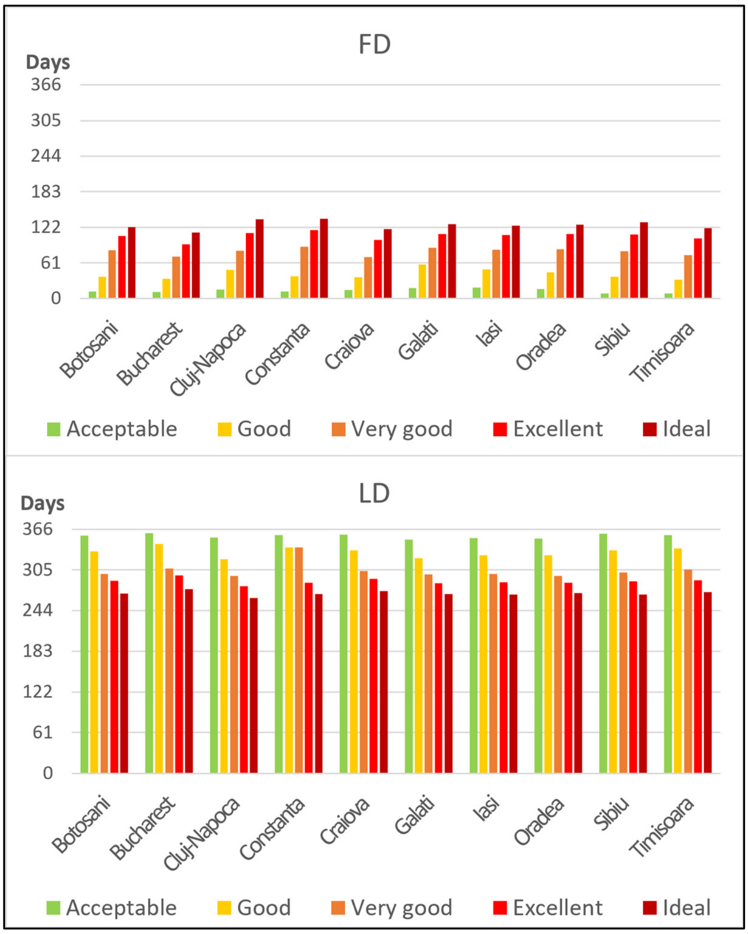

Figure 6. Mean FD (**up**) and LD (**down**) of occurrence for each suitability class and each location considered.

For LD, the differences among the same class from one city to another are relatively minor, varying from 10 to 20 days, except for *Very Good* conditions, which have their LD situated between 21 October (day 295) at Cluj and 4 December (day 339) at Constanța. Furthermore, days with *Acceptable* conditions extend beyond 15 December (day 350) at each station. Those with *Good* conditions have their LD falling between 16 November and 9 December (days 321–344) of the year. *Excellent* conditions have LD between 7 October and 23 October (days 281–297). Similarly, days with *Ideal* conditions have LD between 19 September and 2 October (days 263–276). Notably, these patterns are consistent across the same cities for the last three classes, indicating that days suitable for outdoor recreational activities occur the earliest in Cluj-Napoca and the latest in Bucharest (Table 3 and Figure 6, down).

3.4. Trend Analysis

Over the 61 years considered, for most cities, a general decreasing trend was detected in the FD of *Acceptable*, *Good*, and *Very Good* classes, which means a general shifting of these conditions earlier in the year. The LD indicated an increasing trend for lowlands, especially for those located in the Southern and Eastern regions of the country, mainly for *Good* and *Very Good* conditions. Significant changes were detected in the Southeast, including the Black Sea coastline. The changes in the FD and LD led to an extension of the DOP, which is confirmed by the dominant increasing trends of DOP for most classes. The trends identified are significant in the extra-Carpathian regions, especially for the *Acceptable*, *Good*, and *Excellent* classes. The *Ideal* comfort class had a dominant increase in the FD and a dominant decrease in the LD and DOP. The only exception was for the Black Sea seaside region, which recorded opposite trends, with a significant increase in the DOP (Figure 7 and Table S3). The highest Sen's slope was calculated for Constanța, where FD indicated a decreasing trend for each class. The most prominent was the *Good* conditions class, which decreased by 9 days/10 years. LD increased more than 4 days/10 years for *Good* and *Excellent* conditions. DOP increased for *Good* class with more than 13 days/10 years, and FO with almost 6 days/10 years of *Ideal* conditions. Consistent changes were also recorded in Galați, with increasing trends in FO and DOP, Sen's slope values ranging between 3 and 8 days/10 years, and decreasing trends in FD, with values falling between 2 and 6 days/10 years, for *Acceptable*, *Good* and *Very Good* comfort classes (Tables 4 and S3).

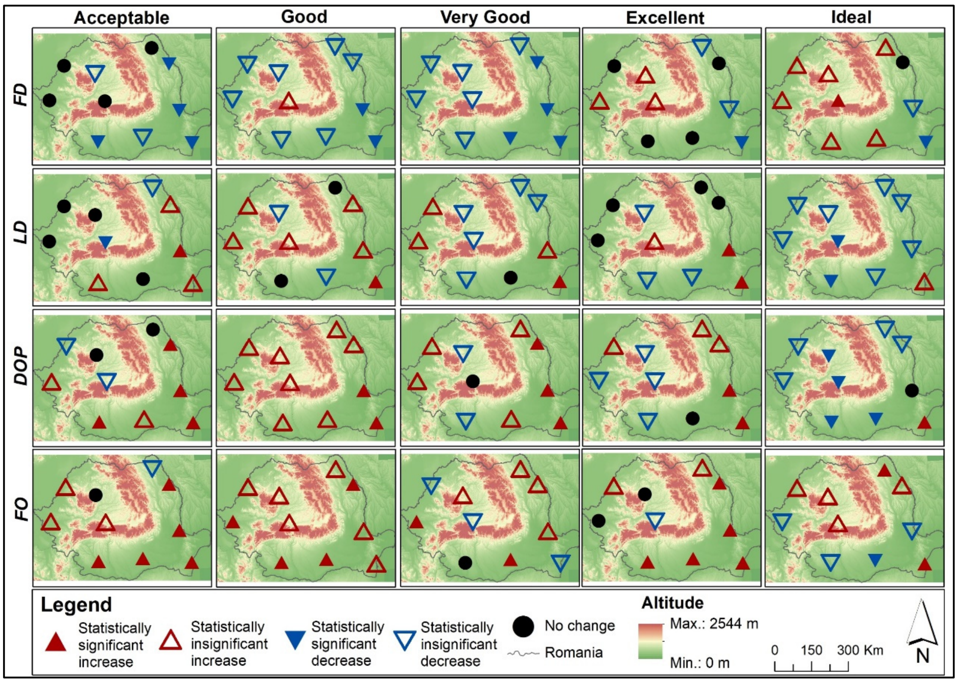

Figure 7. Trend detection of FD, LD, DOP, and FO for the analyzed cities (1961–2021).

Table 4. Sen's slope of FD, LD, DOP, and FO for the analyzed cities (days/10 years).

Sen's Slope	Comfort Class/City	Botosani *	Bucharest	Cluj-Napoca	Constanța	Craiova	Galați	Iași	Oradea	Sibiu	Timișoara
FO	Acceptable	−0.270	**1.765**	0.000	**1.868**	**1.797**	**2.857**	**1.206**	0.000	0.000	0.800
	Good	0.674	0.694	0.440	0.445	**1.559**	0.960	**1.650**	0.435	0.000	**1.500**
	Very Good	0.920	**0.909**	0.667	−0.339	0.000	0.270	0.455	−0.282	−0.351	**2.000**
	Excellent	0.455	**1.920**	0.000	**0.909**	**1.304**	**4.211**	**1.667**	0.769	−0.445	0.000
	Ideal	**1.786**	**−2.168**	1.357	**5.789**	−0.960	−0.231	1.684	0.952	0.649	−1.667
DOP	Acceptable	0.000	1.250	0.000	**3.086**	**3.000**	**5.251**	**3.889**	−0.340	−0.769	0.678
	Good	2.578	1.250	1.250	**13.023**	2.673	**7.592**	3.258	1.847	0.920	0.809
	Very Good	0.558	1.667	−1.027	**6.111**	−0.472	**3.675**	**2.768**	1.901	0.000	1.017
	Excellent	0.408	0.000	−2.500	**6.815**	−1.111	**3.402**	0.412	0.354	−2.158	−0.736
	Ideal	−2.343	**−3.970**	**−3.636**	3.333	**−3.333**	0.000	−1.371	−2.986	**−5.345**	−3.333
FD	Acceptable	0.000	−0.811	−0.208	**−1.304**	**−2.000**	**−1.868**	**−2.754**	0.000	0.000	0.000
	Good	−1.071	−1.772	−1.667	**−9.052**	−2.110	**−5.472**	−1.429	−0.723	1.112	−0.367
	Very Good	−1.765	**−2.367**	−0.227	**−4.483**	−0.909	**−3.333**	**−2.952**	−1.429	−1.158	−0.981
	Excellent	−0.805	0.000	1.579	**−3.371**	0.000	−1.266	0.000	0.000	**2.727**	2.000
	Ideal	0.968	2.440	2.069	**−2.772**	0.909	−1.000	0.000	1.333	**2.604**	2.727
LD	Acceptable	−0.192	0.000	0.000	0.686	0.588	**2.174**	0.667	0.000	**−0.694**	0.000
	Good	0.000	−1.371	−0.222	**4.636**	0.000	1.039	1.429	1.053	0.984	0.381
	Very Good	−1.206	0.000	−1.021	**2.000**	−1.137	0.702	−0.357	1.333	−0.886	0.483
	Excellent	0.000	−0.440	−1.176	**4.508**	−0.645	**1.830**	0.000	0.000	0.729	0.000
	Ideal	−0.984	−1.667	−1.325	0.404	**−1.852**	−0.417	−1.044	−0.952	**−2.500**	−1.818

* Values in bold are statistically significant.

Table S3 presents additional information regarding the trend (*p*-value, Sen's slope) and the mean and extreme values of the four parameters.

3.5. Outdoor Event Analysis and Correlation with Climatic Conditions

Bucharest stands out with its longest DOP for outdoor events, making it an ideal hub for open-air gatherings and festivities. While its status as the capital city undeniably contributes to the high number of events (19), the favorable climatic conditions provide a solid starting point for outdoor event scenes. It is followed by Sibiu, Cluj-Napoca, and Galați, with more than 10 events organized each year (Table S1). One can see a high concentration of events in some cities during summertime, sometimes overlapping during the same decades (e.g., at Sibiu, in the third decade of June and July). That is why there are decades with events covering "more than ten days"; we designated them with 10+ days in Figure 2, right. When analyzing the temporal distribution of the events by cities, one can see a reasonable distribution for Cluj-Napoca, Constanța, and Galați, a continuous long period with events in Bucharest and multiple overlapping events in Sibiu. Together with a high tourist flux in the city, overlapping events could create difficulties for the organizers and discomfort for both tourists and locals. Two festivals of 7 or more days each took place simultaneously, overcrowding the city and putting pressure on accommodation infrastructure and the local population. With Figure 2, right, we aimed to emphasize the great number of events gathered in a specific period when the same or even better weather conditions are specific a decade earlier or later. This is also the case for the third decade of August in Craiova city, where the total number of outdoor festivals and recreational events is relatively low. Still, two major festivals overlap the same days. From a sustainable perspective, they could be easily spread during the summer, and the benefits to the local community in terms of economy and comfort (avoiding overcrowded periods) would be much higher. On the contrary, other big cities like Iași, Oradea, and Craiova present a contrasting picture. Despite the *Excellent* conditions suitable for outdoor events, there is a noticeable shortage of such activities (2–6 events per year) (Figure 2, right and Table S1), which considerably misuses natural potential.

Additionally, it is worth mentioning that some open-air events organized are of great magnitude due to the impressive number of local and international audiences. Festivals such as Untold or Electric Castle (Cluj-Napoca) and Neversea (Constanța), in the most recent years, have attracted annually over 100,000 participants [62–64] (Table S1).

In such cases, but not only, ETCI should be employed to schedule open-air events during periods identified as having *Ideal* or *Excellent* conditions to avoid overlaps and distribute them evenly over extended suitable periods, optimizing tourist influx and mitigating overcrowding.

4. Discussions

This section proposes a complex approach to summarizing climatic findings towards tourism planning, economic implications, and some recommendations from a sustainable development perspective based on city-specific observations.

4.1. City Scale Findings

The ETCI analysis indicates that suitable conditions for outdoor tourism in most Romanian cities analyzed extend beyond the traditional summer months, from late April to mid-October. Over the last six decades, the trend showed a general shift of suitable weather conditions for open-air events earlier in the year, resulting in a longer duration of potential intervals for such events. The trend was significant for the extra-Carpathian regions, especially for *Acceptable*, *Good*, and *Excellent* conditions classes. The same feature was also noticed in the analysis of the last ten years.

According to the 2012–2021 analysis, open-air recreational and tourism activities are generally suitable from the second decade of March to the first decade of November in most cities, with Cluj-Napoca and Iași starting earlier and Constanța, Sibiu, and Timișoara extending later. Eastern cities like Galați, Iași, and Bucharest experienced *Very Good* conditions a decade earlier. Western and central region cities (Oradea, Cluj-Napoca, Sibiu, and Timișoara) may start up to three decades later. Toward the end of the season, upper suitability conditions decreased, with most locations experiencing *Good* conditions, except for Sibiu, which had only *Acceptable* conditions in late September.

Even though Bucharest, the capital and largest city, exhibits the most extended duration of usable climatic conditions for outdoor events, all other cities indicated a much longer suitable period than the summer months. In terms of events identified, some cities indicated many events, sometimes overlapping (e.g., Sibiu), whereas, for others, only a few events in a year were identified.

4.2. Trends and Economic/Tourism Implications

The results of this study could be very helpful from various perspectives in the context of Romanian tourism, supporting the development of the ten cities considered.

The shift towards a longer climatic suitable season has profound implications for economic development and sustainability, especially in the tourism sector: understanding the best periods for tourism allows sector planners to strategically promote tourism for the detected suitable season. Such targeted promotions can result in consistent economic benefits throughout the year. By effectively employing the ETCI, cities can be prepared to organize and offer more activities and events during early spring and late autumn, which would serve a dual purpose: (i) it could alleviate the pressures of peak season tourism, ensuring a more balanced influx throughout the year, and (ii) it would give visitors and tourists a broader window to engage in outdoor recreational activities, attracting them outside the peak summer months. Thus, more events can be organized at the city scale during the season when *Acceptable*, *Good*, and *Very Good* conditions were detected. This period can be effectively utilized to organize various festivals, fairs, and open-air concerts or sports competitions, providing continuous tourist attractions, enhancing the city's appeal, and extending the overall tourism season. Diversifying event calendars based on climatic suitability is an effective strategy for economic growth. Currently, some cities experience a high concentration of events during the peak summer months (e.g., Bucharest, Sibiu), leading to overcrowding and pressure on local infrastructure and population. Organizing and spreading events across the entire period of suitable climatic conditions and avoiding overlapping events during the peak season, such as scheduling major festivals, dedicated markets, fairs, and sports activities in April, May, September, and October, can alleviate this pressure and can avoid difficulties for organizers. For instance, some events dedicated to the Easter period could be organized in each city in April-May, promoting local/national traditions such as painting Easter eggs. Moreover, in the cities located in the western and central regions of the country (Cluj-Napoca, Oradea, Sibiu, and Timișoara), where both Catholic and Orthodox Easter are celebrated, events like Easter markets can last for more extended periods to cover both holidays. Also, we did not identify any folk festivals in the cities that were considered. They could be of great interest when organized at the regional or national level, enlarging the old generation or tradition-lovers cohort of tourists. Additionally, city tours and urban tourism can be promoted and organized during periods not covered by major events, mainly in spring and autumn.

Enhanced marketing strategies can be developed by utilizing climatic suitability data to create targeted campaigns aimed at different segments of tourists, such as nature lovers who visit/spend time in botanical gardens or urban forests/parks existing in almost all cities considered, cultural tourists, who prefer visiting open-air museums or to participate to various festivals, and adventure seekers during optimal periods that can be organized inside or nearby the cities considered. The city can avoid overcrowding by highlighting unique aspects of each city during the entire season of suitable climatic conditions combined with strategically spreading events throughout this time.

Increasing tourist satisfaction could be an essential benefit. Overcrowding during peak season can degrade the tourist experience, leading to dissatisfaction and potentially harmful reviews. In contrast, less crowded venues and attractions will provide visitors and tourists with a more enjoyable and relaxed experience. Available information for tourists about the best times to visit a city based on climatic conditions can lead to higher satisfaction and repeat visits. Tailoring tourist experiences and packages based on the climatic suitability of different periods, including special offers for spring and autumn visits, can encourage tourists to explore less crowded seasons and, in time, attract more visitors/tourists.

Community and cultural benefits are also significant. By spreading tourism activities throughout the year, local communities can engage more consistently with visitors and tourists, fostering cultural exchanges. Promoting cultural festivals and local events during non-peak seasons can attract culturally inclined tourists, enriching the cultural landscape of the cities.

In terms of economic development, it leads to more efficient resource allocation: when there is clarity about when tourist influxes are expected, resources like transportation, staff, and amenities can be deployed optimally by redistributing the tourism activities and events throughout the entire favorable season. Insights from the ETCI can be leveraged to ensure consistent revenue generation throughout the year. Local businesses can stabilize employment and income by preparing for tourist arrivals based on climatic suitability, reducing the economic uncertainties associated with seasonal tourism patterns.

By understanding the climatic patterns of each city, tourism investors could improve their management operations and reduce the seasonality in tourism flows that are so often influenced by weather and climate. Furthermore, by anticipating tourist arrivals based on the index, city planners and investors can project infrastructure development in a timely, adjusted, and sustainable manner in the mid- and long-term. This strategic alignment offers reassurance and confidence that the local infrastructure will be adequately prepared for increased tourist numbers during the identified suitable periods, enhancing the overall tourism experience.

However, for increasing accuracy, when results are considered by city and tourism planners or by tourism investors, they need to be complemented by newer tourism-climate indices, such as the Holiday Climate Index (Urban version), which are already available from other studies [28].

4.3. Recommendations from a Sustainable Development Perspective

A forward-thinking approach is needed to support sustainable development. Since tourism is one of the most affected sectors by climate change [5,65,66], but at the same time, having a considerable contribution to GHG emissions, mainly due to long-distance travels [67–69], national and international tourism policies must encourage local and regional tourism. Such tourism, which does not necessitate long-distance travel, directly contributes to the sustainable development of cities and climate change mitigation. By reducing travel distances and transport times, as well as using the entire suitable period detected to relieve pressure on the cities, including their environment and local communities, with this approach, we propose a more friendly tourism model that benefits both the (local) economy and the Planet. By reducing peak season pressure, the environmental impact on natural and urban areas can be mitigated, preserving ecological balance and maintaining the quality of tourist attractions. Better planning and distribution of tourist activities can lead to more efficient use of water, energy, and waste management systems. Such distribution can prevent environmental degradation, often arising from unplanned, concentrated footfall during peak seasons.

This can foster a culture of sustainable tourism among visitors/tourists that could become more coordinated with the local environment and its rhythms. This kind of information (results) may be helpful for travelers when planning their vacation: knowing the best times to visit allows them to make informed choices, leading to a better travel experience. Moreover, educating tourists about the appropriate times to visit a destination based on climatic conditions can increase their overall satisfaction and wishes to return.

This type of study could be developed for larger-scale areas like regions or countries to decrease the pressure on crowded destinations. Developing climate mitigation and adaptation strategies based on the shifting trends of suitable conditions is essential. The observed shift towards earlier favorable conditions in the year should be integrated into long-term tourism infrastructure and services planning, ensuring they are resilient and adaptable to these changes.

5. Conclusions

From a scientific perspective, the outcomes of this research are important as they represent advances in the field of tourism climatology in the region, filling gaps in knowledge and informing future studies. With the enhancement proposed in this paper to the original version of the TCI, the assessment of climatic suitability becomes more accurate and, thus, more helpful to stakeholders.

This study is the first to analyze the ETCI values in the most important Romanian urban areas. It covers most of the country's regions and allows an overview of the general climate suitability conditions and the length of the tourism season in the lowland areas. The study can be further extended to the neighboring countries in Southeastern Europe, mainly in the near-border regions.

The main findings are:

- The most appropriate weather for open-air tourism usually begins in the last part of April and ends during mid-October;
- The trend analysis revealed a shift of suitable conditions earlier in the year, resulting in a longer duration of the favorable season for open-air events, with significant trends detected mainly in the extra-Carpathian regions;
- There is a big difference among the numbers of open-air events identified in the cities considered;
- Most of the events in the cities considered are concentrated in the summer months despite the favorable conditions over a much more extended period.

Developing local tourism strategies for the cities considered should consider climatic suitability over the year and the changes detected to accommodate the tourist's and visitor's needs, the tourism infrastructure in the respective cities, and the comfort of locals in the general context of the region.

Local economies, too, stand to gain immensely from this nuanced application of the ETCI. Local businesses can ensure more stable employment opportunities and incomes by preparing for tourism influxes based on climatic suitability. This stability, in turn, can prevent the economic uncertainties that arise from off-peak seasons and uneven tourist arrivals. Furthermore, such insights can also lead to the creation of season-specific tourism packages, enhancing the overall tourist experience and driving economic growth. Another significant advantage is the potential for consistent revenue generation. Instead of facing the economic uncertainties of boom-and-bust cycles driven by traditional seasonal patterns, destinations can achieve a more predictable and steady revenue stream by leveraging ETCI's insights.

Under these conditions, the novel approach we propose could help tourism planners extend the period of outdoor tourism and recreational activities in the cities considered, decrease pressure during the peak season, and optimize the tourist flux over the entire season. Optimizing economic benefits through targeted promotions based on ETCI insights can ensure a steady stream of visitors throughout the year, stabilizing revenue for local businesses and tourism operators. A more consistent flow of tourists can lead to more stable employment opportunities in the tourism and hospitality sectors, reducing the seasonal jobs.

Summarizing, from a tourism climatology perspective, capitalizing on these optimal days by organizing more open-air events in cities with low number of events would undoubtedly be beneficial for the local communities to engage and interact and would be a gain from both socio-economic and cultural perspectives. Local and regional tourism would be encouraged, significantly reducing long-distance travel and contributing to lower GHG emissions. Therefore, local authorities and tourism boards can develop targeted marketing campaigns to highlight these aspects, drawing more visitors and piquing their interest in these lesser-known destinations.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/atmos15080996/s1, Table S1: The Identified Open-air Events by Cities (Events and Details); Table S2a: Frequency of Suitability Conditions—1961–2021; Table S2b: Frequency of Suitability Conditions—2012–2021; Table S3: FO, DOP, FD and LD trend values for each comfort class.

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