THE CLIMATIC-TOURISTIC POTENTIAL OF THE ROMANIAN BLACK SEA COAST DURING SUMMER, ESTABLISHED ACCORDING TO THE METHOD OF BESANCENOT, MOUNIER AND DE LAVENNE

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Abstract: This paper describes the climatic-touristic potential of the Romanian Black Sea Coast during summer, based on daily weather data collected between 1960 and 2009 from the weather stations of Sf. Gheorghe, Gura Portiţei, Constanţa and Mangalia. These data have been processed using the method of Besancenot et al. (1978), establishing a classification which highlights the optimal combination of climatic elements influencing touristic outdoor activities. Following the analysis, we have concluded that the climatic-touristic potential of the Romanian Black Sea Coast is high, at it peak during July and August when _very nice and sunny weather_ reaches a frequency of up to 61%. The less favorable month is September, the registered frequency of _unfavorable weather_ during the first 20 years reaching 18-36% and 34-55% during the third decade.

Key-words: climatic-touristic potential, the Black Sea, method.

1. GENERAL ASPECTS

Several indices and methods have been used by touristic climatology in order to characterize the climatic-touristic potential of a region. The most important _indices_ have been elaborated by Marchand (1986), Clausse & Guérout (1955), Burnet (1963), Poulter (1962), Hughes (1967), Davis (1968), Flocas (1975), Sarramea (1980), Mierczkowski (1983, 1985), Rivolier et al. (1967). These indices have been used by Besancenot (1990), Gaceu (2002, 2003) and Sorocovschi (2008) in methodology papers which also describe the most significant methods climatic-touristic analysis methods (Ciubukov, 1949; Baibakova et al, 1964; Barbierre, 1981; Crowe et al., 1975). Among these, the indices of Clausse & Guérout, 1955, as well as the methods elaborated by Ciubukov (1949) and Baibakova (1964) have been applied to Romanian territory by Fărcaş et al. (1968, 1970); Teodoreanu et al. (1984); Dragotă et al., (1999); Popescu et al. (2010) etc.

The presented indices and methods are very much limited due to the fact that they can only be applied to certain regions, they require an increased volume of data, they do not explicitly indicate the degree of climatic-touristic favorability and furthermore, some indices are expressed in units of measurement that do not correspond to the International System of Units thus generating erroneous results because of mathematical incompatibilities in calculus.

To exemplify, Besancenot (1990) demonstrates that a summer with uninterrupted drizzle (100mm/month), permanently cloudy sky and a constant temperature of $23.5^{0}C$, is considered unfavorable to outdoor activities according to c's method (1962) which indicates an index of 683, whereas in the case of Mieczkowski's formula (1985), the index's value is above 50 and the same summer is regarded as favorable to tourism.

In order to surpass these shortcomings, other researchers coordinated by Besancenot have elaborated another classification of weather types, eliminating the mechanistic approach and proposing a more concrete and more accurate climatic-touristic analysis. It is also used in this study, based on Dragotă and Gaceu's paper (2004).

2. METHODOLOGY

This study is based on the six-hourly meteorological observation data collected between 1960 and 2009 (in the last 50 years) from the weather stations of Gura Portiţei, Sf. Gheorghe, Constanţa and Mangalia (Fig. 1). Amounting to a total of 366.000 data, interpreted by means of 58.472.288 mathematical operations, the observations used regard the average hours of sunshine per day, the daily duration of precipitations between 7a.m. and 7.p.m., the maximum daily temperature, wind speed and vapor tension measured at noon.

In order to better highlight the climatic-touristic potential of the Romanian Black Sea Coast, this study includes the month of September (even though it is off-season) due to the fact that it is more favorable to helio-marine therapy than May (mostly because of the water temperature).

These data have been processed using the method of Besancenot et al. (1978), establishing a classification which highlights the optimal daily combinations of the main climatic elements influencing tourism activities.

Figure 1. The weather stations' positioning on the Romanian Black Sea Coast.

The method applied is intermediate, a mix between that of *weather types* and that of *indices*, borrowing their synthetic character. It is remarkable due to its simplicity, not implying an increased effort when applied and the values thus obtained are real, measurable in what concerns the number of favorable or unfavorable days to outdoor activities, quality which indicates it as the most appropriate for the study of the climatic-touristic potential of a region. Consequently, *for temperate latitudes*, *during summer*, the quoted authors distinguish 9 types of weather which they have transposed on climate diagrams including the types of weather characteristic to each decade, starting from the most favorable (base) highlighted in warm colors and up to the most unfavorable (top) indicated by cool colors (Table 1).

This method can be used only for temperate latitudes in order to characterize the climatic-touristic potential during the warm season. For other seasons and/or latitudes, other specific appreciation criteria are to be used (Besancenot, 1990; Gaceu, 2002).

Table 1. Weather types characteristic to temperate zone during summer

Type 1: very sunny weather $I \geq 9h$ or $Nb \leq 2/8$ $D = 0h$ or $P = 0$ mm $25 \leq Tx < 33^0C$ $V < 8m/s$ $4 < U < 25$ hPa	*Type 6:* warm and overwhelming weather $I \geq 9h$ or $Nb \leq 2/8$ $D = 0h$ or $P = 0$ mm $Tx \geq 18^0C$ $V < 12$ m/s $25 < U < 31,3$ hPa or $I \geq 9h$ or $Nb \leq 2/8$ $D = 0h$ or $P = 0$ mm $Tx \geq 33^0C$ $V < 12$ m/s $U < 31,3$ hPa
Type 2: fine sunny weather $I \geq 9h$ or $Nb \leq 2/8$ $D = 0h$ or $P = 0$ mm $18 \leq Tx < 25^0C$ $V < 8m/s$ $4 < U < 25$ hPa	
Type 3: cool sunny weather $I \geq 9h$ or $Nb \leq 2/8$ $D = 0h$ or $P = 0$ mm $16 \leq Tx < 18^0C$ $V < 8m/s$ $4 < U < 25$ hPa	*Type 7:* fine weather with strong wind $I \geq 9h$ or $Nb \leq 2/8$ $D = 0h$ or $P = 0$ mm $18 \leq Tx < 33^0C$ $8 \leq V < 12m/s$ $4 < U < 25$ hPa
Type 4: fine weather with partially overcast sky $3 \leq I < 9h$ or $2 < Nb \leq 6/8$ $D = 0h$ or $P = 0$ mm $18 \leq Tx < 33^0C$ $V < 8m/s$ $4 < U < 25$ hPa	*Type 8:* unfavorable weather All the other types of weather except type 8 bis
Type 5: fine weather with short wet spells $I \geq 3h$ or $Nb \leq 6/8$ $0,1 \leq D < 1h$ or $0,1 \leq P < 0$ mm $18 \leq Tx < 33^0C$ $V < 8m/s$ $4 < U < 25$ hPa	*Type 8 bis:* moist rainy weather $I < 3h$ or $Nb \geq 6/8$ $D > 3h$ or $P > 5$ mm

The differentiation of types of weather has been conducted according to five climatic parameters: average hours of sunshine (I), expressed in hours; the daily duration of precipitations between 7a.m. and 7.p.m. (D), expressed in hours; the maximum daily temperature (Tx), expressed in ^oC; wind speed measured at noon (V), expressed in m/s; and vapor tension measured at noon (U), expressed in hPa. If stations register incomplete meteorological observations, some element can be replaced by others. Thus, the lack of data regarding the average hours of sunshine can be complemented by data regarding cloud cover at noon, expressed in eights of sky cover (Nb) and the amount of precipitation (P), expressed in mm, can replace the lack of data regarding the duration of precipitations (when the time frame of rainfall has not been registered) (Table 1).

Type 1 indicates v*ery nice and sunny weather* and is characterized by a maximal temperature registered at noon of 25° C up to 33° C, minimal cloud cover during daytime, under 2/8 sky cover or a 9 hours sunshine daily average, a maximal wind speed of under 8 m/s at noon, a vapor tension

registered at noon of 4hPa up to 25 hPa and a lack of precipitation between 6 a.m. and 6p.m.

Type 2 stands for *fine and sunny weather,* characterized by a maximal temperature (registered at noon) lower than that of type 1, with values of 18° C up to 25° C and the same characteristics in the case of the other weather elements.

Type 3 represents *cool and sunny weather,* registering at noon an even lower maximal temperature, of 16° C up to 18° C and the same characteristics for the other weather elements as in the case of type 1 and 2.

Type 4 describes *fine weather with partially overcast sky,* of a maximal temperature at noon registering between 18° C and 33° C, an average daily cloud cover of 2 up to 6 eights of sky cover or an average of 3 up to 9 hours of daily sunshine, registering and the same characteristics for the other weather elements (precipitation, wind speed, vapor tension) as in the case of type 1, 2 and 3.

Type 5 indicates *fine weather with short wet spells,* of a maximal temperature at noon registering between 18° C and 33° C, an average of more that

3 hours of daily sunshine or an average daily cloud cover of 6 eights of sky cover, under an hour of daily precipitations, wind speed and vapor tension observations similar to those registered in types 1, 2, 3 and 4.

Type 6 designates *hot and sultry weather,* characterized by an average of more than 9 hours of sunshine per day, a lack of diurnal precipitations, a maximal temperature of over 18°C, a wind speed at noon under 12 m/s and a vapor tension between 25hPa and 31,5 hPa. Hot and sultry weather can also be characterized by a different configuration of values of characteristic meteorological elements, such as high maximal temperatures at noon, exceeding 33°C, and high levels of vapor tension, reaching up to 31,3 hPa, a lack of diurnal precipitations, and average of over 9 hours of daily sunshine and a maximal wind speed of up to 12 m/s.

Type 7 characterizes *fine weather, with strong winds,* with a daily average of more than 9 hours of sunshine, a lack of diurnal precipitations, a temperature registering at noon between 18°C and 33°C, vapor tension values between 4 hPa and 25 hPa and a wind speed registering at noon between 8 m/s and 12 m/s. For types 1, 4, 5, 6 and 7, maximal temperatures do not exceed 33°C because of the thermal anomaly caused by the thermal inertia of water masses (Apostol, 1990).

Type 8 indicates *unfavorable weather* to tourism activities, characterized by a daily average of less than 3 hours of sunshine and the duration of diurnal precipitations exceeds 3 hours, two meteorological elements representing *damp, rainy weather,* unfavorable to tourism. Moreover, besides the damp, rainy weather, all other possible types of weather which have not been described in the first 7 weather types are unfavorable to tourism.

Therefore, the first seven weather types are favorable to touristic activities, being either perfect in this regard (type 1) or less so because of occasional relative bad weather (types 4 and 5) or because of a certain level of discomfort (types 2, 3, 6, 7), while the last two types, 8 and 8bis represent the types of weather that are unfavorable to outdoor activities.

3. RESULTS

Applying the above method to the observations registered by the four weather stations of the Romanian Black Sea Coast (Sf. Gheorghe, Gura Portiței, Constanța and Mangalia), the results obtained are presented per decade, as shown in figure 2. It is noticeable that the most frequent type of weather is *very nice and sunny weather* (type 1),

ideal for sunbathing and swimming. Its registered frequency for the interval July-August was of 25-54% at Sf. Gheorghe, 37-61% for Gura Portiței, 29-50% in the case of Constanța and for 12-34% Mangalia. For the month of June, the registered frequency of very nice and sunny weather measured per decade is of 24-29% for Sf. Gheorghe, 27-43% in the case of Gura Portiței, 26-36% at Constanța and 15-18% for Mangalia while the month of September registered the lowest frequency per decade: 9-16% in the case of Gura Portiței, 5-11% for Sf. Gheorghe, 9-20% at Constanța and 3-6% for Mangalia.

The second most frequent type of weather, *fine and sunny weather* (type 2) is also favorable to helio-marine therapy even though it presupposes a slight thermal discomfort: for the interval July-August, its registered frequency per decade is of 0-16% for Sf. Gheorghe, 0-24% at Gura Portiței, 3-20% in the case of Constanța and 2-19% for Mangalia, though it is more common in June and September when it registers a frequency of 18-43% at Gura Portiței, 16-38% for Sf. Gheorghe, 22-38% in the case of Constanța and 9-30% for Mangalia.

The third most frequent type of weather, *unfavorable to outdoor activities* (type 8) is generally present in 18%-36% of cases, reaching a maximum of 22%-37% in the month of September and even a frequency of 53% for Sf. Gheorghe and Mangalia in the case of the last decade.

Next in the order of frequency, *fine weather with partially overcast sky* (type 4) is also favorable to helio-marine therapy despite a thermal discomfort; it is observed at all station, registering a lower frequency per decade for the interval July-August: 7-23% at Gura Portiței, 3-11% for Sf. Gheorghe, 6-18% in the case of Constanța, 7-24% at Mangalia and a higher frequency for June and September, respectively 15-24% for Gura Portiței, 6-19% at Sf. Gheorghe, 12-34% in the case of Constanța and 11-35% for Mangalia.

Fine weather with short wet spells (type 5) registered for all stations and all months a low frequency per decade, between 0% and 5%. *Hot and sultry weather* (type 6) registered a higher frequency for the interval July-August (7-22% at Sf. Gheorghe, 4-16% for Gura Portiței, 14-28% in the case of Constanța, 16-40% for Mangalia) and a lesser one for June and September (0%-8% at Sf. Gheorghe, 0-6% in the case of Gura Portiței, 1-5% for Constanța and 0-10% at Mangalia).

Fine weather, with strong winds (type 7) is more frequent in the case of the Sf. Gheorghe station (6%-18%) and less so for the other (0-9%),

being relatively uniformly distributed over the summer season, per decade.

Finally, the other two types of weather described, *cool and sunny weather* (type 3) and moist rainy weather (type 8bis) have registered a negligible frequency in the case of the Romanian Black Sea Coast.
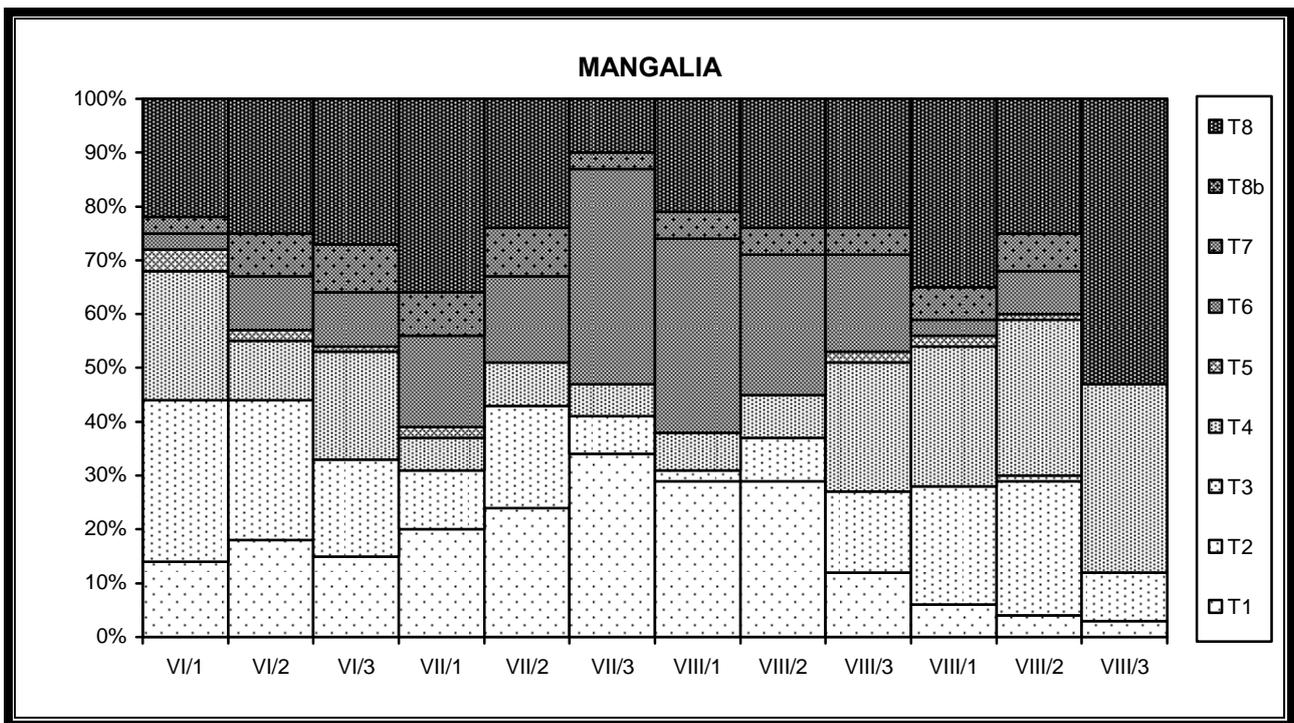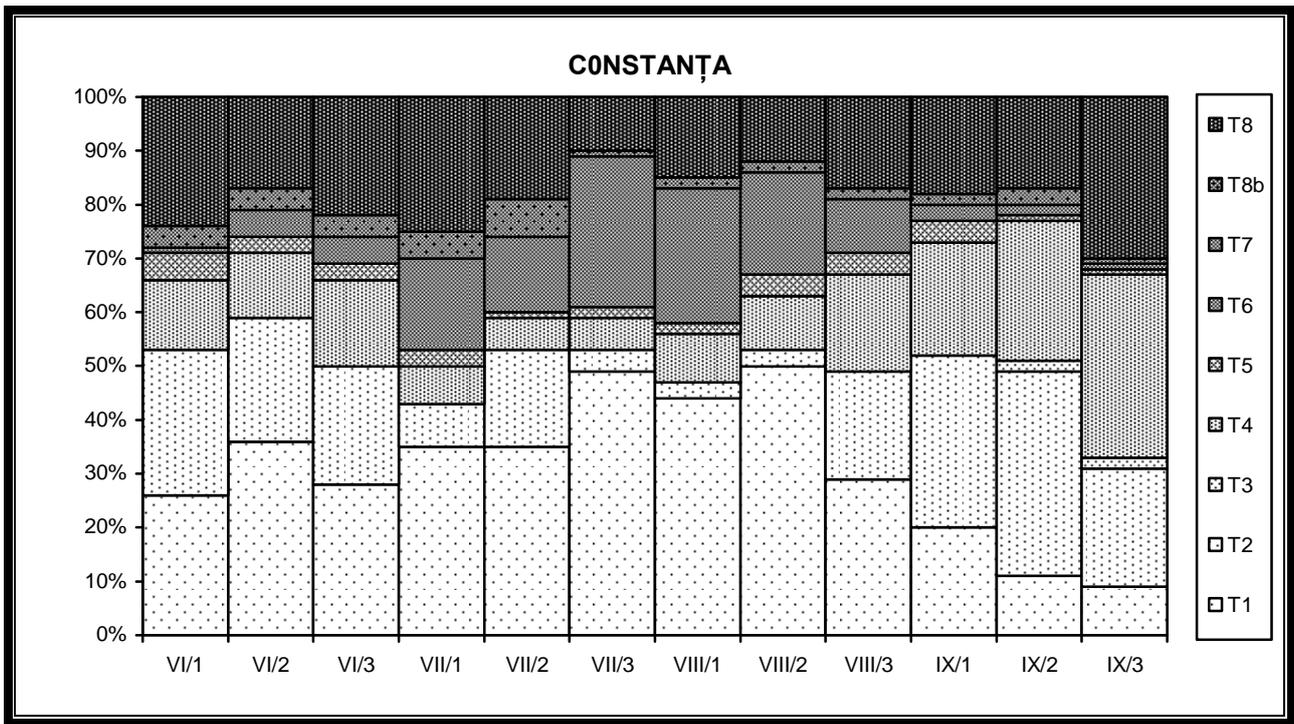
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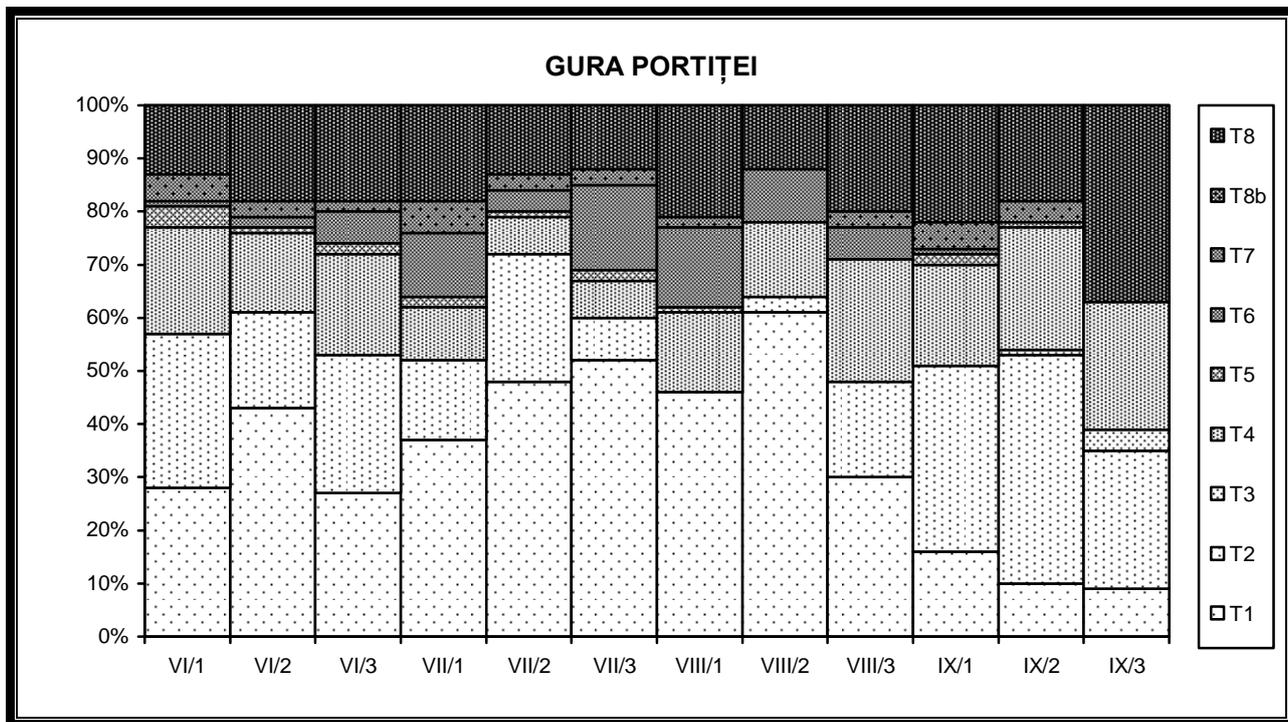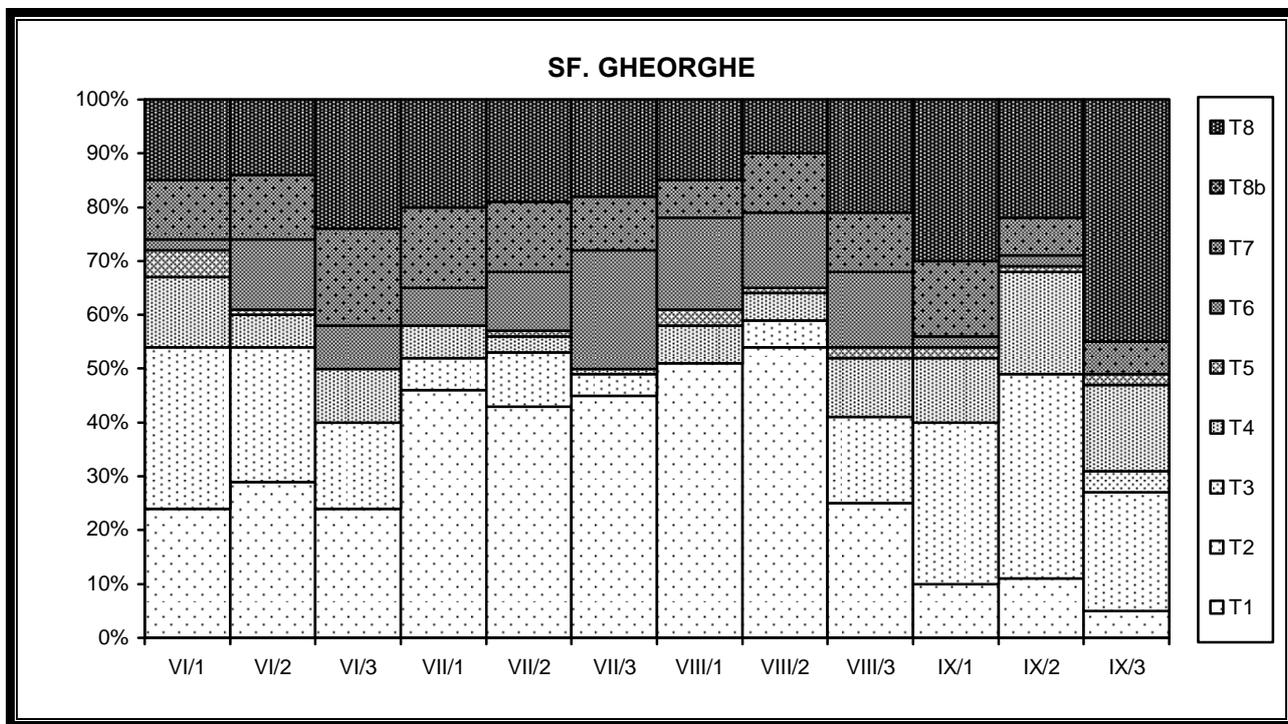
Figure 2. Weather types characteristic to the Romanian Black Sea Coast during summer.

4. CONCLUSIONS

The undergone research allows us to draw the following conclusions:

1) The Romanian Black Sea Coast profits from a high climatic-touristic potential. Contrary to what specialized literature describes and despite appearances, this potential increases from south to north. This augmentation corresponds to the expansion of aquatic surfaces situated near the coastline (such as the Razim-Sinoie lagoon complex, the Danube Delta), favorable to thermal inversions (The Geography of Romania, vol. V, 2005) during the warm season, inducing high atmosphere pressures and descendant currents which disrupt cloud systems, thus generating very nice, sunny weather. The Balkan advancement of Mediterranean cyclones engenders cloud cover at

their northern periphery and often, precipitations (Apostol, 2008). Thus, the south of the coastline is more affected in this respect (generally, very nice and sunny weather being least frequent on the south coastline);

2) The most favorable months are July (in the case of Mangalia) and August for the rest of the Romanian coastline. Less favorable circumstances during high-season, in July more so than in August, on the southern coastline as opposed to the northern and central parts of the coast are explained by two main causes:

In July, the higher frequency of Atlantic cyclones on the North European Plain can cause cloud cover and sometimes precipitations at the southern extremities of their fronts, phenomena which decrease significantly towards south.

The thermal inertia of water masses is less significant on the continental platform, towards north, towards the Gulf of Odessa due to the fact that this region comprises shallower depths and an extended area of contact with continental grounds as well as an important flow of surface water brought by numerous rivers, thus warming the superior level of the Black Sea faster than in the southern region. Compared to the northern area, the anticyclonic regime of the center and southern regions of the Black Sea, associated with fine weather, is more frequent in July than in the north.

During July and especially August, the anticyclonic regime of the Azoric Anticyclone's dorsal is predominant, averagely extended over the western half of Romania (The Climate of Romania, 2008), sometimes affecting the coastline area. At times, the expansion of the North-African Anticyclone's dorsal towards Greece generates tropical air advections, from the south-west and the south (The Geography of Romania, vol. I, vol. 1, 1987). In both cases, *very nice and sunny weather* registers a frequency of up to 61%;

3) The highest frequency of *very nice and sunny weather* during July-August is registered in the northern part of the coastline, in the Danube Delta at Gura Portiței (37-61%) and Sf. Gheorghe (25-54%) respectively, while the lowest frequency is registered in the southern part of the Romanian Black Sea coastline, area where most resorts are situated, as is the case of Constanța (29-50%) and Mangalia (12-34%);

4) Cumulating types 1 and 2, *very nice and sunny weather* and *fine, sunny weather*, the frequency of weather favorable (from a climatic point of view) to helio-marine therapy on the Romanian Black Sea Coast during turist season (June, July, August, September) is of 35% up to 85% for Gura Portiței, 25%-70% at Sf. Gheorghe, 32 up to 70% in the case of Constanța and 12% up to 53% for Mangalia;

5) June is more favorable to tourism than September due to the fact that the frequency, per decade, of *very nice and sunny weather* is of 15-36% for June, compared to 3-20% for September;

6) The most unfavorable period of the year is the month of September when, because of the growing instability of the weather, during the first two decades, all weather stations have registered a frequency of 18%-36% of unfavorable weather, while for the third decade, at Constanța and Gura Portiței the registered frequency was of 34-37%, 45% for Sf.Gheorghe and 55% in the case of Mangalia.

7) Despite being less renowned, with a limited accessibility and tourism infrastructure, its extended beaches (the beach of Sf. Gheorghe is second in size among European touristic beaches), its high-quality sand, less saline water, seafood cuisine, different sights and exterior decorations compared to what is offered in the south are advantages that will promote the northern part of the Romanian Black Sea Coast. Its climatic-touristic potential, highlighted by this study as being superior to that of the southern coastline can significantly increase the attractiveness of this area. This northern expansion towards the north may be of importance to Romania, due to the coastline length-population ratio.

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