CLIMATE RISKS IN THE BABADAG PLATEAU, DOBROGEA, SOUTHEASTERN ROMANIA

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ABSTRACT. - Climate risks in the Babadag Plateau, Dobrogea, Southeastern Romania. Climatic risk phenomena are researched and monitored by specialized institutions at both national and international level, due to their important economic and environmental impact. The purpose of this study is to know in detail the climatic risks to which the Babadag Plateau is subjected and the effects they have on society and the environment. Based on the official data recorded during 1965-2005, at the analyzed meteorological stations, maps were developed through the GIS (Geographic Information System) software, graphical representations for a better comparison of the particularities of climatic risk phenomena, and several specialized bibliographic sources were consulted. The results of the study highlight the fact that the Babadag Plateau can be subject to climatic risks throughout the year. The need for knowledge of these phenomena is imposed by the consequences they have on the economy, society and agricultural activities carried out within that territory.

Key words: climatic risk phenomena, Babadag Plateau, environmental impact

1. INTRODUCTION

The analysis of the climatic risk phenomena in the Babadag Plateau (Fig.1) is based on the data obtained from the observations of four meteorological stations between 1965-2005. The study regarding the climate risks begins with meteorological observation and ends with the monitoring of risk factors. This is a complex activity and includes several stages: the existence of a very long string of statistical data of observations, the establishment of the average characteristics of each analyzed climatic parameter, the extraction of the extreme values (the highest and the lowest monthly and annual averages, as absolute maximums and minimums) which represent possible limits of variation of the phenomenon etc.

Several scientific national papers have been published over the years and have contributed to the study of the climatic risks in this region, such as: Bucşa I., I.F. Mihăilescu (2002) - "Climatic risk phenomena in Dobrogea", Lungu M.,

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(2009) - "Climatic risk phenomena in Dobrogea", Lungu M., (2010) - "Climatic resources in Dobrogea", etc. Also, some scientific articles were developed within this research field during 2011-2013, which have as a result the study of the climatic risks in the south-east of Romania, such as: "Torrential rainfall in Dobrudja" (Lungu M., Panaitescu L.) and "Territorial distribution of hydrometeors risk in Dobrudja during the hot season" (Lungu M., Panaitescu L.).

The purpose of this study is to find out in detail the climatic risks to which the Babadag Plateau is subjected, as a result of analyzing climate deviations in this area, for a period of 40 years.

The different degree of heating and cooling, due mainly to the penetration of continental or maritime air masses, is the main cause of the formation and differentiation of climate risks in the Babadag Plateau.

After the period of occurrence of the risk phenomena, three types can be identified within the Babadag Plateau: climatic risk phenomena from the cold period of the year, climatic risk phenomena from the warm period and possible climatic risk phenomena for the entire year.

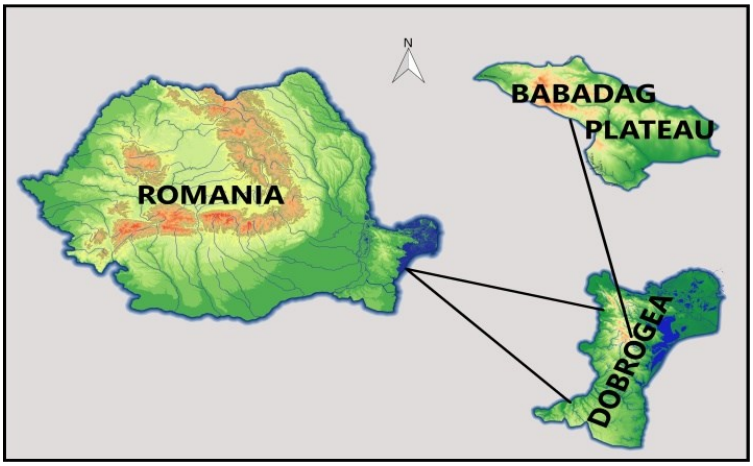

Fig. 1. The geographical position of the Babadag Plateau
Source: http://www.geo-spatial.org

2. MATERIALS AND METHODS

In order to elaborate this climate study, there have been used data on climatic peculiarities of the analyzed area (temperature, precipitation, wind, etc.) and the climatic risk phenomena within it: blizzard, snow cover, massive cooling, downpours, fog, etc. The data used are officially recorded data from 1965-2005, at the meteorological stations: Jurilovca, Corugea, Hârşova and Tulcea.

Based on the data recorded at the meteorological stations mentioned above, maps have been developed using the Geographic Information System (GIS) software and graphical representations to better analyze and compare the particularities and climatic risk phenomena specific to this area. Also, several specialized bibliographic sources have been consulted for the elaboration of this study.

3. RESULTS AND DISSCUSION

The Babadag Plateau falls within the category of areas with low hills topoclimate, due to its geographical position and altitudes. In this area, the following values and aspects are recorded: the annual average temperature is 10-11°C (Fig.2), the average temperature in January is 0°, the average temperature in July is ≥ 20°C, thermal amplitudes are moderate compared with those from other regions of the country, the frost phenomenon lasts for about 90-100 days, an average nebulosity of 5,1-5,4 tenths is translated by about 60- 65 unclouded days.

Regarding the pluviometric regime, the value of the annual average precipitations is about 350-450 mm, of which nearly half is recorded in the summer, in the form of downpours.(Fig.3) Regarding the snowfall, it can be mentioned that it occurs on average in 15 days of the year, and the snow layer with centimeter thickness is preserved about 20 days (Lungu M., 2010).

Fig. 2. Map of annual isotherms (^{0} C) in the Babadag Plateau (after Lungu M., 2010)

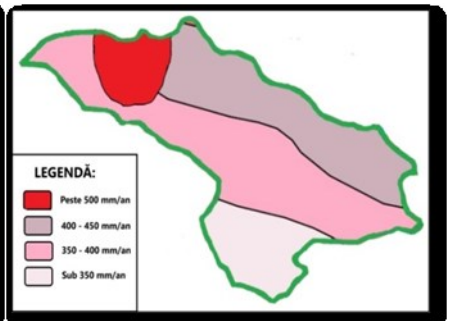

Fig. 3. Territorial distribution of annual average rainfall (mm/year) in the Babadag Plateau (1965-2005) (after Lungu M., 2010)

3.1. Climatic risk phenomena of the cold season of the year

(after Ciulache S., Ionac N., 1995).

The main characteristic of these phenomena is the decrease of the air and soil temperature, which leads to the occurrence of the frost phenomenon. The main climatic phenomena of the cold season of the year occurring within the Babadag Plateau are: the blizzard, the snow layer and the cold waves.

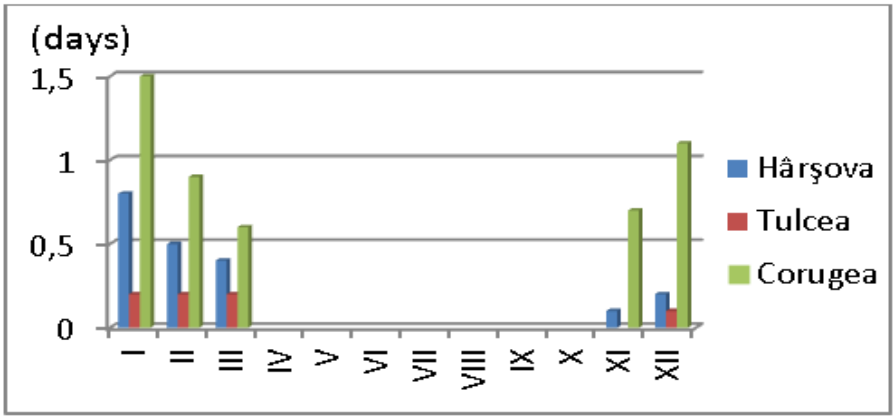

Fig. 4. The average monthly number of days
with blizzard in the Babadag Plateau (1965-2005) Source: ANM

a) Blizzard – The Babadag Plateau is part of the area with most days with blizzard per year, in the south and east of the country, with the highest average annual values between 5 and 7 days. The generation of blizzard can be observed both in the cold season of the year and in the off season. If it occurs out of the usual range, the blizzard becomes a climate risk through the consequences it exerts on the environment and society (Lungu M., 2009).

Regarding the extreme dates of the blizzard appearance in the Babadag Plateau, during the analyzed period, the earliest blizzard occurred in November (4.XI.1993, 20.XI.1995), and the latest in April (18. IV.1974), the latter being accompanied by massive snowfalls with a wind speed of 20 m/s (Lungu M., Panaitescu L., 2010).

The annual average number of blizzard days in the Babadag Plateau is low, although the duration of the propitious period for the blizzard is quite long, overlapping the cold season. (Fig. 4) The annual average number of days with blizzards within the Babadag Plateau was 0,7 days between 1965-2005.

During the blizzards produced in the Babadag Plateau, the wind direction is north and north-east and the average speed can reach 11-15 m/s or 6-10 m/s in the sheltered areas. The more the blizzard has a longer run time and the wind speed

remains above the average, the higher the climate risk. Such an example could be represented by the blizzard of 21-22.XII.1998, which lasted 48 hours in the Babadag Plateau, as well as the blizzard of 2-4.I.2008 which lasted 54 hours (Lungu M., 2009).

b) Snow layer - Snow layer is a phenomenon specific to the cold season of the year when soil and air temperatures record negative values for several consecutive days. Its formation is determined by the existence of negative air and soil temperatures, a sufficient quantity of snow fall and the existence of atmospheric calm.

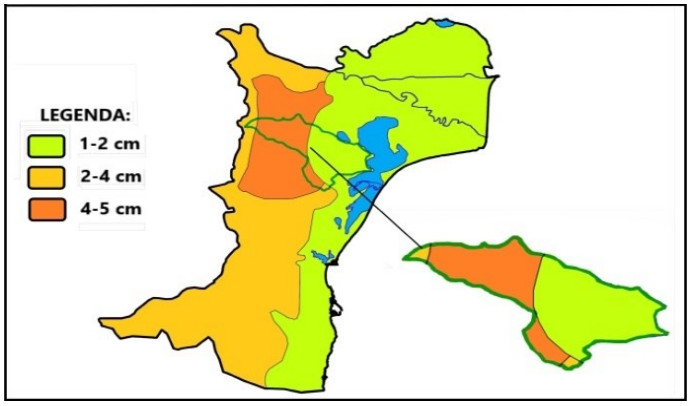

Fig. 5. The decadal average thickness of snow layer in Dobrogea and the Babadag Plateau (after Lungu M., 2010)

The average decadal thickness of the snow layer is much smaller than in the other regions of Romania, ranging between: 4-5 cm in the higher areas of the western Babadag Plateau and 1-2 cm in the lower areas in the eastern part, near the Complex Razim-Sinoe lagoon (Fig. 5).

Just like frost or hoar-frost, the snow layer may have certain critical intervals that can cause great damage, especially to agriculture. There are two such risk intervals, namely:

- The autumn risk interval, when the earliest snow can produce snow. It is associated with strong cooling and frost phenomena that can cause a lot of damage to agriculture;

- The spring risk interval. In this lapse, the risks are greater and come from the rapid melting of the snow layer of the last snowfall that occurs off-season, causing flooding, but also by freezing the crops at the beginning of the growing season (Lungu M., 2009).

For the Babadag Plateau area, the autumn risk lapse ranges between 20.XI. and 10.XII, and the spring risk interval between 15.III and 1.IV.

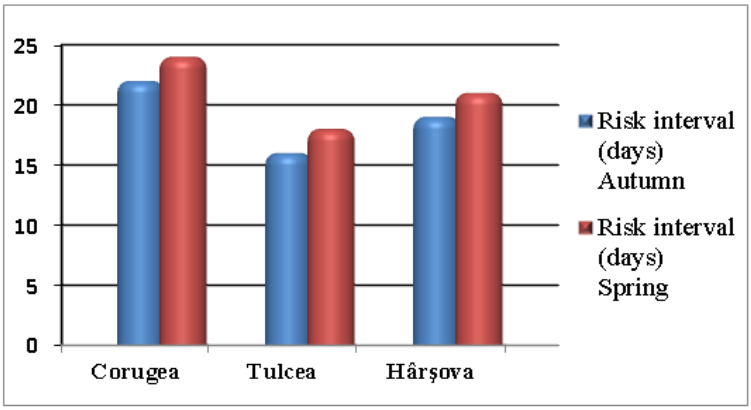

Fig. 6. The snowfall risk interval in the Babadag Plateau (1965-2005) Source: Lungu M., 2010

The snow layer represents a climatic risk phenomenon within the analyzed area, both through its presence and its absence. In the first case, it can become a climatic risk phenomenon if: it is the result of heavy snowfalls accompanied by blizzards that cause snowdrifts and snow covers, it forms in the offseason, deposits in thick layers on deforested slopes, can cause avalanches and if the melting of the snow layer is suddenly produced. Also, the lack of snow layer is an indirect risk, favouring the production of deep frosts and leaving the autumn crops fallowed (Văduva I., 2008).

c) Cold waves - The geographical positioning of the Babadag Plateau in a contact area of the main baric centers makes the temporal and spatial evolution of climatic phenomena appear to be significant deviations from the multiannual environments.

During 1965-2005, in the Babadag Plateau, there were numerous situations where temperatures below -15°C were recorded, but only those that were recorded as absolute minimum temperatures at stations over the whole period of observation were considered, for which they were called "massive cooling".

In the period under consideration, we found that in the Babadag Plateau, the annual average number of days with minimum temperatures ≤10ºC was 10 days in the western part, the area with the highest altitudes, between 4 and 10 days in the central part, and under 4 days at the eastern extremity of the plateau.

3.2. Climatic risk phenomena of the warm period

The summer thermic regime exerts a special influence on certain climatic phenomena that occur in the Babadag Plateau, such as hail, torrential precipitations and massive heating.

a) Hail - The average frequency of hail days depends on: the thermobaric contrast between the sea and the land, the instability of the air masses, the exposure to the sun's rays, and the advections of wet air, relief, altitude, etc. Thus, the hailing frequency increases as the degree of continentalism increases (Văduva I., 2008).

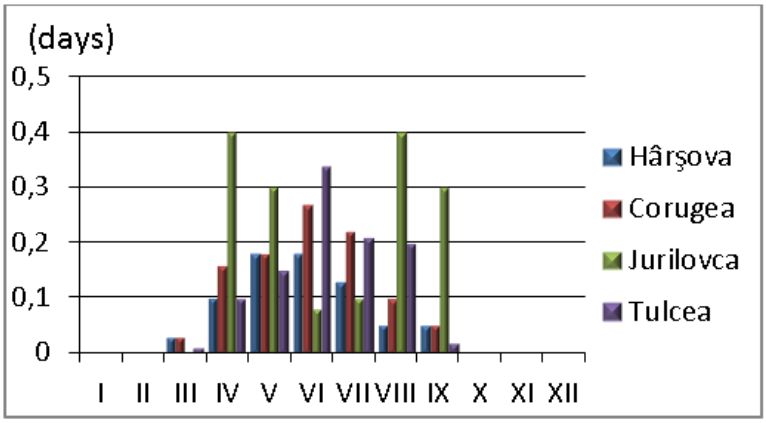

Fig. 7. The average number of hail days per month in the Babadag Plateau (1965-2005)
Source: ANM

In general, hail occurs during obstructions or torrential rains characterized by a short duration. Thus, the average duration of hailing on the Babadag Plateau ranges from a few minutes to 15 minutes (Lungu M., Panaitescu L. et al. 2013).

From the analysis of this phenomenon in the period 1965-2005, it is evident that in spring and autumn, in the Babadag Plateau, the hail diameter is smaller, less than 5 mm compared to the summer, when the diameter can even exceed 10 mm.

Of the more important cases, we can mention the one from 12.08.2004, which affected the county of Tulcea (852 ha), including the Babadag Plateau. In about 15 minutes (between 4:40 pm and 4:59 pm), the hail stones, which had an average diameter of 7 mm, destroyed the wheat and the colza crops, as well as the vine and fruit trees.

b) Heat waves - Massive heating is a phenomenon generated by the advections of tropical air. Due to the fact that the Babadag Plateau is situated in the temperate climate zone, in a continental area with many climatic influences, tropical heat waves float over the plateau, causing positive deviations from the normal air temperature, thus establishing some climatic records.

An analysis of the average temperatures in July and August shows that the most intense heating is ≥ 25°C, after the absolute maximums (monthly or annual)

are the temperatures that exceed 30°C (tropical days), and after the minimum nocturnal temperatures, the ones ≥ 20°C (tropical nights).

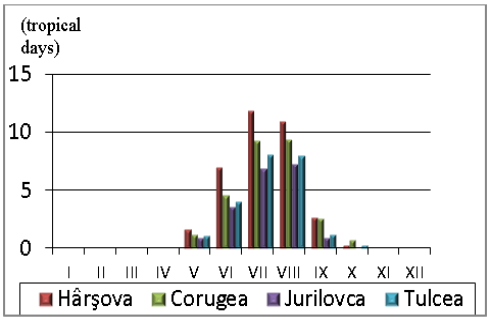

Fig. 8. The average number of tropical days (1965 – 2005) Source: ANM

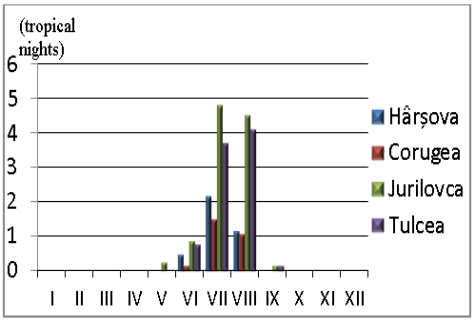

Fig. 9. The average number of t ropical nights (1965–2005) Source: ANM

Intense warming during the summer months can negatively affect the environment and people's activities, especially agriculture, causing plant wilting and even totally compromising crops. In this regard, the year 2000, when agricultural crops were affected by this phenomenon, can be mentioned (Lungu M., 2009).

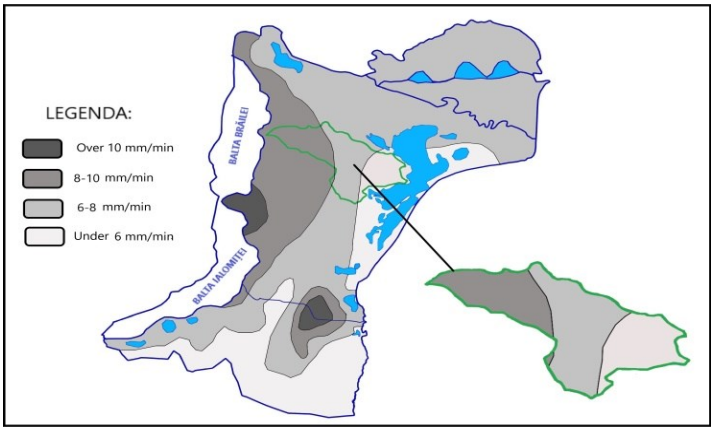

Fig. 10. The maximum rainfall intensity (mm/minute) in Dobrogea and the Babadag Plateau in 1965-2005 (after Lungu M., 2010)

c) Rainfalls - In the Babadag Plateau, the precipitations ins the summer season are of a frontal nature and occur mainly during the day, most of the time

being of the shower type, and they can be caused mainly by: the west and north-west circulation, activating and reactivating the country's polar front and the summer thermic convection (Lungu M., Panaitescu L., Niţă S., 2011).

Torrential rains are mainly characterized by their intensity. From the data processing recorded over a period of 40 years (1965-2005), it can be noticed that the torrential rains that occurred in the Babadag Plateau were characterized by intensities of 8-10 mm/minute in the western part, 6 -8 mm/minute in the center of the plateau and even below 6 mm/minute in the eastern extremity of the plateau (Fig. 10).

Torrential rain generates a quantity of water directly proportional to the duration and intensity of the rain, but also to its genetic conditions.

Between 1965-2005, the largest quantities of fallen water, over 100 mm, were recorded in the case of some 60 minute downfalls and fell across Dobrudja, including the Babadag Plateau.

Rainfalls can pose certain risk issues if they cause floods, certain accelerated erosion processes, etc. In addition to intensity and duration, the risk of torrential rain is also given by wind speed, slope size, degree of afforestation, timing, etc.

d) Tornadoes - Tornadoes are the most dangerous natural climatic phenomena, both because of the immense destruction they cause and because they appear almost without any warning, both during the days and nights.

In Dobrudja, including the Babadag Plateau and its proximity, tornadoes have occurred at different times in recent years and even before 1989, but were not brought to the attention of the public. Among the most recent tornadoes that have had a significant impact on the natural environment and the Dobrudjan economy are those of: August 12, 2002 in the central-western part of Dobrudja (also known as "the tornado in Făcăeni"); May 7, 2005, when no less than 9 tornadoes occurred in the area: Hârşova (Ciobanu village), Topolog, Olimp, Cernavoda; June 2, 2016, when the tornado had destructive effects in the vicinity of the Babadag Plateau, but also inside it, affecting numerous buildings within Babadag.

3.3. Climate risk phenomena possible the whole year (after Ciulache S., Ionac N., 1995).

Of the climatic risks encountered on the Babadag Plateau, the environment is affected in all seasons by: thunderstorms, fog, strong winds, drought and aridity.

a) Thunderstorms - In the Babadag Plateau, the haze phenomena are characterized by the variation of the occurance period in one year, but also by the variation in the number of days in which they occur.

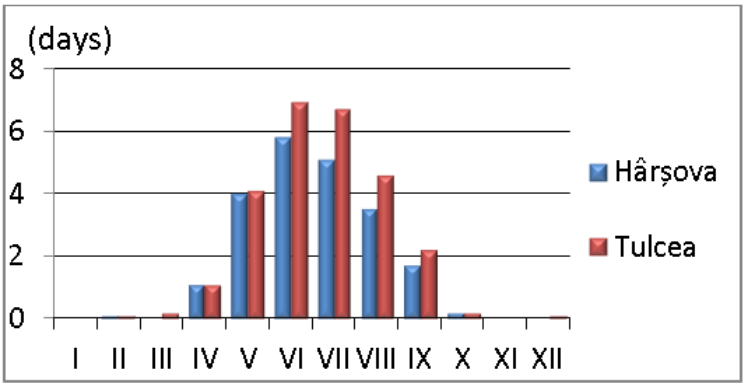

Fig. 11. The average monthly and annual number of days with thunderstorms (1965-2005) - Source: ANM

Analyzing the data from the meteorological stations on the Babadag Plateau, between 1965-2005, it was noticed that the average monthly number of days with thunderstorms is low during the winter months: December, January and February. It could also be noticed that most days with thunderstorms are in the summer months: June and July (Fig. 11).

Regarding the occurance of thunderstorms, it is observed that they have the highest frequency during the day, especially in the afternoon, between 14 and 17, due to the heating of the active surface. At the opposite end, the lowest frequency in the thunderstorms production is recorded during the night and over the early hours of the day (Lungu M., 2009).

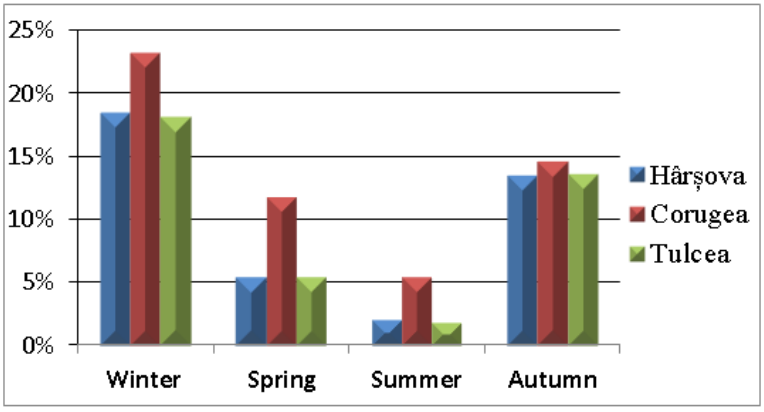

Fig. 12. The seasonal frequency of days with fog on the Babadag Plateau - Source: ANM

b) Fog - The maximum of days with fog in the Babadag Plateau is recorded in the winter and autumn seasons, the winter being between 21 and 16 days, and autumn between 5 and 11 days. At the opposite end there are summer and spring seasons, and in summer the lowest frequency of this phenomenon is recorded with values between 1-2 days and maximum 5 days at the Corugea station.

The highest values of the number of days with fog and its duration are recorded in the winter months, with an extension of 1-2 months in the autumn and spring seasons. This conclusion contradicts some beliefs that spring and autumn are the foggiest seasons.

c) Strong winds - In the daily generation of strong winds in the Babadag Plateau, a higher frequency is observed during the night and in the morning. There is also a higher frequency in winter (over 70%) and a lower frequency in the other seasons (less than 50%), of winds with an intensity greater than or equal to 15 m/s. In the summer season there is a decrease in the severity of the North and North-East winds.

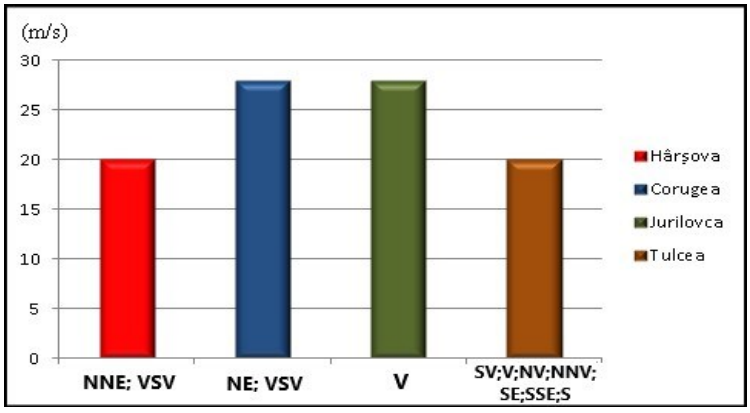

Fig. 13. The maximum wind speed in the warm semester and the corresponding directions (1965-2005) - Source: ANM

Winter is the season with the highest wind speed. In the Babadag Plateau area, the intensity of the winds ≥10 m/s is between 3-6% (3-6 days). In the case of strong winds ≥15 m/s, the frequency is 1-2%. In the spring, the frequency of the strong winds is attenuated, oscillating between 1-2%.

Summer is the season with the lowest frequency of winds ≥10 m/s, oscillating between 0.5-1.5%. In autumn, the frequency of these strong winds intensifies again. In the areas of orographic intensification of the air currents on the hillsides, the frequency of strong winds ≥15 m/s is close to the one recorded on the sea surface (over 3%).

d) Drought - From the analysis of the period between 1965-2005, within the Babadag Plateau, it can be noticed that the drought phenomenon affects, in particular, the warm period of the year, namely the interval April-October, when the average monthly temperature is above 11 ºC.

In the Babadag Plateau, the drought phenomenon shows a different intensity, with a gradual increase from 1-2 months/year in the western part to 3-3.5 months/year in the eastern extremity of the plateau. However, there is a great variability in the duration and intensity of drought and dryness phenomena from one year to another.

From the point of view of the frequency and intensity of the phenomenon of drought and dryness, Dobrudja, including the Babadag Plateau, is in the top in the country, which again highlights the climatic characteristics specific to this region (Lungu M., 2009).

e) Aridity - Aridity represents a major permanent climate risk for Dobrudja, including the Babadag Plateau. Aridity in this region is highlighted by the continued decresing of water resources and its quality, a phenomenon that is an important risk factor, considering the acceleration of the global warming process. The knowledge of this phenomenon is necessary to explain the characteristics of the geographical environment and the rational management of water reserves (Lungu M., 2009).

Although aridity is often confused with drought, there is a clear difference between these two phenomena. Aridity is a permanent feature of a region, determined mainly by low rainfall and high evapotranspiration, while drought is a temporary feature of a region.

Within the Babadag Plateau, due to the global warming, acceleration of aridity can be observed, a phenomenon that can lead even to the desertification of this region, as a result of the increase of the evapotranspiration and the decrease of precipitation value.

Regarding the preventing or mitigating the consequences of aridity, national and local authorities should implement certain strategies for the areas affected by this phenomenon. Some of these strategies could be to rehabilitate and build new irrigation systems, but also to use hybrids with high resistance to water stress.

4. CONCLUSIONS

This study presents the main features of the climatic risk phenomena in the Babadag Plateau as: intensity, frequency and duration. The Babadag Plateau is highlighted by specific weather conditions, determined by the physical and geographical characteristics of the territory.

As a result of the analysis of the data from the meteorological stations in this region, the Babadag Plateau may be exposed to climatic risks throughout the year.

Of all the climatic risk phenomena that occur in the Babadag Plateau, aridity and drought are the most complex and among the most representative phenomena for the analyzed area.

The high frequency of aridity and drought phenomena is mainly due to the air temperature and the atmospheric precipitations in this area. It is noteworthy that the eastern extremity of the Babadag Plateau is part of the area with the lowest amount of rainfall in the country. This is due to temperature inversions on the Black Sea surface, which are characterized by high stability, act as a orographic barrier that disperses muddy systems and, as a result, reduce the amount of atmospheric precipitation. Also, due to the influence of the water surface in the proximity of the Babadag Plateau, the annual average temperature increases from the west to the east, reaching up to 11°C (Bogdan O., 2005).

The need to know these less studied phenomena is imposed by the negative effects they have on the economy, society and agricultural activities carried out within this territory.

REFERENCES

1. Bogdan Octavia, (2005), *Riscuri climatice complexe în Rezervația Biosferei Delta Dunării. Fenomenele de uscăciune și de secetă.* Institutul de Geografie al Academiei Române, Bucureşti;
2. Ciulache S., Ionac Nicoleta, (1995). *Fenomene atmosferice de risc şi catastrofe climatice*. Editura Ştiinţifică, Bucureşti;
3. Lungu M., (2009), *Fenomene climatice de risc din Dobrogea*. Editura Universitară, București;
4. Lungu M., Liliana Panaitescu, (2010), *Blizzard – Venture hydrometeor in Dobrogea*. Present Environment and Sustainable Development, nr. 4;
5. Lungu M., Liliana Panaitescu, Simona Niță, (2011), *Torrential rainfall in Dobrudja*. Present Environment and Sustainable Development, Vol. 5;
6. Lungu M., Liliana Panaitescu, Dumitrela Lungu, Simona Niță, (2013), *Territorial distribution of hydrometeors risk in Dobrudja during the hot season*. Present Environment and Sustainable Development, Vol. 7;
7. Văduva Iulica, (2008), *Clima României*. Editura Fundației România de Mâine, București;
8. *** Administrația Națională de Meteorologie;
9. *** http://www.geo-spatial.org.