CONSIDERATIONS ON THE DROUGHT PHENOMENON IN CLUJ COUNTY

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ABSTRACT. - Considerations on the drought phenomenon in Cluj County. Cluj county area is 6674 km², and is located in the northwestern part of Romania. The climate is temperate continental with oceanic influences, relatively humid, but there are also periods of drought and even years with deficient rainfall, as there are periods of excess rainfall. Dryness and drought phenomena are caused by cosmic, climatic, hydrological (groundwater depth, the existence of surface water sources) factors, features of the underlying surface, vegetation coverage, soil texture and structure. The relief determines a climate elevation with differences in terms of precipitation and temperatures quantities. To calculate the dryness degree of the climate at weather stations in the Cluj county, the Emmanuel de Martonne aridity index was used. Drought do not induce into the substrate the geomorphologic processes per se, however, they pave the way for starting the deflation process, surface erosion and ravine, by reducing the cohesion between the particles and the formation of deep cracks in the soil and even rock. In these climatic conditions, droughts are less frequent in the county of Cluj, in relation to the extra-Carpathian regions and are distributed unevenly across the county. The number of periods of drought decreases with the increase of the altitude, from an average of 2.6 drought periods a year at Dej (altitude of 232 m) to an annual average of 0.3 draught periods at Vlădeasa Peak (altitude of 1836 m).

Keywords: drought, dryness, moist.

1. INTRODUCTION

Cluj County has a surface of 6674 km² and is located in the northwestern part of Romania, being crossed almost in the middle by the parallel of 46˚50' northern latitude and meridian of 23˚30' east longitude. To the north it shares a border with the counties of Salaj and Maramures, with Bistrita-Nasaud to the east, to the south-east with Mures, with Alba to the south and to the west with Bihor.

Relief: The western part of the county is occupied by the Vlădeasa, Gilău and Muntele Mare Mountains and the north-east part of the Trascău Mountains, the northern district overlaps the Someş Plateau and the south-east overlaps the Transylvania Plain (Someş Plain and the north-west part of the Mureş Plain).

Climate: temperate continental with oceanic influences.

The Cluj county is situated in a relatively humid climate compared to the counties in the eastern and south-eastern parts of Romania. Nevertheless, even here exist years with drought periods and even years with scarce rainfall, as there are periods of excess rainfall.

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Fig.1. ***Physical map of the Cluj county***

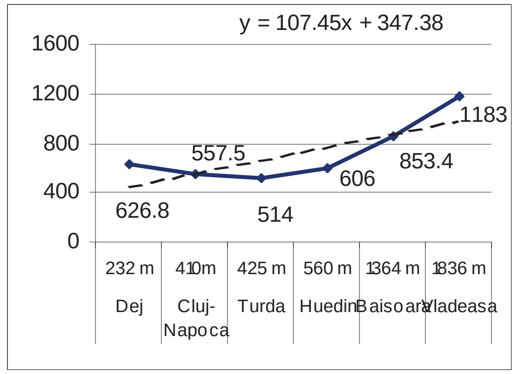

Fig. 2. ***The annual average precipitation at the meteorological stations in the Cluj County, in the period 1961-1990 (in mm).***

Average annual rainfall, calculated according to the average for the period 1961-1990, for the meteorological stations in Cluj County, is between: 514 mm at Turda and 1183.8 mm at Vlădeasa Peak, with differences according to the altitude and exposure to the dominant movement of the air masses (Figure 2).

2. DEFINITION AND CLASIFICATION OF DROUGHTS

The term drought signifies a complex of climatic and hydrological factors that reduce, in a certain region, the intensity of the water cycle during a longer or shorter period of time and whose first result is the stagnation in growth or the drying of the plants (N. Topor, 1964).

A period of drought is always preceded by a period of dryness. C. Donciu, in 1962, using the Hellman criterion of pluviometric characterization of a period, defines the dry period as being the absence of rainfall in 5 consecutive days, during which time it did not rain at all, or if it did rain, the precipitation that day did not exceeded the daily average. A drought period is characterized by the absence of rainfall for least 14 consecutive days during the cold season (October to March) and for least 10 consecutive days during the warm season of the year (April to September), and if precipitation occurred, they did not total an amount greater than 0.1 mm. Both phenomena (dryness and drought) occur firstly in the air (atmospheric drought) and if it persists for a long period of time, and the temperature and wind intensify the evapotranspiration processes, reducing the water reserve in the soil, then the dryness and drought phenomena descends from the air towards the soil (pedological drought). The merging of the two is called mixed drought (Octavia Bogdan, 1999). Hydrological drought occurs in certain conditions, associated to the lack of precipitation or if rainfall level are too low to help fuel the hydrographic system (I. Minea, CI Left, 2004).

3. DROUGHT TRIGGERS

The dryness and drought phenomena are caused by cosmic, climatic, hydrological (groundwater depth, the existence of surface water sources) factors, features of the underlying surface, vegetation coverage, soil texture and structure.

3.1. Cosmic factors

From the statistical research methods to substantiate the long-term forecasting, considering the helio-geophysical factors, conclusions regarding the correlation between the sign of the interplanetary magnetic field anomalies (Kp) and the production of droughts in the country were drawn. According to research, the maximum repeatability in our country's drought is expected to occur before a maximum of Kp values, remaining relatively high during maximum Kp years, according to the Kp peak the probability of droughts decreases a lot. The deviation from annual average of the meridian circulation indices (which favors the formation droughts phenomenon) for the atlanto-European area is influenced by the production of extremes solar activity (Răhău L. 1978).

3.2. Climatic factors

Dry periods are mostly determined by high pressure-anticyclonic formations, and in some cases and by the cyclone formations composed of masses of dry air or of a uniform pressure field, with a value close to the normal value (1013 hPa) and without showing cyclonic or anticyclonic circulation at the ground level. The sustainability of the drought regimes is proportional to the intensity of the anticyclone, its height, the volume of hot air in the column above the central part and the origin of the hot air supply in the upper parts.

3.3. Case Study: 24^{th} of September – 26^{th} of October 2000 time interval. Synoptic situation

For the synoptic analysis maps of altitude, geopotential field and temperature from 850 to 500 hPa and soil maps from wetterzentrale.de and NCEP-NCAR reanalysis maps were used. In the 24^{th} of September to the 26^{th} of October 2000 time interval our country was under the influence of a high pressure field, caused by the expansion to the south, south-east of the ridges of the Scandinavian Anticyclone and to the south-west of the ridges of the Eastern European Anticyclone. During this period of time, at the meteorological stations at Turda and Dej no precipitation occurred at all, this being the longest period without rainfall recorded in the county of Cluj. At other stations in the county, the rainfall during this period was very low, ranging between 0.4 l/m^2 at Cluj-Napoca, 0.6 l/m^2 at Băişoara, 2.0 l/m^2 at Huedin and 2.1 l/m^2 at Vlădeasa.

At ground level, on the 24^{th} of September 2000, the northern part of the European continent was under the influence of the Scandinavian Anticyclone. Its core is centered over the North-Eastern part of the Baltic Sea has a value in the center of 1035 hPa. In Romania, the pressure at ground level is high, of 1025 hPa.

Beginning with the 26th of September its core this gradually weakens reaching a value of 1025 hPa, and lengthens in form of a belt from Finland to Bulgaria, stopping the advance of Iceland Low from the Atlantic Ocean on continent. From the 29th of September, the extended ridge of the Scandinavian Anticyclone, merges with the ridge of the East - European Anticyclone formed above the Central Russian Plain, covering the northern parts of Europe, between the Scandinavian Peninsula in the west and the Ural Mountains in the east, and it extends towards the south to the Mediterranean Sea. In Romania, the pressure at ground level, though slightly declining, remains at high levels of 1020 hPa. On the 1st of October, the pressure at the center of the Eastern European Anticyclone reaches 1030 hPa, and in Romania the pressure increases up to 1025 hPa. Until the 5th of October the pressure remains high in the eastern part of the European continent, the Eastern European Anticyclone is active, while the Scandinavian Anticyclone is slightly weakened, allowing the movement of the Iceland Low trough towards the Scandinavian Peninsula. In the following days ground level pressure remains almost unchanged, after which in the time interval between the 8th of October un the 13th, the high pressure field in the eastern part of the continent strengthens, and also to withdraws towards the east, the pressure in the northeastern Russian Plain reaching 1040 hPa. The anticyclone ridge that acts over Romania maintains a high pressure of 1020 hPa at ground level. Because of the withdrawal eastward of the East European Anticyclone, the Iceland Low trough, which is at first placed above the west of Great Britain, moves forward towards the west and north-west parts of the continent. In the 13th of October the high pressure field occupies the whole part northern Europe, the Iceland Low trough retreating from the west of the continent towards the middle of the Atlantic Ocean. In Romania, the pressure remains high, with values of 1025 hPa. In the 17th of October the high - pressure field in the northern part of the continent moves from the Scandinavian Peninsula towards the western parts of the Russian Plain, its ridges creating a belt of high pressure from Finland to the Mediterranean. In Romania, the pressure at ground level remains high, with values of 1025 hPa. The Iceland Low remains active in west of the continent and the trough connected with it dominates the coasts of Great Britain. In the following days no significant changes in the weather are observed. On the 20th of October the high pressure field that dominates the northern part of Europe, sends ridges from Finland to Greece, increasing the pressure at ground level in our country to levels of 1030 hPa. The Atlantic Cyclon deepens, the pressure at its center reaching values of up to 995 hPa.

In the 23rd of October the ridges of the anticyclone in north-east part of Europe merge over Romania with the ridges of the Azores High, which is expanding. The Iceland Low is positioned in the north-west part of the continent, approaches the continent with a eastward movement of its trough. Two low pressure centers with values of 995 hPa are developed, one in the northern part of Scandinavian Peninsula and the other one above Northern Ireland. The weather in our country remain unchanged until the 26th of October, when the Azores High ridge withdraws to the south-west of the continent, and Eastern European

Anticyclone ridge withdraws to the north-east, while Iceland Low trough in the north-west of the continent is moving towards the south-east, determining small amounts of rainfall in the region of our country, on the 27th of October. From the 29th of October the high pressure field over our country is reorganized and rainfall stops again. In the NCEP-NCAR reanalysis map in Figure 3, it is shown that the average values of the pressure in our country were between 1018-1022 hPa.

At the 500 hPa isobaric level, at the beginning of the time interval, on the 24th of September it can be observed that the 500 hPa area is located at the 584-588 dmgp level. The extension of a ridge to Italy and Greece makes the whole continent to be in an area of high geopotential. Above Romania is 576 dmgp isopleth. Beginig with the 29th of September, above Romania is the 568 dmgp isopleth. On the 1st of October at the 500 hPa level, the ridge of the Eastern European Anticyclone remains active and moves to the west and south-west of the continent, reaching Germany. Between the 8th and the 13th of October in the anticyclone core, values of the height of the surface of 572 gpdm are recorded, and the 13th of October these values are rising, reaching 580 dmgp. Above Romania the 568 dmgp isopleth maintains its position. From the 17th of October until the 16th of October the geopotential values remain high, decreasing from the 26th of October reaching a value of 564 dmgp. On the 24th of September 2000 the temperature at 850 hPa isobaric level, above Romania was of 5°C, compared to the climatic normal for this period (9°C). Beginning in the 29th of September it increases slightly to values of up to 6-8ºC. This temperature value is maintained until the 5th of October when starts growing, reaching 10ºC. In the 17th of October, the temperature at the 850 hPa level increases up to 12ºC, then on the 20th of October it drops to 6°C, close to the climatic normal of 4°C.

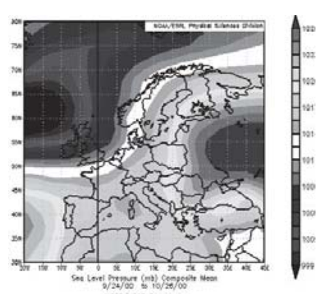

Figure no. 3. ***Average distribution of isopleths at ground level, period 09.24.2000-23.10.2000***

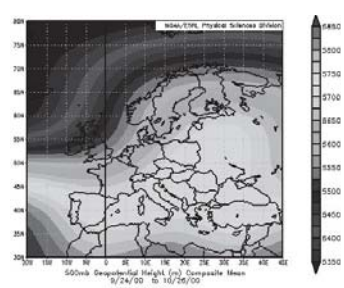

Figure no. 4. ***Average distribution of isopleths at 500 hPa, period 09.24.2000-23.10.2000***

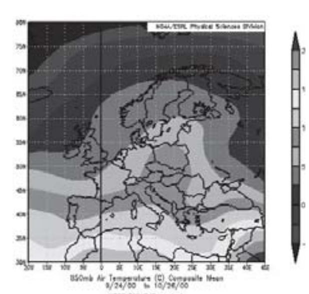

Figure no. 5. ***Average distribution of isotherms at 850hPa level, period 24.09.2000 to 23.10.2000***

Mean values of meteorological elements in the middle troposphere, in the time interval between the 24th of 2000 and the 25th of October 2000, can be seen on the NCEP-NCAR reanalysis maps (Figure 4 and 5).

3.4. Topography and vegetation

Relief determines a natural setting of the climates with differences in terms of precipitation, temperatures and other elements. The amount of precipitation increases with altitude, with a precipitation average gradient of 100 l/100 m (in our area), until it reaches the optimum level of precipitation, at about 1600-1800 m and then it begins to decline. The average annual number of periods of drought decreases with the increasing of altitude. Figure 6 shows a decrease in average annual periods of drought with the increase of altitude. Thus in Dej, located at an altitude of 232 m, the average drought periods per year is 2.6, and at Vlădeasa at an altitude of 1836 m the average annual number of cases is reduced to 0.3. The presence of vegetation, especially the forest, favors air humidity growth in the evapotranspiration process and hence the falling of the convective type of precipitation.

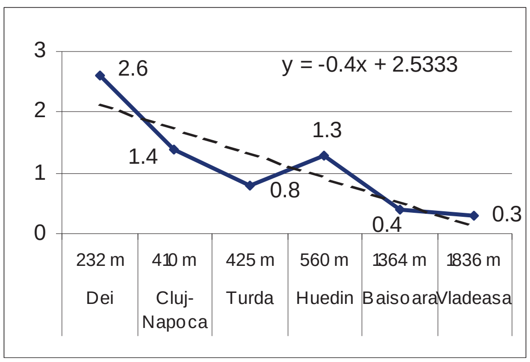

Figure no. 6. ***Average annual number of periods of drought, period 1991-2000.***

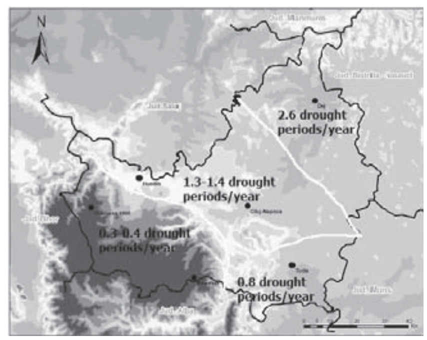

Figure no. 7. ***Map of the distribution of drought periods***

In our country's temperate continental climate, differences are observed according to the altitude. A classification of climates based on elevation includes the following types of climates: lowland climate (in our county is not met); hilly and plateau climate; mountain climate and climate of depression regions.

4. CLUJ COUNTY REGIONALISATION ACORDING TO THE DEGREEE OF DRYNESS OF THE CLIMAT

To calculate the degree of dryness of the climate at the weather stations in the county of Cluj, the aridity index of Emmanuel de Martonne was used, which is calculated by dividing the annual average amount of precipitation to annual average temperature and adding 10; $A = P/T + 10$. According to the results of these computations (Figure No. 8) the Cluj county is situated in a semi-humid climate (lower basin of the Aries), perhumid climate in the mountainous region and humid climate in the rest of the county (Figure No. 8).

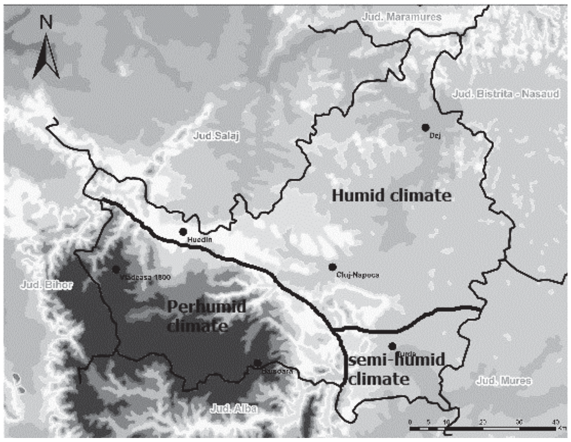

Fig. 8. ***Map of the regionalization of climates in Cluj county according to the Emmanuel de Martonne aridity index***

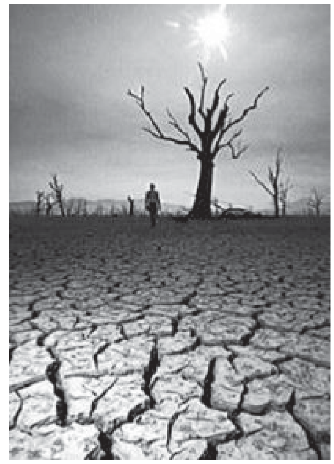

Fig. 9. ***Production of cracks and soil salinization under the influence of drought (Google images)***

5. GEOMORPHOLOGICAL PROCESSES INDUCED BY DROUGHT

Drought do not induce into the substrate the geomorphologic processes per se, however, they pave the way for starting the deflation process, surface erosion and ravine, by reducing the cohesion between the particles and the formation of deep cracks in the soil and even rock. By strong evaporation, the salts from depth are involved in a movement of ascendance, with water, towards the surface layers, thus causing soil salinisation. On slopes where deep cracks were formed due to drought, if torrential rain fall, the ravenatie processes will occur easily.

Weakly cohesive soils decay easily, after droughts, transforming into fine particles and dust, which are mobilized by the wind (the deflation phenomenon) (Figure 9).

6. CONCLUSIONS

Cluj county is situated in a temperate continental climate with oceanic influences ranging from 1183.8 mm rainfall/year at Vlădeasa, at an altitude close to the optimum rainfall (1836 m), and 514.1 mm/year at Turda, located in a region with foehn influences.

In the Cluj County, according to the “de Martonne” aridity index, three types of climates are found:

- semi-humid climate in the lower basin of Aries, because of the foehn influences.
- humid climate in the rest of the hill and plateau region with slight foehn influences and lower precipitation in the upper Somesul Mic Corridor.
- perhumid climate in the mountain region.

Under these weather conditions, droughts are less frequent compared with the extra-Carpathian regions and are distributed unevenly across the county.

The number of periods of drought decreases with the increase in altitude, from an average of 2.6 annual periods of drought at Dej (altitude 232 m) to an average of 0.3 annual periods at the peak Vlădeasa (altitude 1836).

An exception is Turda, which even though is located in a region with foehn influences and lower amounts of precipitation, has a averaged of only 0.8 annual drought periods compared to Huedin, which has an average of 1.3 annual drought period.

At the Dej meteorological station are recorded both the average of the longest period of drought and the dry period with the longest time span in the county (along with Turda), which lasted from the 24th of September to the 26th of October 2000.

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