PRESENT ENVIRONMENT AND SUSTAINABLE DEVELOPMENT, VOL. 5, no. 1, 2011

ANNUAL VARIATION OF AVERAGE MONTHLY PRECIPITATION AMOUNTS AT THE BOTOŞANI METEOROLOGICAL STATION

Liviu Apostol[1], Delia-Nicoleta Vieru[2]

Key-words: precipitations, Angot ratio, variation.

Abstract. The atmospheric precipitations present a great variability and discontinuity in space and time, their distribution and regimen depending, equally, on the dynamic, physical-geographical and radiative factors. In Romania, precipitations generally have a continental character, with a maximum in June and minimum in January – February. However, from the analysis of monthly multi-annual values of the precipitations quantities registered in the period 1962-2009 at the Botosani station, as a consequence of the intensification of the cyclonic activities in the months of July of the last 12 years, but also of the intensification of the thermal convection in this month, results that the highest value is registered in July (94,2 mm). The quantitative difference between this month and June is notable (9,8 mm). On the other hand, the urbanization processes and human activities determined, in the last years, an increase of the number of condensation nuclei and an increase of precipitations frequency.

Botosani municipality is located in the contact area between two great relief units, Campia Moldovei (Moldavia Plain) and Podisul Sucevei (Suceava Plateau) (sector Seii Bucecea-Vorona), in the depression chute evidenced by the high relief, with coastal character, in the West and the hilly plain, higher, in the East. It is characterized by the low hills relief or the rolling plains, developed on monoclinic deposits (gently sloping toward the south-east), with low slopes, with very wide valleys, with inter-rivers like plateaus and with reduced relief energy (30-40 meters on average). Botosani weather station is situated in the north-west part of the town, at the altitude of 161 m.

The climate of this region fits into the transition temperate type, the sub-sector outside the Carpathian arch (Ciulache, 1998, 2002; Apostol, 2000, 2004), this character being firstly due to the predominantly Western circulation influence, both

[1] Prof. PhD., Alexandru Ioan Cuza University, Iaşi, apostolliv@yahoo.com
[2] PhD. Stud., Alexandru Ioan Cuza University, Iaşi, deliavieru77@yahoo.com

over the Carpathian, and for this area, also in the northern part, to the relative domination of the old maritime polar air, to the annual moderate quantity of precipitations (569,6 mm) and to the ratio of precipitation to temperature, both annual and monthly (the "de Martonne" aridity index). The geographic location of this urban center contributes more to the appearance of large temperature differences between summer and winter, Botosani being situated at the contact between Podisul Sucevei (Suceava Plateau) and Campia Moldovei (Moldavia Plain), widely open to the north, north-east and east, the influence of continental air currents increasing the positive or negative thermal values in this area.

The main humidity sources for Romania's territory are Atlantic and Mediterranean, which together ensure 80% (Ujvári, 1972). The change in the last period of the monthly precipitations maximum in July is bound to the raising of the retrograde cyclones balance formed above the Black Sea (most times by regeneration of some Mediterranean cyclones arrived in this area), or of the cyclones generated in Ponto-Caspian steppes (Strutu et al, 1972), and the main contribution at the medium multi-annual volume represents precipitations in liquid form in the warm period of the year determined by the advection of moist and unstable air masses that come from the Atlantic Ocean and by the frontal activity or the thermo-convective processes which lead to rain production. The lack of precipitations or their little amounts are due to the installation of anticyclone weather type and to the dry continental air advections in the east and north-east of Europe.

Tab. 1 - Monthly and annual medium precipitations amounts in Botosani (mm) in the period 1962-2009

Period	I	F	M	A	M	I	I	A	S	O	N	D	Year
'62-97	23.6	21.6	28.8	47.7	69.3	90.5	82.4	59.4	42.9	31.2	31.0	27.3	555.7
'98-09	20.9	25.4	30.0	58.1	51.3	66.3	129.8	72.9	53.5	51.9	29.7	21.7	611.5
1962-2009	22.9	22.5	29.1	50.3	64.8	84.4	94.2	62.7	45.5	36.3	30.6	25.9	569.6

Because the precipitations amounts present a great variability in time, we analyzed for the annual variation of medium monthly precipitations amounts, the interval 1962 – 2009. From the processing and analysis of the pluviometric data registered in Botosani results a multiannual medium of the atmospheric precipitations of 569,6 mm and an annual course of medium monthly amounts characterized by a single maximum and a single minimum (tab. 1). Calculated only for the period 1962-1997, this average is much lower in relation to that of the next period, 1998-2009, which can indicate a tendency of increase of the atmospheric precipitation amounts in the last decade.

The evolution of precipitations is directly related to the evolution of the great baric centers which require atmospheric circulation, direct air masses and atmospheric front. Precipitations increase gradually from February until July, when the annual pluviometric maximum is produced, and they diminish gradually from August until February, when the annual pluviometric minimum is produced.

Based on the comparative analysis and on the calculations made for the two above mentioned intervals, we can highlight the characteristics of the annual regimen of atmospheric precipitations (fig. 1). The lowest amount of precipitations is registered in the period from January to March because of the anticyclone regime predomination, which prevents the development of thermal convection. The driest month in a year is February, with 22,5 mm.

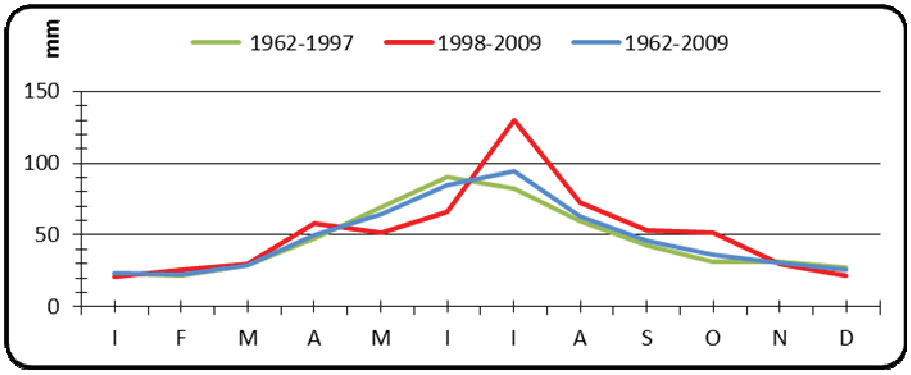

Fig. 1-Annual variation of monthly medium precipitations amount in Botoşani (1962-2009)

As a result of the cyclonic activity intensification, but also of the thermal convection extremely active in the warm period of the year (especially inside unstable air masses), for the interval April – July, the monthly medium amounts rise progressively. The highest value is registered in July, 94,2 mm. This is 13,1 mm higher than the normal of the month, considered 81,1 mm, and the quantitative difference between this month and June and August is 9,8 mm and 31,5 mm respectively. The high amount of precipitations is determined by the frequency of oceanic cyclones which bring cold and humid air masses, favourable to the formation of precipitations and convective processes which destabilize the air and drive to the production of heavy rains and great water amounts. The urbanization processes and human activities determined, too, in the last years, an increase of the number of condensation nuclei and an increase of precipitations frequency. For this

month, in the last 35 years, we can observe in Figure 2 a slight increasing tendency of medium precipitations amounts.

In the August – September interval, the monthly medium values begin to decline, because, although the convective processes are still active, the humidity sources for evaporation and evapo-perspiration diminish its reserves.

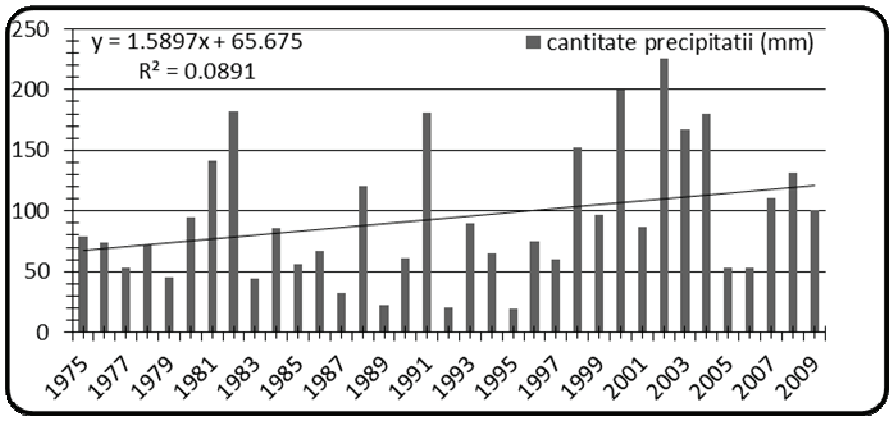

Fig. 2 - Annual value of precipitations amount in July, in Botosani (1975-2009)

Tab. 2 - Values of the Angot ratio and the precipitations regime

Values of Angot ratio	*Precipitations regime*
	Continental
	Transitional
	Oceanic
	Mediterranean

In the cold period of the year, as a result of the intensification of the anticyclonic activity, the convective processes decrease and the monthly precipitations amounts diminish. The medium multiannual amount in January for the analyzed interval was 6,4 mm less than the amount considered normal for this month (29,3 mm).

The *Angot Ratio* is an indicator for the continental degree of precipitations, allowing highlighting the role of thermal convection and the interaction between the atmospheric circulation processes with the relief and with the other physical geographical factors. It is the ratio between the multiannual medium amount of precipitations in the warm semester and the amount in the cold semester. In our

country, this ratio was analyzed for the Bucegi Mountains by Stoenescu St., in 1951, and the correspondence between the values of the ratio and the precipitations regime is reproduced in Table 2.

In Romanian climatological literature, the warm semester is considered April – September, and the cold one, October – March. The most important argument for that purpose is the solar radiation criterion. For three quarters of the country area, October is warmer than April (Apostol, 1987). Not only for this reason, but also in order to maintain the ratio as it was defined by Angot, we consider during the study, the warm semester, the interval May – October, and the cold semester, the interval November – April. From the ratio of the interval May – October amounts, and November – April interval, it results that for the Botosani station, the value of Angot ratio is 2,1. This means a *continental ratio* of precipitations attributed to the distance from the Black Sea basin and from the Mediterranean influences, also to the shelter offered by the Eastern Carpathians against western circulation. For the annual variation of monthly medium amounts of precipitations, we also calculated the values of the *Angot pluviometric index,* in order to remove inaccuracies derived from the unequal length in days of the months, with the formula:

$K = q \times 365 / Q \times n$, where:
q – monthly medium amount of precipitations;
Q – annual medium amount of precipitations;
n – number of days in the respective month;
365 – number of days in one year.

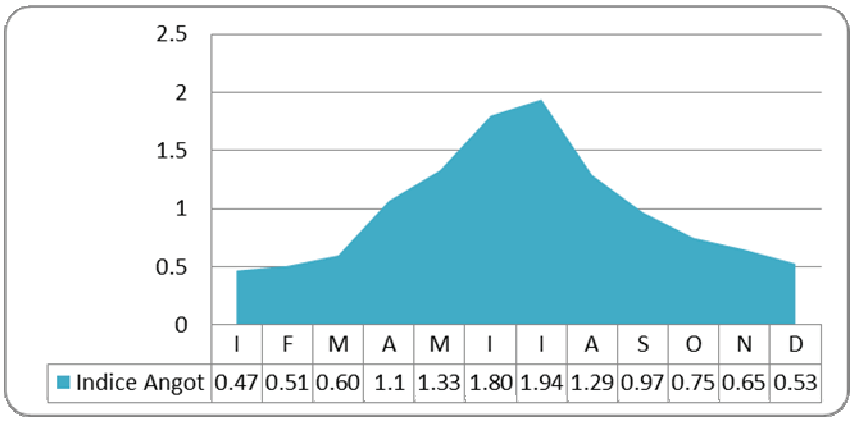

Fig. 3 - Variation of Angot monthly pluviometric index, in Botosani

The Angot index shows the climate shade of every month of a year, meaning that the subunit values reproduce the dry months, and the overunits values – the rainy months. According to the calculation of this index, we can notice in Figure 3 that the annual minimum belongs to *January* (with a value close enough to that of February), and the annual maximum, to *July* (1,94), as it resulted also from the previous calculations.

Subunit values are registered in: January, February, March, September, October, November, December – months we will consider *dry* for the Botosani weather station, and the value of overunit pluviometric index is registered in April, May, June, July, August – months we will catalogue as *rainy*.

In conclusion, we can say that the annual variation of precipitations amount in Botosani municipality presents a great variability and a rhythmic character, specific for the eastern part of the country, and the monthly evolution of Angot pluviometric index values strengthens the continental character of the precipitations regime.

References:

Apostol, L. (1987), *Consideraţii asupra raportului dintre cantităţile semestriale de precipitaţii în România,* Lucrările Seminarului Geografic „Dimitrie Cantemir", nr.7/1986, Iaşi, pg. 53-64.

Apostol, L. (2000), *Precipitaţile atmosferice în Subcarpaţii Moldovei,* Editura Universităţii, Suceava.

Apostol, L. (2000), *Clima Subcarpaţilor Moldovei,* Editura Universităţii, Suceava.

Băcăuanu, V. şi colab. **(1980)**, *Podişul Moldovei - natură, om, economie*, Editura Ştiinţifică şi Enciclopedică, Bucureşti.

Ciulache, S. (1988), *Die Klimatische Einteilung Rumäniens,* Analele Universităţii Bucureşti, ser. Geogr., an XXXVII, Bucureşti, pg. 55-63.

Ciulache, S. (2002), *Meteorologie şi climatologie,* Editura Universitară, Bucureşti.

Erhan, Elena, Precupanu-Larion, Daniela (1995), *The annual regime of the atmospherical precipitations in the Moldavian Plaine*, Analele Ştiinţifice ale Universităţii „Al. I.Cuza", Seria IIC-Geografie, Tom. XL-XLI, Iaşi, pg 89-98.

Gaceu O.*(2002), Elemente de climatologie practică,* Editura Univesităţii Oradea.

Mihăilă, D. (2006), *Câmpia Moldovei. Studiu climatic*, Editura Universităţii Suceava.

Niculescu, Elena (1997), *Extreme pluviometrice pe teritoriul României în ultimul secol,* SC Geogr., seria XLIV, Bucureşti.

Struţu, Margareta, Militaru, Florica, Stoica, C. (1972), *Les Carpates Orientales comme élément modificateur de l'évolution des cyclones au déplacement rétrograde,* Lucrările celei de a V-a Conferinţe de Meteorologie a Carpaţilor, 1971, I. M. H., Bucureşti.

Ujvári, I. (1972), *Geografia apelor României,* Editura Ştiinţifică, Bucureşti.

*** Anuarele meteorologice pentru perioada 1961-1972.

*** Tabelele meteorologice lunare TM - 1 pentru perioada 1971-2009