THE VARIATION OF ANNUAL RAINFALL IN THE SUCEAVA PLATEAU

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Abstract
Although the Suceava Plateau covers a not very high area, the corresponding annual precipitations have great spatial and temporal variability. To highlight this phenomenon in the Suceava Plateau area, annual precipitation amounts were used from 5 meteorological stations for a common period of 50 years, and for two of them (Suceava and Roman), for a longer period, of 88 years. The analysis, consisting in the processing of graphs and statistics, resulted in positive or negative variations, different from the average yearly rainfall at all weather stations analyzed, between 56% and 180% for the last half century, or even higher percentages, 183% for the period 1922-2010.

Key words: rainfall variation, frequency, tendency, climatic hazards.

INTRODUCTION

The Plateau of Suceava is positioned in the central and Northern part of Moldova, between Eastern Carpathians and Moldova's Plain, being the highest part of The Moldova's Plateau and partially overlapping historical Bucovina.

The dynamic factors of the climate are the ones which record substantial changes from year to year, contributing the most in the non-periodical variation of rainfall. The various aspects of weather, continuously changing, are determined by the position of the baric centers in relation to the studied habitat (the existing dorsal of the two anticyclones, Azoric and Euroasian, cause in the North of our country the change in cold air in North and North-East). The mountainous chain of Eastern Carpathians is a real obstacle against the movement of air masses to Suceava's Plateau but also against the Eastern and North-Eastern ones, increasing their existence above this habitat.

The plateau is characterized by relatively abundant precipitations (between 500mm and 700mm) and relatively moderated temperatures (between 7.5°C and 9.5°C).

The most frequent pluviometrical or baric climatic hazards, of termic nature, are: early frosts in autumn or late frosts in spring (harmful to agricultural crop and plants), blizzards (from 9 to 14 days each year), white frost (from 10 to 12 days a year), glazed frost (9 to 12 days a year) and fog (30-50 days annually), each representing a specific phenomenon for the cold seasons of the year. During the warm season, there are storms and showers,

sometimes rich in precipitations, other times accompanied by hail (once or twice a year).

The extraordinary variability of this climatic aspect from the habitat of Suceava's Plateau points out remarkable pluviometrical differences during different temporal entities (annually, biannually, monthly and daily speaking), strongly related with the general or local circulation of the atmosphere (the physical, geographical factors, regional and local factors) and of the solar radiation.

MATERIALS AND METHODS

The database used in this material looks into the annual sums of precipitation from 1992-2010 (Suceava and Roman) and 1961-2010 (Rădăuți, Fălticeni and Cotnari). Meaningful reasoning was based on documentation of specialty (see bibliography) and the main used processes were observation, statistical and mathematical analysis, comparison and also several graphical methods.

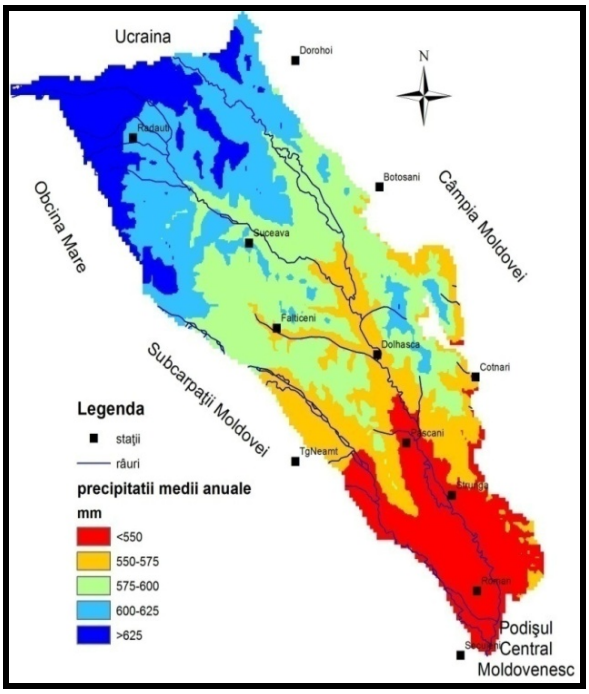

Fig. 1. The territorial repartition of the annual quantities of precipitations in Suceava's Plateau.

RESULTS AND DISCUSSION

The annual average sum of atmospheric precipitations from Suceava's Plateau is approximately 580 mm (the average of annual sums from 1961 to 2009, information provided by the 5 main weather centers).

As we analyze the rainfall repartition from the area we are studying (figure 1), we can observe meaningful differences, of over 100mm between the Southern habitat and the Northern one; in Roman it is registered an annual average quantity of 523.9mm while in Radauti 634.8mm (figure 2a). Taking into account the pluviometrical stations, these differences increase even more, from 500mm in South (498.6 mm in Upper Muncel) to over 700mm in the North-Western part (737.5mm in Solca).

The atmospheric precipitations gradually decrease from North-West to South–East once the relief looses altitude (figure 2b) and once the masses

of humid air, of oceanic and Atlantic origin, are less frequent (including a slight appearance of the foehn phenomenon).

Also, the relief is largely open to East which facilitates the entrance of continental drier and warmer masses of air (of lower humidity).

Besides pluviometrical differences, there is also an alternation of humid sectors which are positioned over the higher areas of the relief with drier sectors, sequence well distinguished on the direction North-West – South-East. Meanwhile, the slopes experiencing the change in masses of air from West and North-West, being more humid, perceive bigger quantities of precipitations while the Southern ones are drier, this also because of the phenomenon of foehn.

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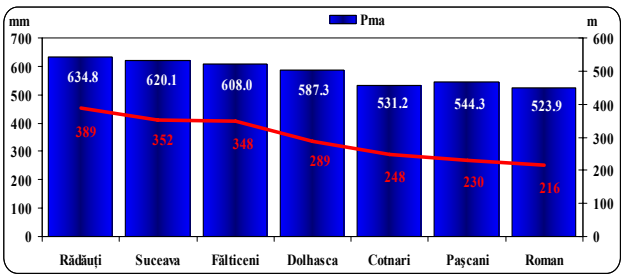

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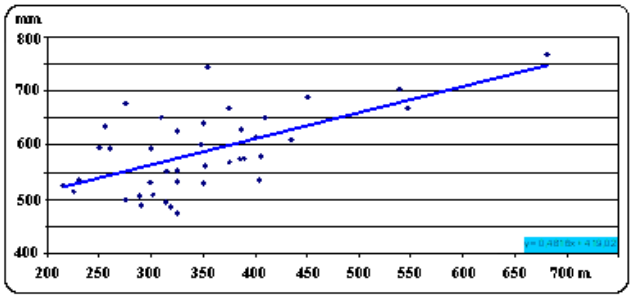

Fig. 2. The variation of the annual average quantities of atmospheric precipitations, reported to the altitude from the meteorological centers (a) and pluviometrical stations (b) from Suceava (1961-2010).

Analyzing the annual quantities of precipitations from 1961 to 2010, recorded at the weather centers from Suceava's Plateau, we can observe a special variation in time of this climatic element, sometimes with opposite aspects. The data covering a longer period of time (before 1961), indicates an even higher variation than in the period we are studying, due to some years in which extremely different quantities were recorded (higher or lower, like in Suceava where the annual extremes were 330mm in 1946 and 1021.3mm in 1933, or 346.7mm in 1986 and 883.2mm in 2008).

The annual sums of precipitations from Suceava's plateau have had bigger or smaller variations, situated between the extreme values reported by the 5 weather centers (table 1): Rădăuți - 352,8mm in 1986 (56% from normality); Suceava – 330.0mm in 1946 (57%) and 1021.3mm in 1933 (173%); Fălticeni – 369.2mm in 1986 (61%) and 819.1mm in 1991 (137%); Cotnari – 313.5mm in 1986 (60 %) and 825.1mm in 1991 (158%); Roman – 299.0mm in 1973 (58%) and 945.6mm in 1991 (183%).

The graphical representations of the evolution in time of the quantity of precipitations show us some very anfractuous lines, oscillating from one side of the mean to the other.

Table 1

The biggest and smallest annual sums of precipitations, exceptions and differences between them in the Suceava's Plateau (1961-2010).

Precipitation	Rădăuți	Suceava	Fălticeni	Cotnari	Roman
Average	634.8	620.1	608.0	531.2	523.9
Minimum	352.8	346.7	365.3	313.5	299.0
Year	1986	1986	1986	1986	1973
Maximum	914.5	883.2	819.1	825.1	945.6
Year	2005, 2010	2008	1991	1991	1991
Deviation -	-282.0	-273.4	-242.7	-217.7	-224.9
%	56	56	60	59	57
Deviation +	279,.7	263.1	211.1	293.9	421.7
%	144	142	135	155	180
Amplitude	561.7	-536.5	-453.8	-511.6	-646.6

Apparently, they don't obey any rule, registering general tendencies of soft increase in the analyzed time (figure 3).

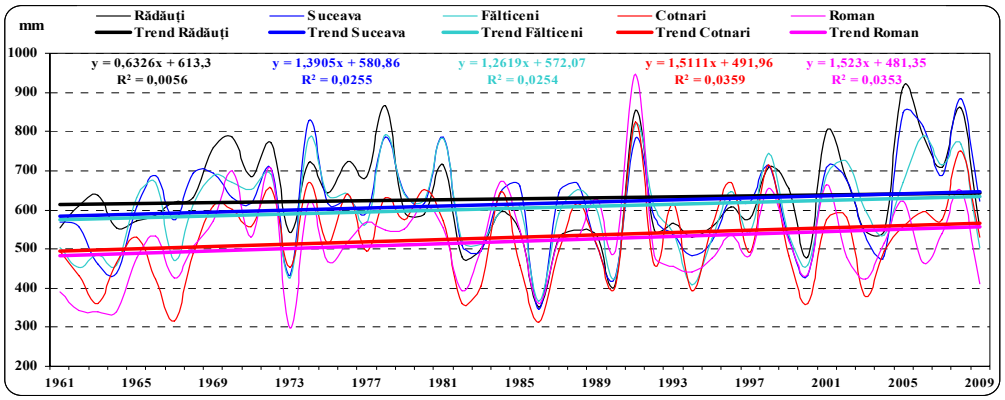

Fig. 3. The evolution, variation and tendencies of annual atmospheric precipitations in Suceava.

In comparison with other climatic elements (temperature, pressure, humidity, nebulosity), the variation in the annul sums of precipitation is much more highlighted.

In the same time, the parallelism of the evolution of these sums is not that much noticeable as sometime the sums intersect and other times they slowly move away one from another.

The general tendency of annual rainfall from 1961 to 2010 was to easily increase, the coefficients of the regression equation (y) being positive (between 0.8741 in Rădăuți and 1.9067 in Roman).

A more detailed analysis could determine smaller intervals of time with tendencies of a more accentuated increase between 1961 and 1972, 1998-2008, but also of stagnation, between 1972-1979 or 1981-1998. On each station these periods are much more accurately registered. The spreading of the annual values of precipitations is at minimum in Roman (0.053) and at maximum in Fălticeni (0.0369), from 1961 to 2009, becoming even larger for a longer period of time we analyzed (between 0.067 in Roman and 0.0748 in Suceava).

The calculus and the evolution of the precipitations' deviation from normality (the multiannual average) from all the meteorological centers in the period between 1961 and 2010 or beyond it (figure 4) in Suceava and Roman point out some interesting aspects.

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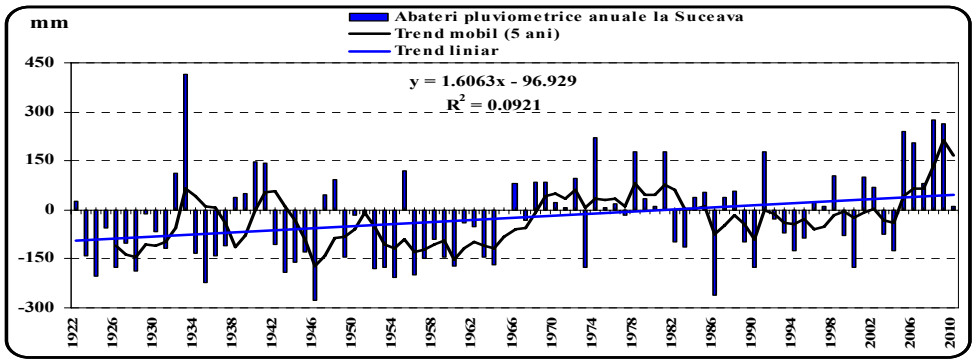

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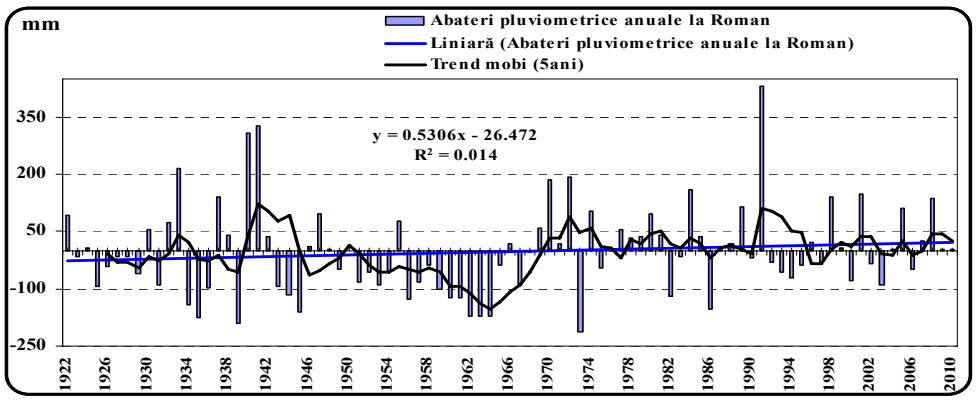

Fig. 4. The long run evolution of annual sums of precipitations from 1922 to 2009 in Suceava (a) and Roman (b).

In Radauti, some atmospherical precipitations have had the biggest variation from all Suceava's Plateau; the minimum was of -282.0mm(1986) and the maximum 279.7 mm (2005, 2010); for a larger period of observation (1955-2008), minimum negative exception becomes -286.9mm

(1986) and the positive maximum exception changed to 577.9mm in 1955 (when there was a maximum of 1217.6 mm per year).

In Suceava, the negative minimum was of –263.1mm (1986) and the positive maximum was of 263.1mm (in 2008, year known for the biggest floods ever experienced in this area); between 1922 and 2008, the variation increased, being comprised in the total precipitations of 330mm (1946 - the drought of the century), from a negative of -249.1mm to 1021mm in 1933 and a positive maximum change of 442.1mm.

In Roman, the variations of precipitations were registered between 299.0mm (1973) and 945.6mm (1991), with departures between -219.5 and 427mm (calculated for the period 1961-2009) or between 212.8 and 433.8mm (1986-2009).

Analyzing the frequency of the annual precipitations' sums (figure 5), we can see that the annual sums of precipitations between 500mm and 600mm are the most numerous as percentage in Suceava's plateau, of 29%, with an assurance higher than 73%. On stations, the situation doesn't always obey this rule.

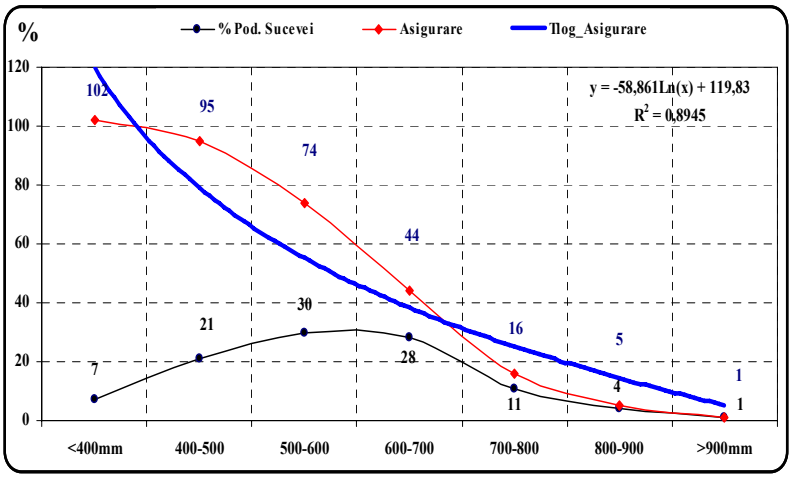

Fig. 5. Probability and assurance rate on intervals of 100mm for annual sums of precipitations in Suceava's Plateau.

In Suceava and Fălticeni, years with precipitations between 600mm and 700mm are the most frequent (38%), while annual sums between 500mm and 600mm are in proportions of only 23-25%. So, the most frequent annual quantities of precipitations are between 500mm-700mm in Rădăuți (61%), Suceava (61%), in Fălticeni (63%) and 400-600mm in Cotnari (56%) and Roman (62%). Lower frequencies were registered by the sums of precipitations between 700-800mm (4-17%) and the minimum, the very large, ranging from 800-900mm and over 900mm (0-2%).

Between 1961 and 2009, there was just one case of rainfall which registered less than 300mm (Roman) and there weren't more precipitations higher than 1000mm. In Rădăuți (where the maximum annual quantity of precipitations occurred), in 40% of the years were registered precipitations of 500mm-600mm and in the others below 400mm and above 900mm (2%).

In most of the cases, years with precipitations in surplus, close to normal in deficit, are grouped in shorter or longer periods. Certain years have had annual quantities much more below average (1887, 1896, 1964, 1973); the smallest sums of precipitations occurred due to atmospheric anticyclonic circulation, with changes resulting in warm masses of air.

In other situations, annual sums were beyond the multiannual average, thanks to the predominant cyclonic activity (1933, 1943, 1974, 1981, 1985, 1988, 1991).

These large quantities of precipitations were generated by rain and abundant showers during the warm season and transition periods. They characterize a relatively humid region, rich in precipitations, which combined with the thermal regime and evaporation (both low), assure a normal development of spontaneous vegetation and agricultural crops, because of the periods of drought and dryness. Also, this phenomenon occurs in autumn months, when the vegetative cycle of plants is over or almost finalized and is more frequent in the South-Eastern part of the studied area.

From the pluviometrical point of view, in the Plateau of Suceava, rainy periods are more frequent than the droughty ones.

CONCLUSIONS

The small quantities of precipitations in the habitat of Suceava city have had a great variation in time, the pluviometrical excess and deficit fallowing one another in many different intervals of time. This variation is increasing, as it's naturally, with the expanding of the periods we are analyzing and it numerically fits between the extreme quantities of precipitations: annually (330mm-1946 and 1021mm-1933), seasonally (69mm-1935-1936, 311mm-1987-1988 in the cold season, 173mm–1976 and 694mm-1974 in the warm season), monthly (0mm in November 1926, February or December 1931 and 253mm July 2003), daily (between days without precipitations and the maximum of 85.5mm registered July 8th, 1967).

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