SOME PECULIARITIES OF THE PLUVIOMETRIC REGIME IN SUCEAVA

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Abstract

This paper is part of a comprehensive study on the meteorological characteristics of Suceava locality and presents some peculiarities of the pluviometric regime since 1922. In the 83 years the prevailing frequencies (40-60%) were between 401-500 mm in the period 1922-1966, while in the period 1967-1986 dominant were the quantities of 601-700 mm annually. The largest share (56%), over the entire 83-year period, had the precipitations between 400 and 600 mm annually, and precipitations below 400 mm were recorded only in two years out of 83 years, respectively 1935 and 1986.

Key words: rainfall, multiannual average, quantitative amplitude, pluviometric distributions.

Atmospheric precipitations, such as condensation and crystallization products of water vapour falling from the clouds in liquid, solid or mixed form, are one of the most important climatic elements with a particular influence on the geographic landscape of a region and constitute an important link of the circuit of water in nature.

In order to obtain optimal harvests, there are necessary rains distributed as uniformly as possible during the phenophases with a requirement for the humidity factor and not in large quantities (which, if they have a high intensity, can become harmful through their erosive and torrential potential). Thus, the number of days with precipitation amounts, even reduced by 0.1 mm, is an important element of agrometeorological characterization of a period or a year. The need of water for plants increases directly proportional with the air and soil temperature, but each species has its own moisture requirements, distributed over different periods (Tanase I., 2011).

MATERIAL AND METHOD

This paper is part of a comprehensive study on the meteorological characteristics of Suceava locality and presents some peculiarities of the pluviometric regime since 1922. We have analysed the meteorological data referring to the amount of rainfall that fell during 1022-2009, with the exception of 1944-1948 when there were no records, respectively 83 years. The period 2010-2018, due to the fact that it has some specific peculiarities, will be presented in a future paper.

RESULTS AND DISCUSSIONS

The annual rainfall limits recorded at the Meteorological Station from Suceava are between 348 mm (1986) and 1021 mm (1933) (*table 1*). Although the Suceava locality is located in the sub-humid area, the share of the years with precipitation below 500 mm represented 60% in the years 1942-1966 and 50% between 1922 and 1931. The consequence of this pluviometric distribution is illustrated by the fact that the highest percentage (34%) had, in the 83 years, the precipitations that did not have the ability to influence the climate in having a sub-humid character.

According to the data presented in table 1 it results that the multiannual average of the precipitations in the analysed period was 581 mm and that almost always the largest quantities were registered in June and July. What is surprising is the almost symmetrical distribution (some months), as follows:

Pair months	I-XII	II-XI	III-X	IV-IX	V-VIII	VI-VII
Years 1922-1966	23/20	24/30	23/32	43/40	71/72	81/74
Years 1967-2009	21/25	22/29	27/36	54/52	76/74	100/109
Years 1922-2009	22/24	23/29	25/34	49/46	73/73	91/92

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Table 1

Annual and decadal monthly values of rainfall in Suceava

Years	Specifi-cation	Months												
		01	02	03	04	05	06	07	08	09	10	11	12	annual
		rainfall												
1922-1966*	medium	23	24	23	43	71	81	74	72	40	32	30	22	535
	minimum	2	0	2	7	10	17	15	12	4	2	0	0	384
	maximum	65	123	108	112	195	162	199	202	131	126	86	55	1021
1967-2009	medium	21	22	27	54	76	100	109	74	52	36	29	25	625
	minimum	5	2	2	6	9	18	3	20	0	5	7	4	348
	maximum	59	52	61	135	172	229	298	223	148	106	86	62	882
1922-2009*	medium	22	23	25	49	73	91	92	73	46	34	29	24	581
	minimum	2	0	2	6	9	17	3	12	0	2	0	0	348
	maximum	65	123	108	135	195	229	298	223	148	126	86	62	1021

***** *the years 1944-1948 are missing*

Also from tble 1 it results that the monthly minimums were extremely low compared to the multiannual average (monthly), about 11-29 times in the cold season and 5-46 times in the hot season. At the same time, the monthly maxims were 3-4 times higher compared to the same multiannual monthly averages, without differentiating them according to the seasons (*table 2*).

Based on these data it can be appreciated that from the point of view of the quantities of precipitation, the tendency to take over the continental climate was maintained without a without seizing incipient influences of the arid climate in the central area of Suceava Plateau, especially taking into consideration that the average of 1965-2009 was 17% higher compared to the average of the years 1922-1964. In other words, the average of the years 1965-2009 (624 mm / year) was 95 mm / year higher compared to the one recorded in the 1922-1964 stage (529 mm / year).

The data in table 2 suggests that it was highly probable that in the period 1965-2009 the tendency to take over the continental climate would have increased as a result of the higher quantitative amplitudes and that it would have also manifested itself in stages with lower quantitative amplitudes, especially if the minimum quantities were lower, respectively 440-458 mm.

The estimation of the uniformity of time distribution of rainfall can be done through Christiansen's relation (*1960, quote from Laşiţă and Grumezea in 1967)*:

$100[1-(\sum(X-x)/\sum X]$, having the following ratings of the precipitation distribution uniformity (cup)

- very uniform - above 85%;
- satisfactorily uniform: 81-85%;
- quite uniform: 75-80%;
- non-uniform: 60-74%;
- very non-uniform: less than 60%.

Since all the monthly values of the quantitative precipitation coefficient were below 70, many of them being even lower than 50 (over 40% of the values shown in table 3), it becomes obvious that in the continental climate, which also characterizes the Suceava Plateau, it is uncertain a precipitations distribution as uniform as possible. In this context, it becomes impossible to record constant productions, although the annual values of this estimator have exceeded 80%.

The data in *table 3* may also generate erroneous estimates if only annual values that have not dropped below 80 are taken into account. For example, the 89 value characteristic for the 1965-1985 period may lead to the belief that there is an excellent rain distribution, even dough the annual repartition from each month was very un-uniform over the course of six months.

The hypothesis that the volume of monthly precipitation correlates with the annual precipitation has no practical basis, since on the basis of the 996 values the statistical expression of the interrelation estimated by the correlation coefficient was only 0.003.

Table 2

Statistical estimates of the amounts of extreme annual precipitation

Stage	Maximum precipitations		Minimum precipitations		Difference max-min
	No. of years	Average (mm)	No. of years	Average (mm)	
1922-1931	4	571	6	458	113
1932-1943	6	758	6	456	302
1949-1964	5	592	11	440	152
1965-1982	7	742	11	636	106
1983-1998	5	714	11	520	194
1999-2009	5	774	6	556	218
1922-2009	32	701	51	517	184

Table 3

Variability of uniformity coefficients of rainfall and air temperature distribution in Suceava

Years	Months												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
	precipitations												
1922-64	42	40	36	53	54	58	66	57	42	40	45	47	81
1965-85	47	40	56	60	62	67	57	60	38	34	61	17	89
1986- 09	45	58	48	57	44	60	49	47	48	55	50	45	81
1922-09	42	46	44	56	55	62	53	55	40	52	50	48	81
	air temperature												
1950-09	42	26	14	82	91	94	94	95	91	88	37	18	91

Table 4

The frequency of the series of 2-5 consecutive months very and excessively dry or rainy in Suceava

Stages	Very and excessively deficient regime				Excessive overflow in the warm season			No. months[4] with regime	
	cold season[1]		warm season [2]		no of series			poor[5]	excess[5]
	no of series		no of series						
	2 months	3 months	2 months	3 months	2 months	3 months	5 months		
1922-31	4	2	1	-	1	-	-	16	2
1932-41	1	1	-	-	1	-	1	5	7
1942-56[3]	2	-	4	-	1	1	-	12	5
1957-66	1	-	1	-	1	-	-	4	2
1967-76	3	-	2	-	2	-	-	10	4
1977-86	4	-	3	-	-	-	-	14	-
1987-96	1	-	-	1	1	-	-	5	2
1997-09	2	1	1	-	2	2	-	9	10
Total	18	4	12	1	9	3	1	75	32

1) months 11-03; 2) months 04-10; 3) missing the years 1944-1948; 4)part of the series; 5) very and excessive.

The analysis of the data in table 4 allows highlighting several aspects:

- despite the fact that Suceava is located in the suburban area, during 83 years there were more months (36), very and excessively dry during the cold season, than during the warm season (24);

- the frequency of two consecutive very dry months in the hot season has not increased with the warming of the air over the last 20 years;

- the number of months included in the highly and excessively deficient series (75) was 2.3 times higher than the surplus months (32).

These data does not suggest a trend towards the possibility that the climate would become arid:

Years	1922-1931	1932-1941	1942-1944+ 1949-1956	1957-1966	1967-1976	1977-1986	1987-1996	1997-2009	1922-2009
Aver. rainfall	503	637	496	502	641	614	580	654	581

The delimitation of the nine types of pluvial regime using the Hellman method, the most commonly used, is achieved by multiplying the precipitation average (m) by the appropriate correction coefficients as follows:

ratings	excessively dry	very dry	dry	moderately dry	medium	moderately rainy	rainy	very rainy	excessively rainy
limits	<0.5m	0.5m-0.69m	0.7m-0.79m	0.8m-0.89m	0.9m-1.1m	1.11m-1.2m	1.21m-1.3m	1.31m-1.5m	>1.5m

The analysis of the data from table no. 5 shows that the relative frequency of cases of excessive drought in the four seasons is very close to the frequency of excessive rainy stages from the same seasons. Instead, the frequency of very dry seasons was at least twice higher than the frequency of very rainy seasons.

Table 5

Relative frequencies (%) of the pluviometric regimes in Suceava, delimited according to Hellmann's criteria

Period	excessively dry	very dry	dry	moderately dry	medium regime	moderately rainy	rainy	very rainy	excessively rainy
1922-1966[1.2)]	-	-	15	33	22	10	5	13	2
1967-2009[3)]	-	7	9	14	35	21	9	5	-
1922-2009[4)]	-	6	19	14	29	10	12	9	1
Winter	22	16	7	7	11	5	5	6	21
Spring	18	20	4	6	11	6	8	10	17
Summer	13	18	12	10	14	4	5	7	17
Autumn	26	14	6	5	9	5	6	7	22

1) missing years 1944-1948; 2) annual precipitation averages - 535mm; 3) annual precipitation averages-625mm; 4) annual rainfall average 581mm.

The most frequent cases of moderate drought (33%) were recorded during the years 1922-1966, while the one of the years 1967-2009 was evidenced by the highest frequency (35%) of the years with an average rainfall regime, as the average values of the precipitation quantities differ according to the duration of the analysed element - month, year - of the same rainfall type. For example, the frequency of the moderately dry or rainy regime is quite different if the evaluation refers to years, stages, seasons, etc. Since the evaluation of the frequency of a pluviometric regime type for a decade does not suggest satisfactory information, table 6 lists the frequency suites for stagess that include successively a decade at a time. The recording of less fluctuating trends was only reported after four decades.

By doing so, from 1922-1976, the values of the level of rainfall are free of perturbing induction. As a result, although every decade that has been included in the previous group of years has some differences from previous values, however, the magnitude of the frequencies within the nine Hellmann classes does not change significantly. The analysis of the data included in table 6 shows that the amplitude of the frequencies starting with stage 1922-1976 represents only 1-5 percentage points. To a large extent, this uniformity of the differences between stages is also due to the fact that the limits of a Hellmann class are quite wide, including significant quantitative variations.

Table 6

Variation of rainfall humidity levels according to Hellmann, in %

Ranges	1922-1941	1922-1956	1922-1966	1922-1976	1922-1986	1922-1996	1922-2009
Excessively dry	-	-	-	-	-	-	-
Very dry	5	-	-	2	3	3	4
Dry	15	30	15	16	17	16	18
Moderately dry	30	17	32	24	23	21	19
Medium regime	15	27	22	28	25	29	28
Moderately rainy	15	7	10	10	13	13	10
Rainy	5	3	5	10	9	11	12
Very rainy	10	13	12	8	8	6	7
Excessively rainy	5	3	4	2	2	1	2
Moderately dry- moderately rainy	60	51	64	62	61	63	57
Dry + very dry	20	30	15	18	20	19	22
Rainy + very rainy	15	16	17	18	17	17	19

Among the observations suggested by the data in table 7, one must highlight the inconsistency between the annual and monthly frequencies of many levels of the rainfall regime. Thus, although the frequency of years falling between the precipitation (m) average of -10% and m + 10% represents 28% the frequency of the months with precipitation ranges between m-10% and m + 10%, it was on average only of 11%, oscillating between 5% and 19%. It is also noticed that no annual average was lower than the average of -50%, while the monthly precipitation amounts considered to be excessively dry had an average frequency of 22%, with limits ranging from 14% to 30 %. Characteristic of this group is that the highest frequencies of the excessively dry months were recorded in September-January.

Table 7

Frequency (%) of months in pluviometric terms according to the Hellmann criterion, in the years 1922-2009

Symbols	Months												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
ed	27	22	22	20	19	15	14	17	30	28	25	25	-
vd	15	16	118	15	18	19	18	18	13	13	11	16	4
d	6	10	10	2	5	7	14	11	5	6	5	2	18
md	7	9	5	6	6	7	12	7	2	4	7	7	19
m	7	11	5	15	9	19	10	16	6	12	9	11	28
mr	3	4	7	9	9	8	4	4	9	4	8	5	10
r	4	4	5	7	8	7	3	5	4	6	7	6	12
vr	7	6	9	9	10	3	7	7	8	8	8	9	7
e	24	18	19	17	16	15	18	15	23	19	19	19	2
a ed+vd	42	38	40	35	37	34	32	35	43	41	37	41	4
b ed+vd +d	48	48	50	37	42	41	46	46	48	47	42	43	22
c er+vr	31	24	28	26	26	18	25	22	31	27	27	28	9
d er+vr+r	35	28	33	33	34	25	28	27	35	33	34	34	21
a-c	11	14	12	9	11	16	7	13	12	14	10	13	5
b-d	13	20	17	4	8	16	18	19	13	14	18	9	1

ed - excessively dry; vd- very dry; d- dry; md- moderately dry; er-excessively rainy; vr- very rainy; r- rainy; mr-moderately rainy

Table 8

Frequency (%) of annual precipitations

Years	Quantities - mm					
	under 400	401-500	501-600	601-700	701-800	over 800
1922-1931	-	50	40	10	-	-
1932-1941	10	30	-	20	30	-
1942-1956	-	60	30	-	10	-
1957-1966	-	60	30	-	10	-
1967-1976	-	10	10	60	10	10
1977-1986	10	20	10	40	10	10
1986-1996	-	20	50	10	20	-
1997-2009	-	16	23	15	31	15
1922-2009	3	31	25	19	16	6

At the same time, it should be pointed out that although the frequency of the years with an excessively rainy regime was only 2%, the monthly frequencies in the same precipitation class ranged between 15 and 24%. A similar trend was registered in the case of the "very dry" class. Instead, average monthly rainfall frequencies range between 5.5 and 7%, in the moderate dry, medium, moderate rainy and rainy groups, annual frequencies range from 10 to 19% (table 7). Exception to these trends is the parallelism between the monthly frequencies of the very rainy regime (7.6% on average) and the frequency of very rainy years of 7%.

A characterization of the precipitation regime that can be of practical interest is suggested by the data listed in table 8, from the analysis of which some tendencies emerge.

The annual rainfall quantities below 400 mm were recorded in only two years out of the 83 years (1935 and 1986) and frequencies of 50-60% of the precipitation volume ranging from 400 to 500 mm annually were recorded during the periods between 1922-1931, 1942-1956 and 1957-1966 (table 8). The important frequencies, of 40-50%, of the amounts of 500-600 mm, including the multi-annual (581 mm) average of the Suceava locality (Tănasă, 2011), were recorded in the decades 1922-1931 and 1986-1996. Stages

1967-1976 and 1977-1986 are characterized by the highest frequencies - 60% in the first stage and 40% in the second stage of the 1967-1986 period, the quantities ranging from 601mm to 700 mm.

The analysis of table 8 also shows that in the 83 years the prevailing frequencies (40-60%) had the quantities of 401-500 mm in the years 1922-1966, while in the years 1967-1986 dominant were the quantities of 601-700 mm. It is also noted that the largest share (56%), during the whole period of 83 years, was of precipitations ranging from 400 to 600 mm.

CONCLUSIONS

The multi-annual average of precipitation in the analysed period was 581 mm, and almost always the largest quantities were recorded in June and July.

The hypothesis that the volume of monthly precipitation correlates with that of the annual rainfall has no practical basis, since the statistical expression of the interrelation estimated by the correlation coefficient was only 0.003.

Although Suceava falls in the sub-humid areal, during 83 years there have been more months (36), very and excessively dry in the cold season, than in the hot season (24).

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The largest share (56%), over the entire 83-year period, had the precipitations between 400 and 600 mm annually, and precipitations below 400 mm were recorded only in two years out of 83 years, respectively 1935 and 1986.

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