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THE CHARACTERISTICS OF THE ATMOSPHERIC PRECIPITATING DURING THE HOT SEASON OF THE YEAR IN THE PLATEAU OF SUCEAVA

Dumitru Mihăilă[1] Ion Tănasă[2]

Key words: rains, intervals with maximum intensity during the rains, duration, quantity of precipitations, medium and maximum intensity, torrential episodes/precipitations.

Abstract. The characteristics of the atmospheric precipitating during the hot season of the year in the Plateau of Suceava**.** The atmospheric precipitations represent the most veritable climatic element (Donisă I., 2000), and their detailed study can reveal and clarify many aspects linked by the genesis, the temporal and spatial manifestation, the environmental impact etc. A detailed pluviometric study on the air temperature and the atmospheric precipitations from the Plateau of Suceava was made in 2009 by Nistor B. But this includes only partially the issues approached in the present demarche. For the geographic subunits around the Plateau of Suceava (the Subcarpathians of Moldavia, the mountain Sector with storage lakes of the Bistrita Valley, the Plain of Moldavia) the detailed study of the rains was made by Apostol L., 2000, Mihailescu I. F., 2001, Mihaila D., 2006. From here the necessity of responding to some existing gaps in the Plateau of Suceava climatological research. The ignorance would have urged us to give up certain details which apparently are known (eg. the precipitating intensity is bigger at and after noon). The analytical spirit has urged us also to argue scientifically, among other things, what it looks like we know for a long time and to identify certain spatial differentations of this process. Starting from those three remarks, disposing of a consistent database (the period 1968-2010) from 3 meteorological stations from the Plateau of Suceava (Radauti, Suceava and Roman – situated, actually, in the south-eastern extremity of the plateau, in the Siret River Corridor) and from Tg. Neamt, from the south-western vicinity of the subunit studied, we proceeded to a detailed analysis of all the rains parameters from the interval of the year (April - October) in which, on the platforms of the respective stations, the pluviographs are in operation. In our attention sphere entered parameters like: the cumulative and average number of rains and intervals with maximum intensity, the cumulative and average duration of the rains and of the intervals with maximum intensity, the maximum and

[1] University Lecturer dr., Geography Department, The Faculty of History and Geography, „Ştefan cel Mare" University of Suceava
[2] Meteorologist I dr./meteorologist I, Suceava weather station, C. M. R. Moldova, National Meteorology Administration

minimum durations of these pluviometric entities, the cumulative and average, maximum and minimum quantities of precipitations that fall during the rains or during the intervals with the highest intensity among them, the medium and maximum intensities during the rains or during the „peaks" of precipitating etc. The results obtained and which find themselves synthesized in tables and numerous representations, the feedback made on them, can represent landmarks for many climatologists, hydrologists, agronomists specialists, professional foresters etc.

Introduction

During the hot season of the year, in the area of the Plateau of Suceava, the precipitating is often violent and has a major negative impact on the whole geographical environment or on its various components.

In this study, through the hot season we are making reference to the interval 1.IV – 31.X, even though the hot season of the year starts, in terms of calendar, at 1.IV and ends at the date of 30.IX. But most of the times, meteorologically, both the hot season and the cold one expand themselves outside the temporal frame of manifestation of the homonymous calendar seasons.

In „Instructions for the observation, identification and codification of the clouds and of the meteorological phenomena", the I.M.H., 1986, is made the distinction between sudden showers and the precipitations with torrential character. „The sudden showers are characterized through the almost unexpected commencement and termination and through rapid, sometimes violent variations of intensity, generally having short duration" and can give variable quantities of water (sometimes very large, other times insignificant). The sudden showers are usually generated by Cumulonimbus clouds and are accompanied, in the most of the cases, by thundery phenomena. „Unlike the sudden showers, which can sometimes give large quantities of water in relatively short time intervals, the precipitations more or less continuous with torrential character give large quantities of water, but in a longer time." Their duration is usually long and their intensity increases and decreases gradually. They are generated by stratiform cloud systems. At the same time with the duration increase, the precipitating intensity decreases.

Meteorological parameters of the precipitating such as the duration, the intensity and the quantity of precipitations were approached at the level of the whole Romania in the treaty The Geography of Romania, Vol. I, The physical Geography (1983), pag. 242-244. From the quoted material appears that in the Plateau of Suceava the rains from the hot semester of the year last on average over 190 min., during a rain it precipitates between 6 and over 8mm, and the average intensity has the value of 0,04mm/min.

Scientific interests in this direction exist in our country for a very long time (Hepites St.- 1900, Donciu C. -1929, Platagea Gh. - 1959, Gugiuman I. - 1960,

Stoica C., Strutu Margareta – 1964, Topor N. - 1964, 1970, Mihai Elena - 1975, Erhan Elena - 1979, Bogdan Octavia - 1980, Teodorescu Elena – 1980 etc.). These pluviometric studies referring to the scale of the entire country, or to some natural units or localities, have sometimes taken into analysis short periods of time, focusing on the case research, or reached only tangentially some quantitative and qualitative parameters that define the precipitating from the zone of the studied area. Their value is indisputable, considering the fact that the researchers who approached this kind of study themes have often confronted themselves with an acute lack of data, and if these existed, they included short periods of time and presented nomerous discontinuities.

Fig. 1. The Plateau of Suceava and the surrounding geographical subunits. The location of the meteorological stations from which we used data within or related to i

During the last 40 years, the numbers of the studies focused on the problems of the humidity excess, the torrential rains and the pluviometric extremes have multiplied exponentially, considering the more and more significant impact of them on the geographic environment components, but also the increasing of the research means posibilities, represented especially by the meteorological radars and satellites.

From the multitude of researchers who approached this theme it is worth mentioning the followings: Balan V. et al. – 1984, Stancescu I, Goti Virginia - 1992, Niculescu Elena - 1996, 2003, Bogdan Octavia – 1999, 2000, 2002, 2003, Bogdan Octavia and Marinica I. -2006, Apostol L. – 2000, 2004, Vasenciuc Felicia – 2001, 2002, 2003, Marinica I. – 2002, 2003, 2005, 2006, Marinica et al. – 2005, Hauer Elza et al. – 2003, Moldovan Fl. – 2003, Gaceu O. – 2005, Apostol L., Amariucai M. – 2005, Cheval S. et al. – 2005, Croitoru-Eliza Adina – 2006, Dragota Carmen, Balteanu Dan – 2002, Dragota Carmen – 2006, Mihăila D. – 2006, Mihaila D. et al. – 2007, Mahara Gh., Roman P. I. – 2009, Nistor B. – 2008, Bostan Diana et al. 2009, Mihaila D. et.al, 2009, Tiron Gina, Carolina Irina Oprea – 2009 etc.

The number of the studies linked by the excessive manifestations of the different spatial and temporal entities pluviometry is much more comprehensive, both in domestic and foreign plans. For example, at the XXII Colloquy of the I.A.C. organized in Cluj Napoca in September 2009, from those 81 topics presented there, more than 20 focused themselves on the pluviometric problems and especially on its risk generating aspect.

Starting from the current considerations, the multiple connotations of practical-applied nature, and theoretical too, of the theme, our demarche is directed to a detailed analysis of the Plateau of Suceava pluviometry during the hot period of the year (1.IV-31.X) from the interval 1968-2010, period from which we disposed of the Meteorological Tables MT-3 and MT-13 from the meteorological stations Radauti ($47^0$50' lat. N, $26^0$53' long. E, 389m), Suceava ($47^0$38' lat. N, $26^0$15' long. E, 352m), Roman ($46^0$55' lat. N, $26^0$50' long. E, 216m), to which were added for comparison the data from the meteorological station Tg. Neamt ($47^0$13' lat. N, $26^0$23' long. E, 387m), situated in the Subcarpathians of Moldavia – fig. 1.

Study area. There has been chosen as research area for this theme the Plateau of Suceava (fig. 1) from more reasons.

From these we are mentioning some:

- the valorification of the meteorologists consistent and lasting obsevations at a superior level and their bringing out from the archive anonymity,
- the lack of some detailed studies on the theme in cause with an exact reference to this well humanized geographical subunit and from here the desire of eliminating this deficiency through the detailed research and the releasing to the academic community and the administrative decisional factors the results of our study,
- the existence, in the scientific community's mentality, of a perception that, in this natural subunit the pluviometry has not so acute manifestations as in other

natural units or subunits from our country (Eg.: the Romanian Plain, the Plateau of Dobrogea), wishing to validate or to invalidate this perception etc.

Methodological and terminological clarifications. The decipher of the pluviograms from the pluviometers placed on the meteorological platforms of the Radauti, Suceava, Roman and Tg. Neamt stations from the period 1968-2010 allowed the drawing of the meteorological tables MT-3 and MT-13, which have been the basis of the statistical processing that argues our demarche quantitatively, analytically and also synthetically.

The statistical basis processed includes all the rains registered by the pluviographs of the mentioned stations, regardless of their intensity (the rains intensity was determined according to the formula $I = h/t$, where h = the quantity of precipitations in mm, and t = the time in minutes). There were taken into account even the rains of which intensity was only 0,01mm/min.

Should be noted that we operated with two categories of pluviometric events: rains (**R**) and intervals with the highest intensity (**IHI**) integrated to the rains. Many times, the rains do not present variations of intensity during their falls. Yet, sometimes, during a rain, takes place one, more rarely two and very rarely more than two „flare-ups", peaks that present intensities higher than the rain average.

For this reason, in the current material is made the distinction between R and IHI integrated to the rains. For those two entities with which we operated: R/IHI there were taken into account certain main parameters (the number of rains – **NR** and the number of intervals with maximum intensity – **NIMI**, the duration of the rains – **DR** and the duration of the intervals with maximum intensity – **DIMI**, the quantities of water fallen during the rains – **PpR** and during the intervals with maximum intensity – **PpIMI**, the intensity of the rains – **IR** and of the sequences with more intense pluviosity – **IIMI** etc.) completed by a series of secondary parameters like the beginning and the end of the rains and of the maximum intensity intervals included to the rains.

The results obtained. The number of rains – NR and of intervals with maximum intensity –NIMI. During the hot season of the year the NR (from which a big part has torrential character) evolves in direct relation with the frontal phenomena amplification and especially those of thermoconvection, which, at the Plateau of Suceava latitude, reach significant scales during the interval May-June, but also with the water vapors sources that are more numerous and more consistent in these two months.

On average, in the interval 1.IV-31.X, above the Plateau of Suceava (for the calculation of the pluviometric parameters for the entire Plateau of Suceava there have been taken into consideration only the data from the meteorological stations

from Radauti, Suceava and Roman, without the ones from Tg. Neamt, station included to the Subcarpathians of Moldavia; these data use only as a comparison guide) occurs a number of 90 rains, and monthly, the most numerous rains manifest themselves in May and June (16-18 rains for each – fig. 2). But not all of them have a beneficial effect on the environmental components.

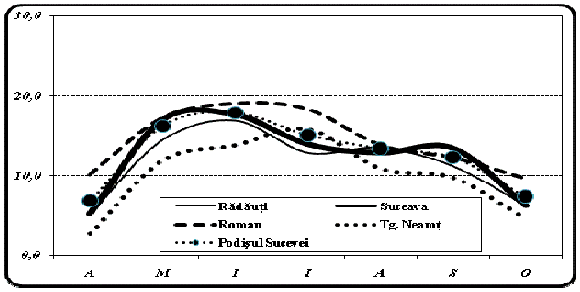


Fig. 2. The seasonal course of the monthly average number of rains (1968-2010)

Usually, each rain shows a single interval which distinguishes itself, pluviometrically, of its whole. Therefore, the seasonal course of the monthly average number of intervals with maximum intensity does not differ significantly by the one of the rains in which it fits temporally. Their evolutive regimes are almost identical.

Even though, apparently, the parameter NR would present only a statistical importance, in fact each rain is a more humid interval that interrupts an episode of dryness or drought. According to statistics, in the Plateau of Suceava, in the interval May-September, the monthly number of rains exceeds the limit of 10 units. By taking this parameter into account, we could appreciate that in the respective interval, when the plants are in full vegetative cycle, the phenomena of dryness and drought are often interrupted, not having the necessary intensity for producing some serious damages. We have to make one more observation, valid especially for the beginning and the ending months of the hot season. In April and October, in some years with later spring comings or with colder autumns, when the freezing phenomena extend themselves in extraseason, the pluviographic recordings are obstructed. During those months, in many situations, the precipitations fall under a solid form and do not make the object of the pluviographic recordings. Therefore, the data from the months of April and October must be seen and analyzed under this reserve.

The duration of the rains (DR) and of the intervals with maximum intensity (DIMI). According to the statistics, in the Plateau of Suceava, a rain lasts

on average 3 hours and 26 minutes, the reality being sometimes contrastive from case to case.

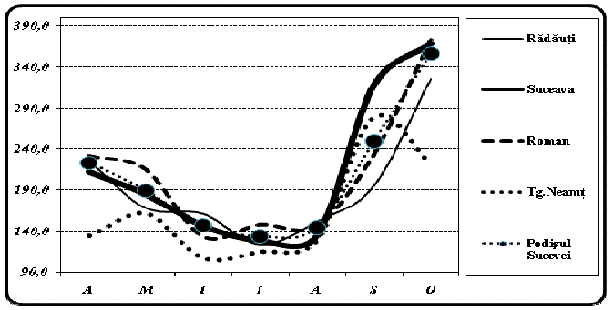


Fig. 3. The seasonal evolution of the rains average durations (in minutes) (1968-2010)

In annual profile, as the active surface and the air temperatures increase, the thermoconvective phenomena amplify themselves and the DR decreases, reaching the minimum from the hot season in July (2 hours and 13 min. on average).

Tab. 1. The rains durations frequencies (in minutes) in:

a. Radauti (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤10'	6,0	4,9	7,3	8,7	5,6	11,8	4,3
11-30'	37,6	20,8	16,4	12,3	15,5	16,9	4,6
31-60'	8,7	14,2	17,9	24,1	17,1	20,4	8,2
61-180'	15,6	26,1	34,1	33,9	28,6	17,1	15,5
181-360'	10,8	21,6	12,1	17,3	26,6	14,6	29,2
361-720'	13,6	10,2	9,7	2,2	4,7	14,4	35,0
721-1440'	4,8	1,9	1,8	1,4	1,4	4,1	3,2
>1440'	3,0	0,3	0,8	0,2	0,6	0,6	0,0

b. Suceava (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤10'	7,4	8,3	15,1	10,8	13,1	9,6	6,5
11-30'	13,2	15,2	21,9	19,7	17,4	15,2	0,7
31-60'	20,7	16,9	8,4	15,9	19,6	8,7	6,7
61-180'	25,1	31,8	28,6	30,4	28,1	24,1	12,5
181-360'	15,2	13,5	14,8	18,2	11,2	12,0	28,0
361-720'	10,7	8,7	8,3	3,6	9,9	19,0	40,6
721-1440'	7,7	5,1	2,5	1,3	0,1	6,1	4,3
>1440'	0,0	0,6	0,4	0,1	0,6	5,2	0,7

c. Roman (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤10'	16,6	4,9	9,1	9,9	6,7	7,3	1,2
11-30'	10,9	21,1	19,3	17,1	24,8	7,8	12,5
31-60'	11,4	12,3	19,6	19,3	16,2	15,1	4,1
61-180'	22,5	25,3	30,0	28,2	34,2	31,1	8,8
181-360'	18,1	19,8	15,0	13,3	10,3	18,2	27,8
361-720'	13,1	12,5	5,0	10,9	4,4	12,8	31,5
721-1440'	6,7	3,1	1,7	1,2	2,9	8,2	11,6
>1440'	0,7	1,1	0,1	0,0	0,6	0,0	2,4

Beginning with the month of August and until October, inclusively, the rains duration increases (fig. 3) as the precipitating from the stratiform cloud systems

gains in share. The autumn rains known in the popular language under the name of „autumn drizzling rains" are thus well highlighted statistically.

By analyzing in detail the rains durations frequencies on different temporal intervals (tab. 1) we can ascertain that over 50% from the number of rains from the interval April – September last less than 3 hours.

In October the rains last more, the biggest share being held by the ones that last from 3 to 12 hours.

The longer duration of the rains at the debut and at the end of the hot season has positive connotations: the processes of precipitations infiltration in soil favor the restoration of the water reserves from soil or from groundwater layers. Nevertheless, the prolonged extension of the humid weather type during the interval September-October generates troubles for the crops raising or in constructions, where the activity must be often ceased.

The most reduced duration of the rains from the interval July-August highlights a higher level of their torrentiality, with a special impact on the flow processes with the production of the floods (eg. the interval 23-28 July 2008 on Suveava and Siret), of the landslides activation, of the torrential organisms and of the erosion in the soil blanket.

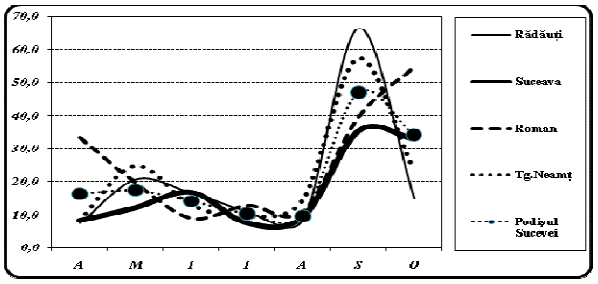


Fig. 5. The seasonal evolution of the average durations (in minutes) of the intervals with maximum intensity during the rains. (1968-2010)

It has to be mentioned the fact that the rains with the longest duration can last 2-3 days (eg. 2870 minutes during the interval 17-18-19.06.1985 in Radauti, 3252 minutes in the interval 6-7-8.08.1972 in Suceava, 3440 minutes in the period 25-26-27.05.1991 in Roman).

The IMI during the torrential rains have, on the whole of the Plateau of Suceava, an average duration of 21 minutes.

Tab. 2. The frequencies of the durations of the intervals with the highest intensity during the rains (minutes).

a. Radauti (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤1'	6,8	6,3	5,3	2,1	10,3	2,8	1,0
2-5'	28,6	47,4	40,3	35,7	52,1	28,4	26,9
6-10'	45,3	25,4	30,9	33,1	19,1	18,4	21,9
11-20'	18,0	14,6	11,7	17,9	14,7	21,0	38,5
21-30'	0,0	2,8	5,1	7,8	2,8	14,2	4,2
31-60'	1,3	1,1	2,6	2,8	0,5	4,7	6,2
>60'	0,0	2,4	4,2	0,6	0,5	10,5	1,4

b. Suceava (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤1'	15,2	16,1	9,8	13,0	8,4	12,9	4,4
2-5'	46,5	44,6	44,0	52,8	54,9	38,4	29,0
6-10'	26,2	22,3	28,4	24,1	23,4	23,4	44,1
11-20'	9,9	13,0	10,4	6,9	6,8	12,4	7,9
21-30'	1,3	1,9	3,8	1,7	4,4	1,3	9,0
31-60'	0,0	0,6	0,7	0,8	0,8	4,5	1,0
>60'	1,0	1,4	2,9	0,7	1,3	7,2	4,8

c. Roman (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤1'	6,5	15,7	13,6	11,2	13,1	6,4	4,3
2-5'	47,5	45,5	51,7	41,6	42,2	35,6	33,6
6-10'	21,1	19,4	19,5	22,9	27,0	20,9	30,9
11-20'	15,1	11,9	10,6	14,9	11,2	24,8	22,2
21-30'	0,0	3,1	1,8	1,8	1,3	2,6	0,8
31-60'	3,4	1,0	1,7	6,5	2,5	3,5	0,0
>60'	6,4	3,3	1,2	1,0	3,5	6,5	8,2

The IMI have the minimum duration in the period July-August (11, respectively 10 min.), lasting more during the months September and October (47, respectively 34 minutes – fig. 5). The interval July-August is the most propitious for the rain showers manifestations, with sudden start and end, generated by Cumulonimbus clouds, which frequently give very large quantities of water and intense thundery phenomena.

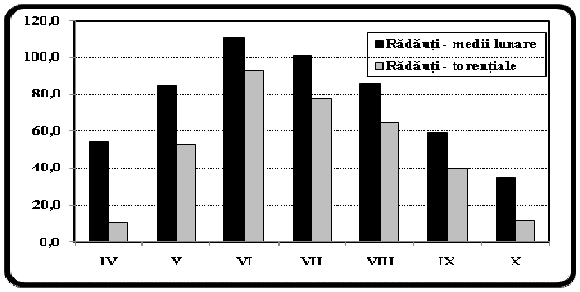
The detailed study of the IMI durations during the rains shows us that the large majority (over 70%) of them lasts less than 10 min (tab. 2).

A significant part (over 50% of the intervals with maximum intensity) has the duration of less than 5 minutes, and a percentage no less important (between 5 and 15%), valid for the months June-July, is held by the intervals with high intensities, but with durations of less than 1 minute.

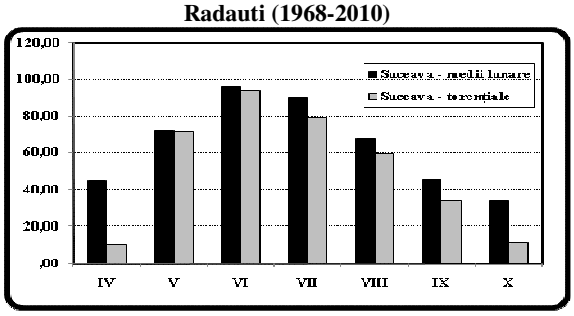
Yet, a small part of them can exceed 60 minutes, case in which confound themselves with the rains (tab. 2).

The quantities of precipitations fallen during the torrential rains (PpR) and during the intervals with maximum intensity (PpIMI). During the hot season of the year, from April until June, the monthly quantities of precipitations increase, reaching the seasonal and the annual maximum in the month of the summer solstice (fig. 6) when are met the conditions most favourable to the precipitating: intense frontal activity sustained by active thermoconvective processes and numerous and consistent sources of evaporation and perspiration.

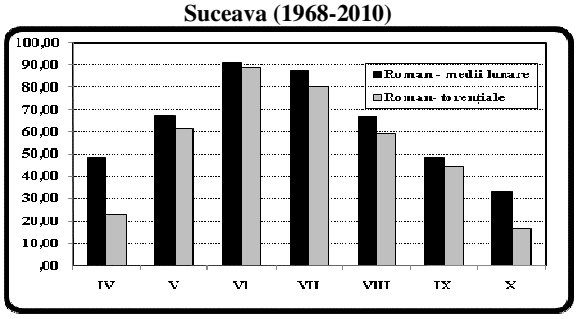
In the months subsequent to the summer solstice (July-October) the monthly amounts of precipitations are continuously declining, one of the most important causes of this decrease being the increase, above the Plateau of Suceava, of the temporal share of the anticyclone time type, with the reducing of the precipitations quantities resulted from frontal cloud systems, the precipitating being usually generated by thermoconvective cloud systems, which yet do not succeed to compensate the pluviometric contribution of the first ones.



Radauti (1968-2010)



Suceava (1968-2010)



Roman (1968-2010)

Fig. 6. The seasonal regime of the monthly average precipitations and of those derived only from torrential rains

Very relevant is the fact that as we approach the middle of the hot season the share of the torrential precipitations within the total ones increases very much. The precipitating has a profound torrential character and from here arises the necessity of keeping the flow control by protecting the afforested and grassy areas, especially on the terrains with steep slopes.

During a rain, in the Plateau of Suceava fall on average 7,2mm of water.

The average quantity of precipitations fallen during a rain increases from the north-west of the plateau (Radauti – 6,7mm) to the centre (Suceava – 7,1mm) and to the south-east of the subunit (Roman – 7,7mm).

The statistical data (tab. 3) show us that from one month to another there isn't a net differentation between the average quantities of precipitations fallen (these vary between 5,2mm as average for a rain for the month of April at Radauti and 9,7mm as average for a rain for the month of July at Roman).

Tab. 3. The average quantities of precipitations fallen during a rain (1968-2010)

Station	A	M	J	J	A	S	O
Radauti	5,2	6,1	8,0	6,9	7,0	5,7	8,0
Suceava	6,1	7,8	7,4	6,9	5,7	7,1	8,5
Roman	5,9	6,9	8,6	9,7	6,9	7,1	8,9
Tg. Neamt	7,5	5,9	6,7	6,6	6,6	9,1	6,3

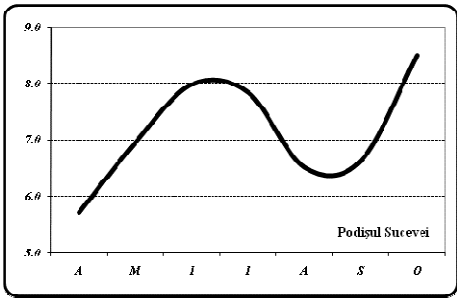


Fig. 7. The seasonal regime of the average quantities of precipitations (mm) fallen duringa rain on the whole of the Plateau of Suceava (1968-2010)

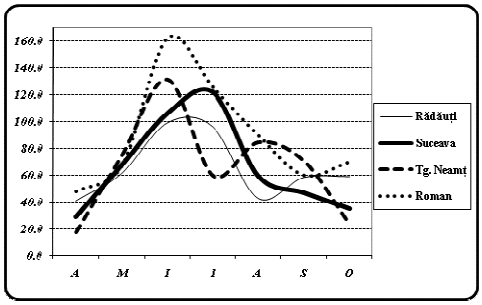


Fig. 8. The seasonal regime of the maximum quantities of precipitations fallen during a rain (1968-2010)

On the whole of the Plateau of Suceava the quantities of precipitations fallen during a rain (fig. 7) increase from the month of April (5,7mm) until the month of June (8,0mm) when they reach a main seasonal maximum, then decrease until the

months August-September (6,5, respectively 6,6mm), then increase again in the month of October (8,5mm).

The reduced quantities of precipitations for a rain from the month of April can be explained by the fact that both the frontal and the thermoconvective processes rarely generate Cumulo-nimbus clouds which to give birth to some consistent rains.

In the months August-September the anticyclonic time and especially the diminution of the evapotranspirating sources make that the hygric deficit from atmosphere to be very high, the quantities of water from the cloud masses to be reduced (even though the thermoconvective processes are ample) and, in consequence, the rains to give on average more reduced quantities of precipitations.

In June are met the best conditions for the precipitations formation, and in the month of October the stratiform clouds give calm rains, of long duration, quantitatively richer.

Unlike the averages, the real quantities of precipitations fallen during a rain can be much larger. The rains give the largest quantities of water in the interval June-July (fig. 8).

Tab. 4. The frequency of the quantities of precipitations come from rains on valoric intervals (mm) at:

a. Radauti (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤10mm	**87,7**	**84,9**	**77,4**	**75,4**	**72,0**	**85,1**	**58,5**
10,1-20mm	9,3	11,4	11,9	19,2	23,9	8,7	35,6
20,1-30mm	1,4	2,3	8,3	4,1	2,9	4,5	5,0
30,1-60mm	1,6	1,2	1,8	1,1	1,2	1,7	1,0
60,1-100mm		0,3	0,6	0,2			
>100mm							

Suceava (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤10mm	**84,4**	**79,9**	**74,4**	**75,0**	**82,6**	**80,5**	**64,2**
10,1-20mm	7,6	9,1	19,0	21,7	13,3	9,6	30,2
20,1-30mm	8,0	6,6	3,9	1,4	1,6	6,7	2,5
30,1-60mm		2,5	1,8	1,4	2,4	3,1	3,2
60,1-100mm		1,8	0,8	0,3			
>100mm			0,2	0,1			

Roman (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
≤10mm	**82,3**	**78,0**	**75,5**	**76,6**	**81,8**	**83,8**	**70,4**
10,1-20mm	15,3	15,9	15,0	14,0	8,1	9,9	24,5
20,1-30mm	1,3	3,8	2,5	2,0	7,8	3,1	2,0
30,1-60mm	1,1	1,4	6,1	6,5	1,9	2,8	2,4
60,1-100mm		0,9	0,8	0,7	0,5	0,4	0,8
>100mm			0,1	0,2			

The largest quantities of precipitations during a rain rose at: 99,2mm in the interval 17-18-19.06.1985 at Radauti, 122,0mm in the period 11-14.07.1969 at Suceava and at 162,3mm between 17-18.06.1985 at Roman (fig. 8). A much more complete picture of the quantities of precipitations fallen during the rains is illustrated in tab. 4.

The largest share (over 90%) is held by the rains which give quantities of precipitations of less than 20mm.

Among them, the rains that bring precipitations ≤ of 10mm are dominant (between 58,5 and 87,7% depending of the month or station which we refer to).

The rains that give quantities of precipitations ≥ of 20mm hold a share of maximum 10% (their share approaches this limit in the interval June-August). In rare situations during a rain (must be remembered the fact that a rain can last even 2-3 days) the quantities of precipitations can exceed the limit of 100mm. As we move from the north-west to the south-east of the plateau, this aspect becomes more and more common, the pluviometry accentuating its quantitative variability.

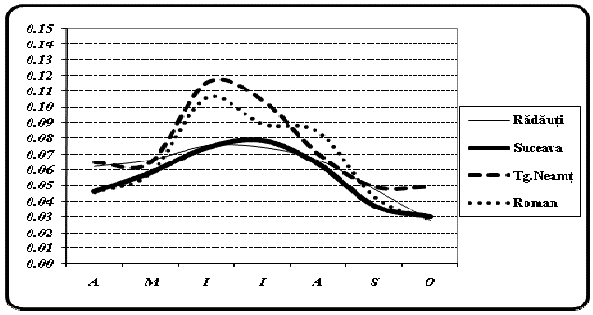


Fig. 9. The seasonal course of the rains average intensities (1968-2010)

The intensity of the rains (IR) and of the most significant sequences from their time (IIMI).

The IR (expressed in mm/m^2/min) is a pluviometric parameter with different practical valences. In the continental or with continental influence climates this parameter highly fluctuates in value, over time.

In the Plateau of Suceava the average intensity of a rain has, on the whole, the value of 0,06mm/min. In the interval June-August the values of the rains intensity usually rise above the average, and in the months April-May and September-October decrease below the average mentioned. It can be observed (fig. 9) the fact that, at Roman, in the months June-August, the values of the rains intensity are superior to both those from Radauti and Suceava.

The averaged maximum intensities of the rains from the Plateau of Suceava converge to the value of 0,34mm/min.

According to the parameters: the average intensity of the rains (noted with **i**) and the average maximum intensity (noted with **I**), Octavia Bogdan and Elena Niculescu (1999), Octavia Bogdan (2002), Octavia Bogdan and I. Marinica (2007)

enclose the Plateau of Suceava on the stage of medium vulnerability in relation to the intensity of the summer rains.

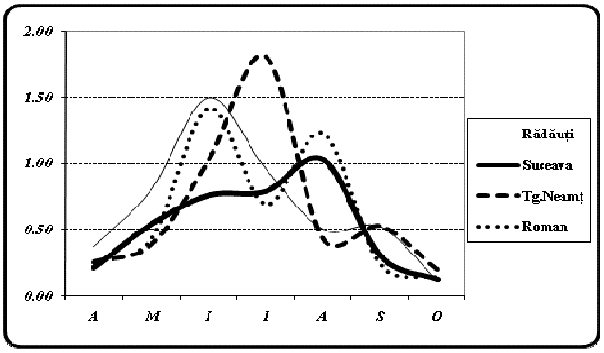


Fig. 10. The seasonal course of the rains maximum intensities (1968-2010)

According to our data (i=0,06mm/min, I=0,34mm/min) and adopting the ranking of the Romanian territory on different stages of vulnerability for the summer rains intensity, propounded by Octavia Bogdan et al., we have obtained as result the enclosing of the Plateau of Suceava on the stage of high vulnerability in relation to these phenomena.

The maximum intensities of the rains (fig. 10) exceeded at all the three stations, during the interval June-August, the limit of 1mm/min (1,50mm/min in June 1971 at Radauti; 1,03mm/min in August 1971 at Suceava; 1,42mm/min in June 1983 at Roman).

The frequency of the rains with intensities between certain limits (tab. 5a-c) shows us that over 70% of them do not exceed the limit of 0,10mm/min.

Yet, as we get closer to the summer months, the rains gain higher and higher intensities that exceed the limits of 0,5 and even 1,0mm/min. Such cases, even though they are rare, constitute themselves as violent pluviometric episodes and most often detrimental.

And the evolution of the averaged intensities of the most significant sequences during the rains shows us (fig. 11) that the summer months represent the temporal interval that is the most propitious to the manifestation of some pluviometric peaks with great intensities (over 0,30mm/min).

Much more edifying for the Plateau of Suceava pluviometry are the cases in which the precipitating intensity has reached the maximum for each month and station in part (fig. 12).

In Radauti the maximum intensity of the precipitating has reached at 4,7mm/min. This peak of intensity took place on 7.VII.1970 during a rain that had

the average intensity of 0,27mm/min, started at 22^{18} hours, lasted 19 minutes, time interval in which fell 5,2mm of water. The peak occurred for 1 minute starting with 22^{31} hours.

Tab. 5. The frequency of the rains with intensities comprised between certain limits

a. Radauti (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
0,01	15,2	5,1	2,7	1,8	2,6	4,7	15,6
0,02-0,03	17,1	37,0	35,5	23,0	23,6	42,2	66,4
0,04-0,05	36,3	17,4	23,6	29,7	31,3	27,4	10,5
0,06-0,10	17,6	29,3	20,4	32,0	30,0	21,9	6,5
0,11-0,20	10,6	5,2	10,7	7,6	9,3	3,1	1,0
0,21-0,30	1,6	3,8	4,6	4,5	1,4	0,0	
0,31-0,40	1,6	1,1	2,0	0,4	1,0	0,2	
0,41-0,50				0,4	0,9		
0,51-1,00		1,0	0,4	0,6		0,4	
1,01-2,00			0,2				
2,01-3,00							

b. Suceava (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
0,01	10,6	4,2	3,8	2,1	3,5	11,4	8,3
0,02-0,03	35,1	31,7	22,5	28,8	34,5	53,8	63,9
0,04-0,05	29,6	32,0	36,6	21,4	23,5	19,1	22,7
0,06-0,10	17,9	20,5	22,3	30,9	27,6	12,6	3,2
0,11-0,20	5,4	8,4	9,1	11,9	8,4	2,5	1,8
0,21-0,30	1,4	2,0	2,2	2,1	0,5	0,7	
0,31-0,40		0,9	1,4	1,3	1,0		
0,41-0,50		0,2	1,5	0,8	0,3		
0,51-1,00		0,2	0,6	0,7	0,3		
1,01-2,00					0,3		
2,01-3,00							

c. Roman (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
0,01	14,1	10,0	3,3	8,9	1,4	9,9	27,1
0,02-0,03	36,8	29,5	21,9	24,5	28,7	35,9	50,1
0,04-0,05	29,2	34,1	23,8	20,6	37,2	32,9	17,1
0,06-0,10	14,6	15,3	23,5	24,2	16,2	19,2	4,9
0,11-0,20	5,6	5,4	16,8	11,4	9,2	1,8	0,8
0,21-0,30	1,4	4,6	4,9	4,9	2,2	0,2	
0,31-0,40		0,8	1,9	2,6	1,3		
0,41-0,50		0,2	1,6	1,3	0,3		
0,51-1,00			1,7	1,6	3,3		
1,01-2,00			0,8		0,3		
2,01-3,00							

For Suceava the episode with the highest pluviosity level occurred on 14.VII.1989. It included itself in a rain with the average intensity of 0,36mm/min, which started at 15^{43} hours, lasted 42 minutes, time in which fell 15,3mm. During this rain, for 1 minute, starting with 15^{47} hours, the intensity reached the limit of 5,9mm.

In Roman the absolute maximum intensity of the precipitating has risen even to a higher level (7,4mm/min). This took place on 20.VI.1994. The rain from that date had an average intensity of 0,26mm/min. It started at 17^{23} hours, lasted 37 minutes during which it precipitated 9,7mm of water. The rain peak of intensity occurred at its debut – 17^{23} and lasted only one minute.

The precipitations intensity maximums from the Plateau of Suceava increase in value on the direction north-west – south-east. To east, in the Plain of Moldavia,

at the same time with the climate continentalization, the precipitations intensity increases significantly (9,1mm/min at Dorohoi, on 31.VII.1985 in the interval 13^{10} and 13^{11}, 9,0mm/min at Botosani on 11.VIII.1999 between 15^{12} and 15^{13}, 8,8mm/min at Rauseni on 26.VII.1998 between 16^{15} and 16^{16} etc. – D. Mihaila, 2006) and towards west (the Ridgelines of Bukovina, Mountains of Stanisoara) and south-west (the Subcarpathians of Moldavia) the pluviometry characteristics change (against the background of the precipitations increase in intensity and quantity, the duration of the episodes with maximum pluviosity increases too, at 2-10 minutes; for example: in Tg. Neamt the maximum intensity reached the value of 4,8mm/min for 4 minutes).

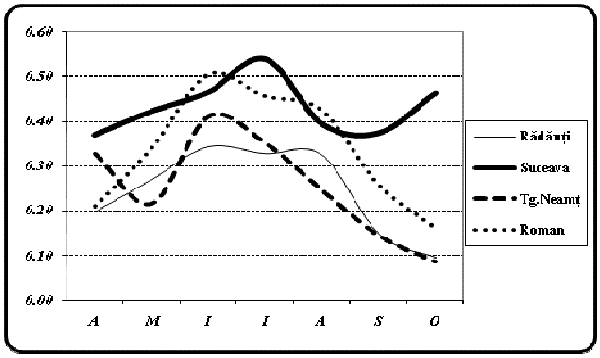


Fig. 11. The seasonal course of the averaged intensities of the most significant sequences during the rains (1968-2010)

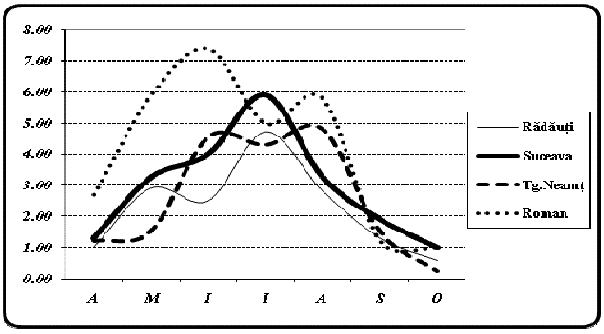


Fig. 12. The seasonal course of the maximum intensities of the most significant sequences during the rains (1968-2010)

Another parameter analyzed is the one of the frequency of the precipitations with maximum intensities comprised between certain limits (for IMI during R).

The data included in tab. 6 show us the increasingly larger development , as a harmonic, of the intensity of the torrential or with sudden showers episodes as we get closer to the middle of the hot season.

The knowledge of these statistical information is absolutely necessary for the hydrologist, hydrotechnician, geomorphological, pedologist, constructor, fitting up and I.E.S. specialists etc.

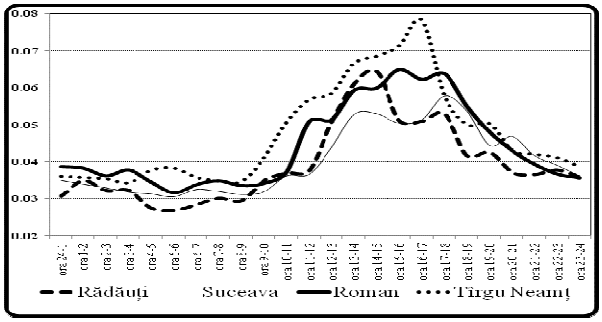


Fig. 13. The diurnal evolution of the IR averages on hourly intervals in the hot season (1968-2010)

The diurnal evolution of the average intensities (fig. 13) and maximum intensities (fig. 14) of the rains shows us that in the night time the precipitating usually occurs at parameters appreciably more reduced than in the daytime.

Both the medium and the maximum intensities present a visible increase in value as we get close to the midday; yet, they do not reach the maximum in that moment, but after 3-5 hours from the Sun crossing over the meridian of the place. By evening, the precipitating intensity gradually reduces itself.

During the afternoons the thermo-hygro-baric processes from atmosphere are very dynamic. Their dynamism is argued by the very sinuous course of the curves of the rains maximum intensities (fig. 15). However, neither the evenings, nights and mornings are not totally lacked of pluviometric convulsions.

Much more obvious (fig. 15) are these „flare-ups" in the case of the IMI during the R.

In the case of this parameter too, the highest intensities of the precipitating occur in the afternoon, on a more exteended interval of time (ranging between noon and midnight).

The nights of the hot season are not lacked of sudden showers and torrential rains, only that their intensity does not raise itself to the one of the similar episodes from the daytime.

Tab. 6. The frequency of the precipitations with maximum intensities between certain limits (for IMI)

a. Radauti (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
0,01		2,2	0,8	0,3	0,5	3,3	
0,02-0,03	1,4	2,1	7,2	3,2	1,8	12,3	1,6
0,04-0,05	4,6	2,7	3,4	5,5	4,9	14,9	*15,5*
0,06-0,10	**31,4**	*22,2*	*14,5*	**20,8**	**20,7**	**33,0**	**65,2**
0,11-0,20	*28,8*	**38,8**	**26,7**	*20,3*	*20,2*	*17,2*	14,6
0,21-0,30	19,3	9,8	9,6	18,1	11,3	8,6	2,0
0,31-0,40	6,3	6,2	12,6	6,2	17,1	4,6	0,0
0,41-0,50	1,4	3,4	4,9	8,2	11,3	1,3	0,0
0,51-1,00	6,8	9,6	*14,5*	11,8	8,6	3,9	1,0
1,01-2,00		2,1	5,1	5,0	3,1	0,9	
2,01-3,00		0,9	0,6	0,0	0,5		
3,01-4,00				0,5			
4,01-5,00				0,1			
5,01-6,00							

b. Suceava (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
0,01							
0,02-0,03							
0,04-0,05							
0,06-0,10	11,2	9,1	11,4	3,6	5,9	16,5	10,1
0,11-0,20	**33,9**	**32,2**	16,3	16,2	**27,8**	20,6	*21,2*
0,21-0,30	*19,1*	12,9	*20,2*	*17,6*	*26,0*	*21,0*	12,5
0,31-0,40	4,9	9,7	17,5	11,7	12,2	7,1	3,5
0,41-0,50	8,3	7,1	5,9	8,0	5,0	9,1	5,4
0,51-1,00	18,6	*24,8*	**21,2**	**36,3**	19,3	**23,7**	**47,3**
1,01-2,00	4,0	3,7	6,5	5,6	3,5	2,0	
2,01-3,00		0,4	0,8	0,9	0,1		
3,01-4,00		0,2	0,3	0,1	0,1		
4,01-5,00							

c. Roman (1968-2010)

Month	April	May	June	July	Aug	Sept	Oct
0,01	4,6	3,2	0,6	6,3	0,4	5,4	7,4
0,02-0,03	4,5	2,2	1,7	2,5	4,6	1,3	4,5
0,04-0,05	14,9	3,7	2,4	3,9	6,3	7,3	2,8
0,06-0,10	**26,8**	*23,4*	16,1	*13,5*	**22,8**	**31,1**	**46,0**
0,11-0,20	*24,0*	**30,3**	**23,6**	**19,5**	*21,5*	*23,1*	*17,4*
0,21-0,30	8,6	13,0	*17,7*	10,9	10,1	8,2	14,2
0,31-0,40	5,1	6,4	7,2	9,7	6,8	6,2	2,8
0,41-0,50	2,2	2,6	6,7	8,5	5,1	2,9	
0,51-1,00	7,6	7,6	13,2	14,9	12,4	7,4	5,0
1,01-2,00	1,2	5,8	6,7	6,9	7,1	7,1	
2,01-3,00	0,5	1,0	1,7	2,8	0,4		
3,01-4,00		0,2	1,0	0,0	0,7		
4,01-5,00		0,2	1,2	0,6	1,6		
5,01-6,00		0,4			0,2		
6,01-7,00							
7,01-8,00			**0,2**				

The highest degree of risk produced by the high intensity of the torrential rains and sudden showers generated by Cumulonimbus clouds places itself, temporally, between the 14^{00}-19^{00} hours. Yet, the statistical reality illustrates that the risk induced by these neficial, thundery, pluviometric and dynamic manifestations that

accompany the Cb clouds are really dangerous in the night time too, by the fact that they mostly catch the human communities unprepared.

The case of the torrential precipitations from Arbore area in the evening of 30 June 2006 in which the levels of some insignificant brooks as Saca and Clit increased very much causing 12 deaths and considerable damages (D. Mihaila et al., 2006) is maybe the most edifying through consequences.

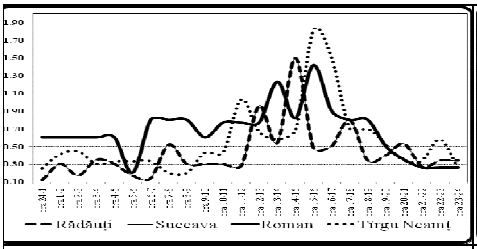


Fig. 14. The diurnal evolution of the highest IR on hourly intervals in the hot season (1968-2010)

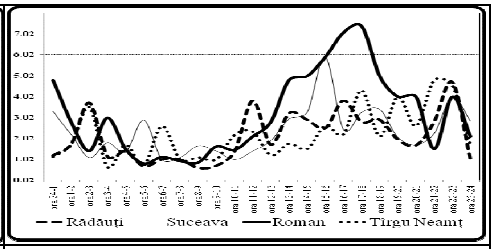


Fig. 15. The diurnal evolutin of the IMI highest values during R on hourly intervals during the hot season (1968-2010)

The isopleths of the rains average intensities (fig. 16) from the Plateau of Suceava clearly show us several aspects:

- during a year the interval of time most favorable to the production of some rains with average intensity with higher values (over 0,05mm/min) has at the one of extremities the half of April and at the other the half or even the end of August,
- during a day, the processes of convective nature that generate rains with average intensity with high values start after 11^{00} hours and fade gradually at nightfall (Radauti) or by the midnight (Suceava, Roman) at the end of June, in July and at the beginning of August,
- at Roman station, the isopleth representation illustrates that the rains with an average intensity over 0,05mm can have an almost continuous diurnal manifestation, both in the day and night time, starting with the 2nd decade of June until the beginning of August,
- nuclei of the rains with average intensity over 0,1mm/min appear statistically in south-east at Roman starting with 11^{00} hours of the days from the months July-August and till 18^{00} hours, in the northern half, at Suceava, between 13^{00}-14^{00} hours and in north-west at Radauti only around 14^{30} hours; but at Suceava and especially at Radauti the statistics shows that the intervals with medium intensity during the rains which exceed the level of 0,1mm/min are limited to a less significant temporal frame of manifestation,
- at Tg. Neamt in the Subcarpathians of Moldavia, the situation is similar to the one from Roman, with the specification that in the first location the rains have

values of the average intensity higher at the debut in the hot season, in the afternoon hours from the days of the months April-May, intensities generated probably by the turbulences of the air dynamics at the advection over the Carpathian peaks to east.

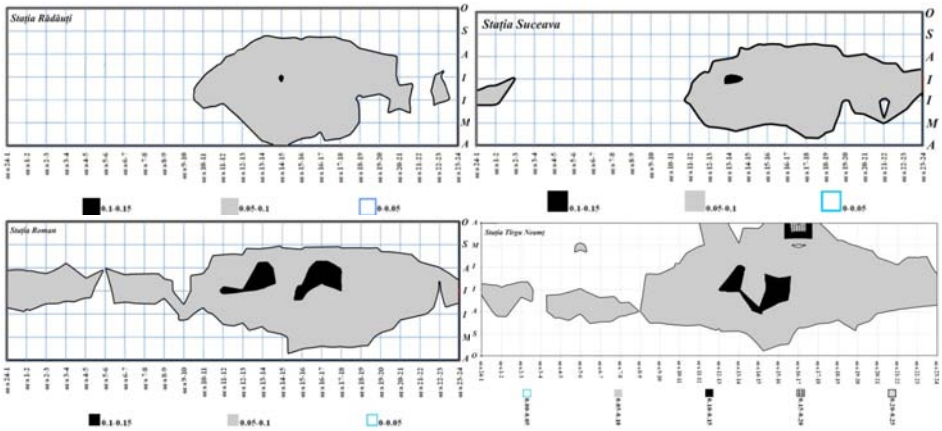


Fig. 16. The isopleths of the rains medium intensities on hourly intervals in the hot season at the meteorological stations from the Plateau of Suceava and at Tg. Neamt (1968-2010)

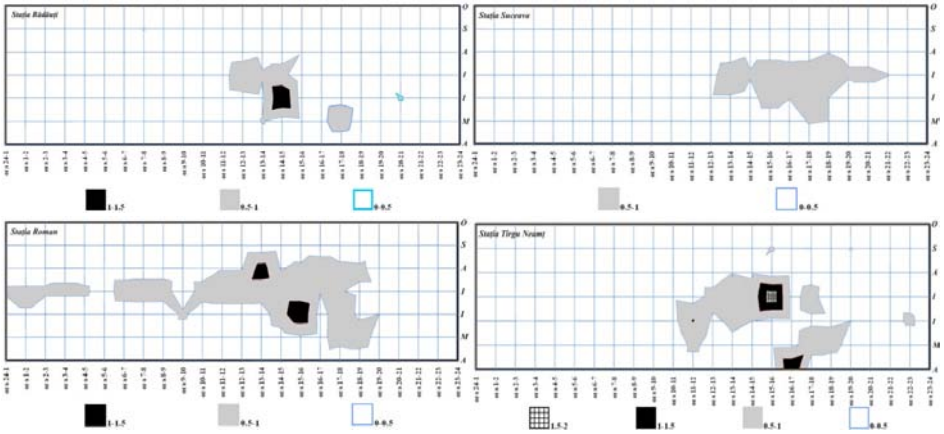


Fig. 17. The isopleths of the rains highest intensities on hourly intervals in the hot season at the meteorological stations from the Plateau of Suceava and at Tg. Neamt (1968-2010)

The isopleths of the rains highest intensities (fig. 17), confirm those already noted above (with the inherent differences between stations), but at a superior value scale, considering the fact that in this situation we are operating only with the

most significant cases extracted from among the rains. So, we remark that in the plateau only immediately after the Sun crossing at the meridian of the place and only in the interval June-August may occur rainfalls whose maximum intensity exceeds the limit of 1mm/min (at Tg. Neamt in the Subcarpathian area, the rains on the whole have intensities that, according to the statistics, may exceed the limit of 1,5mm/min – fig. 17). During the evening, night and morning, in the months April-May and August-October (with small exceptions at Roman) the rains do not usually get to maximum intensities which to exceed the limit of 0,5mm/min.

During the torrential rains, in the summer days, in the afternoon, in certain intervals (that rarely last for a few minutes) take place sequences of the precipitating with a great intensity, which can exceed the limit of 4mm/min at Radauti and Suceava or of 6mm/min at Roman (fig. 18).

The intensity and frequency of these sequences increase from the north-west to the south-east of the plateau. The example of Roman station is very edifying in this respect.

The isopleths representations from fig. 16, 17 and 18 that devolve an enormous volume of data and in front of whose achievement many researches disarm, present for all those involved in the activities that take place in the nature (agronomists, pedologists, foresters, hydrologists, builders etc.) a real and practical importance, one facet of the pluviometry of an area which must be taken into account in everything they do.

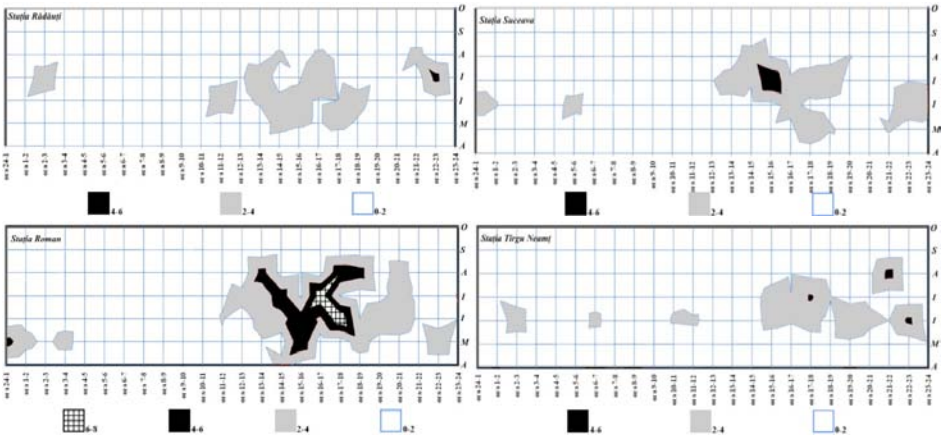


Fig. 18. The isopleths of the highest values of the sequences with maximum intensity (IMI) during the torrential rains on hourly intervals in the hot season at the meteorological stations from the Plateau of Suceava and at Tg. Neamt (1968-2010)

Conclusions

The synthesis of the analysis regarding the particularities of the precipitating in the Plateau of Suceava allows us to draw a few conclusions.

In the interval V-IX, in the Plateau of Suceava, the monthly number of rains (NR) exceeds on average 10 units; the months V-VI detach themselves when this parameter reaches the seasonal maximum (≈ 15 units). In these months the possibility for periods of drought to install and produce themselves is a reduced one.

The average duration of a rain (DR) from the subunit studied is of 206 minutes (oscillating between 133 minutes in July and 356 minutes in October). The maximum duration of a rain extended itself up to 3440 minutes (the rain from 25-27.V.1991 at Roman).

The IMI during the rains last on average (DIMI) 21 minutes (varying between a minimum in the months VII-VIII ÷ 11 respectively 10 minutes and a maximum in the months IX-X ÷ 47, respectively 34 minutes).

One rain brings an average pluviometric contribution (PpR) of 7,2 mm of water (the rains from the months VII and X give the richest quantities of water ÷ 8,0-8,5mm, and those from the months IV and VIII-IX the most reduced ÷ 5,7 respectively 6,5-6,6mm). From agricultural point of view we can appreciate that these pluviometric episodes include themselves, with small amendments, in the limits of the efficiency for plants.

Yet, the largest quantities of precipitations fallen during a rain rose up to 162,3mm (Roman, 17-18.VI.1985). Such quantities, generated by frontal cloud systems, usually end in excess of humidity, intense washes of the soil in surface, with the violent reactivation of the torrential bodies, overflowings and floods and, in the end, with material damages and with victims.

The average intensity of a rain (IR) has, on the whole, the value of 0,06mm/min. The maximum intensity averaged rises at the value of 0,34mm/min, including the Plateau of Suceava on the stage of high vulnerability in relation to these phenomena. The seasonal maximum of these parameters value is usually reached in the months June-July.

The IMI intensities have risen at 4,7mm/min at Radauti, 5,9mm/min at Suceava and 7,4mm/min at Roman. The values (to which are added those of the maximum precipities) should determine those responsible with the hydrotechnical arrangement of this territory to take concrete measures which to aim the control of the flow in the hydrographic basins of various orders.

Both the medium and maximum intensities of the rains and also the maximum intensities of the IMI occur at about 3-5 hours after the Sun crossing at the meridian of the place. The episodes with sudden showers are not excluded to occur

during the night, these manifestations being even more dangerous because they take the human communities by surprise.

In the Plateau of Suceava can be observed, according to the data, that the precipitations intensity (with the afferent parameters) becomes increasingly higher: a) as we get closer to the noon hours and especially to the afternoon ones and to the months July-August, b) from the north-west of the plateau (Radauti) to its south-east (Roman).

By drawing up the matrices of correlation between the parameters of the rains (R) and between those of the intervals with maximum intensity during them (IMI) we could remark, among other things: in the case of the rains (R) the existance of a strong negative correlation (-0,95) between the parameter DR (the duration of the rains) and IR (the intensity of the rains), and in the case of the IMI also the existance of a strong negative correlation (-0,78) between DIMI (the duration of the intervals with maximum intensity) and MaxIMI (the maximum of the intensity of the intervals with maximum intensity).

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