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SOME ASPECTS OF THE MOISTURE EXCESS IN THE WHITE CRIS LANE

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Résumé: ***Certains aspects de l`excès d`humidité dans le couloir dépressionnaire de Crisul Alb.*** Cet ouvrage présente l`excédent de précipitations comme un phénomène climatique de risque dans le couloir de Crişul Alb basée sur les données de stations météorologiques Ineu, Gurahonţ et Ţebea au cours de 1970-2006. On analyse la fréquence pour le type de temps avec excédent pluviométrique après le critère Hellman et après l`Anomalie Normalisée de Précipitations. De cette analyse résulte que les anomalies positives de précipitations ont une fréquence de 43-48%, avec une augmentation de l`excès de précipitations de l`est vers l`ouest du couloir et une fréquence des années très humides (critère Hellman) entre 5-14 %. L`Anomalie Normaliseé de Précipitations indique une fréquence des années extrêmement humides entre 5-14 %, plus élevée en ouest du couloir, et un seul an, à une seule station, extraordinaire humide (Ţebea, 2001).

Mots-clés: excédent, précipitations, couloir, Crişul Alb

Introduction

Excess rainfall is generated by meteorological factors which are related to the dynamics of the atmosphere and can be maintained by the active surface. The excess moisture appears frequently in the case of the interaction of two air masses with different characteristics. As termico-baric contrast between air masses is higher, precipitations are more abundant. The analyse of the excess of moisture from the White Criş passage is based on the interpretation of data from meteorological stations located in the corridor: Ineu, Gurahonţ and Ţebea and for comparison we used data from the stations located near the lane: Chisineu Criş in the plain area and Şiria in the hilly area.

1. Unperiodical variation of precipitations and their positive deviation

To distinguish the magnitude of the moisture excess and succession of periods with precipitations excess we have calculated the amount of positive deviation of annual values, warm season values and monthly values compared to the multi-annual average, considerate as normal.

From the total amount of 37 years taken into consideration (period 1970-2006) the years with excess moisture represented less than 50 %. As we submit into the interior of the lane, from west to east, the frequency of the years with precipitation excess falls from 48,6 % at Ineu to 45,9% at Gurahonţ and 43,2 % at Ţebea.

Comparatively at the stations located outside the lane, the years with precipitation excess had a little higher frequency: 49 % at Chişineu Criş, in the plain area and 56,5 % at Şiria in the hilly area.

The values of the positive deviation were approximately equal to those of negative deviation being between +24,8 mm (1975) and +227,7 mm (1999) at Ineu, between +3,4

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mm (1973) and +258,8 mm (2005) at Gurahonț and between +24,2 mm (1977) and +244,6 mm (2001) at Țebea.

The analyse of the multiannual variation of the rainfall amounts indicates two intervals with precipitations excess: 1970-1980 and 1995-2006.

The highest amounts of precipitation and their deviation from the normal are presented in table 1.

The highest annual amounts of precipitation and their positive deviation

Table 1

Station	Year	Precipitations (mm)	Deviation (mm)	Multi-annual average (mm)
Ineu	1999	878,6	+227,7	650,9
	1970	868,0	+217,1	
	1974	859,2	+208,3	
	2004	852,6	+201,7	
	1991	840,4	+189,5	
	2001	823,7	+172,8	
Gurahonț	2005	996,2	+258,8	737,4
	1970	994,8	+257,4	
	2001	976,4	+239,0	
	2004	967,5	+230,1	
	1999	888,1	+150,7	
Țebea	2001	951,9	+244,6	707,3
	1970	901,6	+194,3	
	1981	896,2	+188,9	

In the table were noted those annual quantity of precipitation which have exceeded 150 mm over the normal values. We can see that the number of years that have been recorded these amounts is bigger at the stations located inside the lane, than the years in which precipitation was more than 100 mm lower than normal values. The largest amount of rainfall exceeded the normal values with 135% at all three stations located inside the lane of Crişul Alb river, while in the plain area located outside the lane, the larges amount of rainfall exceeded the normal value with 140%, but here the number of years with precipitation that exceeded with more than 100 mm the normal values was lower.

The greatest amounts of precipitation have fallen in different years but all in the last decade of the analyzed period: 1999 at Ineu, 2001 at Țebea and 2005 at Gurahonț.

The highest annual amount of rainfall registered in the corridor of Crişul Alb river in 1970-2006 period was 996,2 mm at Gurahonț in 2005.

2. Frequency of the periods with precipitation surplus (consecutive years)

The years with excess rainfall are grouped in periods with precipitations surplus which increase the risk of those phenomena's (table 2).

The frequency of the periods with precipitation surplus with different durations (consecutive years)

Table 2

Station	period								Total periods	Total years
	2	3	4	5	6	7	8	9		
Ineu	1	1	0	2	0	0	0	0	4	15
Gurahonț	1	2	0	1	0	0	0	0	4	12
Țebea	0	2	0	1	0	0	0	0	3	11
Chişineu Criş	2	1	0	0	1	0	0	0	4	13
Şiria	0	2	0	1	0	0	0	0	3	11

The most common are the short periods of 2-3 consecutive years. The long periods are less and cover a shorter interval than the periods with precipitations deficit. The longest

period with excess rainfall, inside the corridor, is 5 years. There appear two such periods at Ineu and one at Gurahonț and Țebea. Outside the corridor the longest period with excess rainfall cover an interval from six years at Chisineu Criș.

The periods with precipitation surplus, in consecutive years, with different duration, are noted, for the three stations located inside de corridor of Crişul Alb in table 3.

The surplus precipitations periods with different duration (consecutive years) 1970-2006

Table 3

Station/period	2 years	3 years	5 years
Ineu	1974- 1975	2004 - 2006	1977 – 1981 1995 – 1999
Gurahonț	1973 - 1974	1995 – 1997 2004 - 2006	1977 - 1981
Țebea	/	1995 – 1997 2004 - 2006	1977 - 1981

The most numerous periods with excess rainfall was recorded in the west part of the lane – four periods, while in the east part of the lane were recorded three periods with excess rainfall.

The number of consecutive years grouped in excess rainfall periods is less than the number of years grouped in periods with rainfall deficit and decreases from west to east: 15 years at Ineu and 11 at Țebea.

3. The frequency of the singular years with precipitation surplus

The excess rainfall periods are interrupted by deficit or normal rainfall periods, inside of which appear singular years with excess rainfall. In table 4 were note the singular years in which excess rainfall exceeded the normal values with 100 mm.

The singular years with rainfall excess (1970-2006)

Table 4

Station	Year	Deviation (mm)
Ineu	1970	+217,1
	1991	+189,5
	2001	+172,8
Gurahonț	1970	+257,4
	1999	+150,7
	2001	+239,0
Țebea	1970	+194,3
	1974	+144,7
	1999	+115,2
	2001	+244,6

The number of singular years with excess rainfall is bigger than that of singular years with rainfall deficit. The number of these years increases from west to the east of the corridor. The years 1970 and 2001 were registered at all three station located inside the corridor as singular years with rainfall excess. In these years the values of the positive deviation were very high: between +1994,3mm at Țebea and +257,4mm at Gurahonț for the year 1970 and between +172,8 mm at Ineu and +244,6 mm at Țebea for the year 2001.

4. The positive rainfall deviation in the warm season (April-September)

The excess moisture in the warm season, during the growing period had negative effects on crops.

In the analysed period the amounts of precipitation in the warm season had higher values between 1970-1980 and 1995-2006.

At the stations located inside the corridor the frequency of the positive rainfall deviations was equal to 43% and the rainy warm season was, at all three stations, the 2001 when the positive deviations exceeded normal values with 149% at Ineu, 154% at Gurahonț and 156 % at Țebea. The greatest amount of precipitation fallen in the warm season during 1970-2006 at the stations located in the lane of White Criş river are noted in table 5.

The highest amounts of precipitation in warm season and their positive deviation

Table 5

Station	Year	Precipitation (mm)	Deviation (mm)
Ineu	2001	582,9	+191,2
	1975	576,9	+185,2
	1974	551,8	+160,1
	1991	546,9	+155,2
Gurahonț	2001	695,4	+244,6
	2005	619,1	+168,3
	1970	606,5	+157,7
Țebea	2001	674,5	+242,5
	1974	569,8	+137,8

In the table were noted those warm semesters in which the excess moisture has exceeded over 100mm the normal values. The frequency of these sessions decreases from west to east in the corridor (from 21, 6 at Ineu to 18, 9% at Gurahonț and 10,7% at Țebea).

5. Positive seasonal deviation of rainfall quantities

To put into better evidence the characteristics of the precipitation regime in the lane of White Criş we analyzed the seasonal deviation. The results of statistical calculations show that the positive, as the negative, deviations values are highest during summer (table 6).

The average positive deviation of the seasonal precipitation **Table 6**

Station	Spring		Summer		Autumn		Winter	
	Average (mm)	Deviation (mm)	Average (mm)	Deviation (mm)	Average (mm)	Deviation (mm)	Average (mm)	Deviation (mm)
Ineu	156,2	+36,1	224,5	+84,0	140,7	+50,4	129,7	+57,1
Gurahonț	182,4	+49,7	256,4	+73,8	158,0	+70,6	140,6	+52,3
Țebea	174,2	+39,1	238,2	+58,3	156,8	+50,6	130,1	+55,4

However, calculating the percentage of those positive deviations we can notice that autumn and winter values (reported on average) are higher- figure 1.

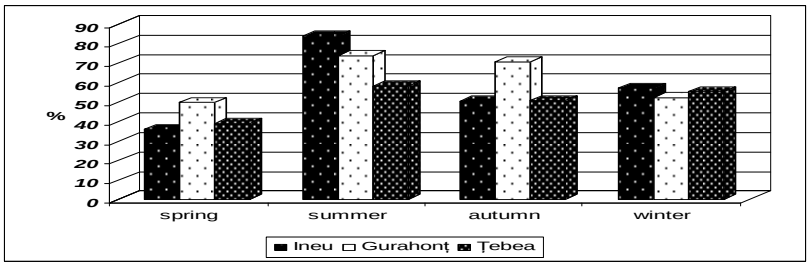

Fig. 1 Seasonal positive deviation (%) reported on average annual amount of precipitation

Spring 2006 was the one in which all three stations recorded an important precipitation surplus which exceeded 100 mm at Gurahonț and Ineu. In the summer, the values that exceeded 100 mm were more common, particularly in the west part of the corridor where at Ineu, the positive deviation in the summer months had the highest values. In autumn the positive deviations that exceeded 100 mm occurred in different years. Gurahonț was the station where they recorded most cases and the largest values. In winter, the number of years with deviations that exceeded 100 mm was lower. Winter 1999 was the one in which all three stations located in the corridor exceeded 100 mm normal values.

6. Frequency of the surplus precipitation type of time under Hellman criterion

We calculated the percentage frequencies of annual and monthly amounts of precipitation to multi-annual average and we established the type of time according to Hellman criterion.

Analyse of annual amounts of precipitation shows that the number of very and excessively wet years decreases from west to east of the lane (table 7).

The frequency of the years with surplus precipitation under Hellman criterion

Table 7

Station		Normal	Moderately wet	Wet	Very wet	Excessively wet
Deviation %		-5,0…5,0	-10,0…-5,1	-15,0…-10,1	-20,0…-15,1	>-20,0
Ineu	Years no.	6	2	0	5	7
	frequency	16,2	5,4	0	13,5	18,9
Gurahonț	Years no.	9	0	4	2	5
	frequency	24,3	0	10,8	5,4	13,5
Țebea	Years no.	8	4	2	4	4
	frequency	21,6	10,8	5,4	10,8	10,8
Chișineu Criș	Years no.	3	2	4	4	6
	frequency	8,1	5,4	10,8	10,8	16,2
Șiria	Years no.	2	3	1	0	7
	frequency	8,6	13,0	4,3	0	30,4

The highest frequency of the excessively wet years appears in the area in contact with the plain, at Ineu, and the lower appears at Țebea. The very wet years have the highest frequency at Ineu to, and the lower at Gurahonț in the middle-lane. Comparatively, at the stations located outside the lane in the west part, the frequency of these years is greater than that at the stations located in the middle and east side of the lane, what is a normal fact due to the predominant Western air masses in the region (figure 2).

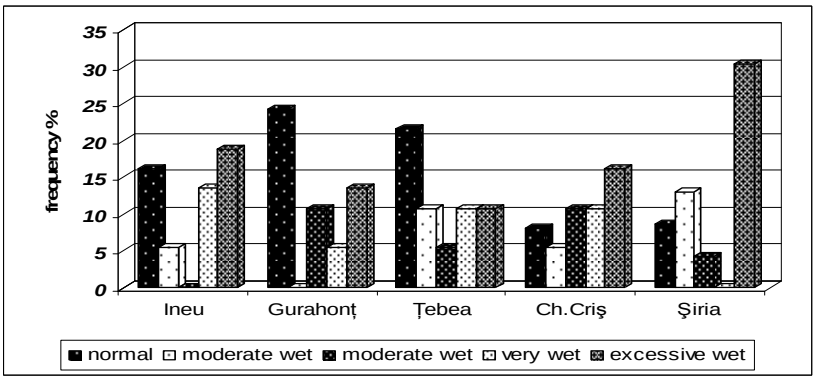

Fig. 2. The frequency of the surplus precipitation type of time according to the Hellman criterion

Generally we observe that the number of years with surplus precipitation is lower than that of years with deficit.

Inside the corridor of White Criş the frequency of the years with surplus precipitation is between 30,0 % at Gurahonț and 37,8 % at Ineu and Țebea (table 8), lower values that those recorded outside the corridor (47,8 % at Şiria and 43,2 % at Chisineu Criş).

Total frequence (%) of years with excess rainfall according the Hellman criterion

Table 8

Epithet of the year	Normal		Excessiv	
Deviation %	-5,0…5,0		>5,0	
Station	Cases number	%	Cases number	%
Chişineu Criş	3	8,1	15	43,2
Ineu	6	16,2	14	37,8
Gurahonț	9	24,0	11	30,0
Țebea	8	21,6	14	37,8
Șiria	2	8,7	11	47,8

Annual growth of precipitation with 15-20 % awarded the qualification very wet or excessively wet to those years in which the growth has occurred.

The very wet and excessively wet years

Table 9

Station	Very wet years		excessively wet years	
	Year	Deviation (%)	Year	Deviation(%)
Ineu	1977 1978 1981 1998 2006	+19,1 +17,6 +15,7 +16,1 +16,1	1970 1974 1980 1991 1999 2001 2004	+33,2 +32,0 +21,4 +29,0 +35,0 +26,5 +31,0
Gurahonț	1974 1981	+18,6 +18,9	1970 1999 2001 2004 2005	+34,9 +20,4 +32,4 +31,2 +35,1
Țebea	1979 1980 1999 2005	+16,5 +19,0 +16,3 +17,4	1970 1974 1981 2001	+27,5 +20,5 +26,7 +34,6
Șiria	/	/	1991 1995 1996 1999 2001 2004 2005	+28,0 +20,3 +32,8 +20,6 +22,2 +25,1 +24,5

The positive deviations of year 1970 (which are part of a series of excess rainfall years- 1969-1973 which affected the entire country) were overcome at the stations in the studied area as follows: in 1999 at Ineu, 2001 at Țebea and 2005 at Gurahonț. It is also interesting to note that the years with the bigger rainfall excess precede or followed the year with the bigger deficit (year 2000).

We could conclude that in recent years the scale of positive or negative rainfall deviation was higher than in previous decades.

The application of the Hellman criterion for the monthly values was made calculating the percentage deviation of monthly precipitation to the normal values. The analyse of the frequency of the months with excess rainfall led to the conclusion that they represent between 35,6 % at Ţebea and 36,9 % at Ineu, lower values than those of the months with precipitation deficit.

The excessively wet months have the highest frequency. They represent between 16, 2 % at Gurahonţ and 19, 1 % at Ineu. In the analyzed area the number of excessively wet months is higher in the west side of the corridor (figure 3). They are followed by the normal months whose frequency is slightly higher at the stations located in the eastern half of the analyzed area than in the west.

In general, moderate wet, wet and very wet months have close frequencies, between 5 an 7 %.

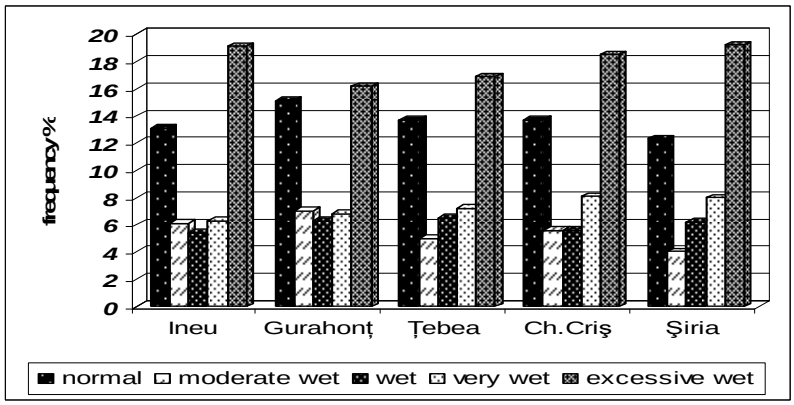

Fig. 3. The frequency of the months with excess moisture (Hellman criterion)

We analyzed in particular the frequency of very wet and excessively wet months.

The frequency of the very wet month decrease from the east to the west part of the corridor of White Criş. The highest frequency is made in different periods of the year. So, at Ţebea the highest frequency of very wet months appears in April and August and at Ineu in March and April.

We observe, like a common element, the high frequency of this type of time in April at all stations located inside the corridor and in August for the stations located in the eastern half of the corridor. January presents fairly high frequency of very wet type of time (between 8, 1 % and 10, 8 %).

The lowest frequencies of this type of time appear in December and February, while at Ineu, October was the month in which this type of time was never observed during the period 1970-2006 (figure 4).

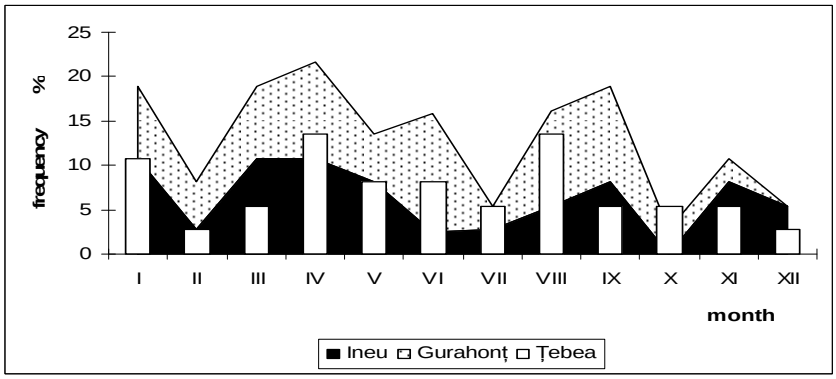

Fig. 4. The frequency (%) of the very wet months at Ineu, Gurahonț and Țebea

Excessively wet months have a bigger frequency that the very wet months. The frequency of these months is higher in the western side of the corridor at Ineu and lower in the middle and eastern side of the corridor. The highest frequency of this type of time appears in the months of autumn especially in October and during the months of transition from winter to spring – February and March.

The lowest frequency of excessively wet type of time appears, at all three stations located inside the corridor, in April (figure 5).

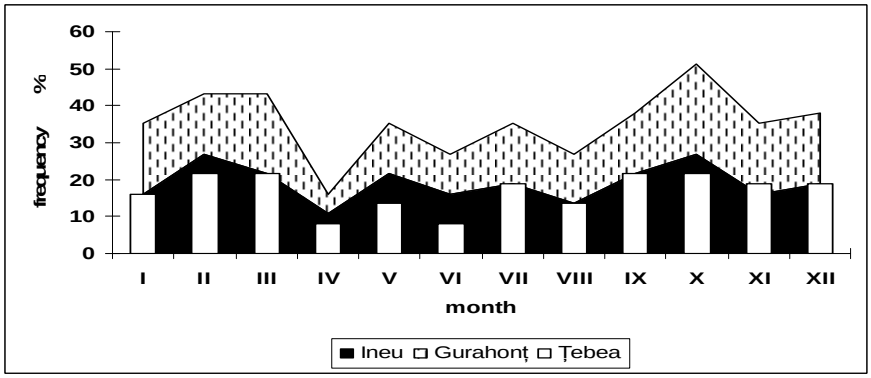

Fig. 5. The frequency (%) of excessively wet months at Ineu, Gurahonț and Țebea

7. Standardized Precipitation Anomaly

Standardized Precipitation Anomaly (SPA) can be used for highlighting rainy periods. We calculated SPA for annual, warm season and monthly precipitation values. They are considered normal periods those in which SPA value is between -0,6 …0,7,wet those with SPA between 0,7…1,4, extremely wet those with SPA between 1,4…2,1 and extraordinary wet those periods in which SPA exceeds 2,1.

Analyse of multi-annual variation of SPA (figure 6) emphasis the existence of two wet periods that overlap the intervals 1970-1980 and 1990-2006.

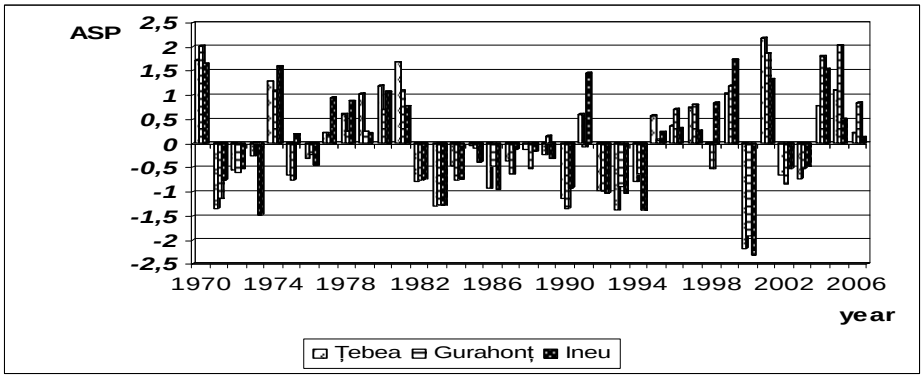

Fig. 6. The annual variation of Standardized Precipitation Anomaly

Most frequent (41%) are the normal years. One single year-2001 at one single station-Ţebea received the qualification extraordinary wet, while the years which received the qualification extremely wet had a frequency between 5% at Ţebea and 14 % at Ineu. So we can notice that the frequency of this years decreases from east to west side of the lane.

The years which receive the grade extremely wet were: at Ineu 1970, 1974, 1991, 1999, 2004; at Gurahonţ 1970, 2001, 2004, 2005; at Ţebea 1970 şi 1981.

The years which receive the grade wet had a higher frequency (19% at Ineu and Ţebea and 16 % at Gurahonţ) (figure 7).

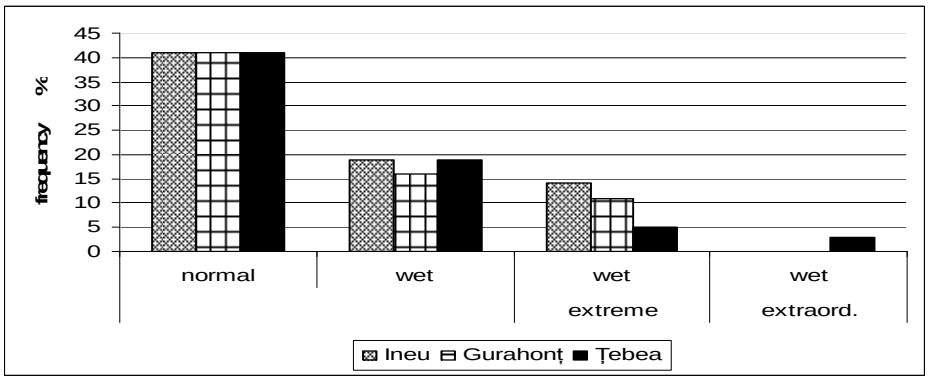

Fig. 7 Frequency (%) of the years whith different characteristics according to SPA

Multi-annual variation of SPA values calculated for the rainfall in the warm season is similar to that of annual precipitation. Normal warm seasons have the highest frequency (slightly higher than the annual values), between 41 % at Ineu and 46 % at Gurahonţ. Only one warm season received the qualificative extraordinary wet. For the 2001 warm season SPA values were 2,5 at Gurahonţ and 2,7 at Ţebea (at Ineu the value was 1,9). The frequency of the warm seasons which received the qualificative extremely wet was between 3 % at Ţebea and 11 % at Ineu. The warm seasons with the qualificative wet had a higher frequency (between 14 % at Gurahonţ and 24 % at Ţebea).

For the monthly precipitation, the highest frequency had the month's considerate normal. July and June have the higher frequency of normal type of time, October and April the lowest.

Extremely wet months had a frequency between 0 and 24 %. Maximum values are characteristic for November at Ineu, while at the stations located inside the lane, the highest frequency for the extremely wet type of time is characteristic for May, July and September (Gurahonț) and July, September (Țebea).

The lowest frequency values for the extremely wet type of time appear in January, April and August.

Apart from extraordinary dry type of time which had a very low frequency, only at Țebea, the extraordinary wet type of time is present at all three stations, with frequencies between 3 and 8% (table 10).

The extremely wet months according to SPA (1970-2006)

Table 10

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Ineu	2003	1970 1999	1988 2001		1991	1970 1974	1975	1975	2001	1974 1991	1977	1981
Gurahonț	1976	1970 1999	1988	2005 2006	1970 1987	1973 1974	1980 2001	1989 2006	2001	1974 2003	1977 2004	1981 1999
Țebea	1976 1987	1970 1978 1999	1988		1974 1984	1974	2001	1989 2006	2001	1974 1992	2004	1981

Conclusions

The analyse of the precipitation positive deviation, emphasis a frequency of excess moisture between 43 and 48%, and the analyse of the positive deviations and the Standardized Precipitation Anomaly showed an increased frequency of the moisture excess from the east to the west side of the White Criş lane. All methods showed a lower duration for the wet periods than for the dry periods, when it is about consecutive years or semesters. Hellman criterion indicated a frequency of the very wet years between 5 and 14 %, higher in the western side of the corridor, and a frequency of the excessively wet years between 11 and 19 %, higher in the western side of the corridor (we observe that both, negative and positive excesses are more common in the western side of the corridor, which it is more widely open to the plain, than the eastern side which is more narrow and more moderate in terms of climate). The Standardised Precipitation Anomaly indicated a frequency of the extremely wet years between 5 and 14 % - higher in the western side of the corridor and a single year, at one single station, extraordinary wet (Țebea 2001).

REFERENCES

Bogdan, Octavia, Niculescu, Elena (1999), *Riscurile climatice din România*, Academia Română, Institutul de Geografie, Bucureşti

Cheval, S., Croitoru, Adina-Eliza, Dragne, Dana, Bălteanu, Dan (2003), *Indici şi metode cantitative utilizate în climatologie*, Editura Universităţii Oradea

Dragotă, Carmen, Măhăra, Ghe. (1997), *Durata efectivă (în ore şi minute) a precipitaţiilor lichide pe teritoriul României*, Analele Univ. Oradea, Seria Geografie, Tom VII, p. 89-95

Pătăchie, Iulia, Călinescu, N. (1986), *Cantităţi excepţionale de precipitaţii înregistrate în sec.XX pe teritoriul României*, Studii şi Cercetări, Meteorologie, Bucureşti, p. 49-57