THE EXCESS OF HUMIDITY AND ITS ASSOCIATED RISKS IN THE REGHIN HILLS

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Abstract. - The excess of humidity and its associated risks in the Reghin Hills. Through its persistence, the excess of humidity can produce a series of natural risks, such as geomorphological, pedological, hydrological and also ecological, each category having a negative impact on the social and economical life.In this paper the focus relies on the analysis of the rain-fall conditions of the Reghin Hills, with a special view on the periods of excess of humidity. For such a purpose we realized an analysis of the main parameters which define the excess of humidity (annual, season and monthly variations in the quantity of rain-fall, the degree of insurance in the different quantities of rain-fall), having as a basis the data recorded between 1978-2008 in the Târgu-Mureş, Eremitu and Gurghiu stations. The establishing of the rain-fall nature for each year, season and month was realized by counting the Standardized Rain-Fall Anomaly.

Keywords: rainfall quantity, humidity excess, natural risks, vulnerability.

1. Introduction

Apparition of pluviometric exceeding periods is the consequence of synoptic situations characterized by low pressure areas that persist over time. The high rainfall quantities from our area that appear in warm season are the result of more intense frontal activities generated by the advection of oceanic moist air masses and by thermal convections. The presence of Oriental Carpathians orographic barrier determines an ascending movement of air masses, their adiabatic cooling and water vapors condensation. These processes generate heavy rainfall in the eastern part of the study area.

High rainfall quantities period from the cold season is determined by cyclonic activity in Mediterranean sector that carries through mobile cyclones warm moist air masses to our country, increasing the appearance of heavy rainfall and thick snow layer, inducing risk situations.

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To determine pluviometric exceeding periods, at first we analyzed the main parameters that define pluviometric regime (annual, seasonal, monthly variations and deviation, assurance degree for various amounts of precipitation); to establish each year and month pluviometric data, we calculated the Precipitation Standard Anomaly (PSA), using data from the pluviomeric regime of the years 1978 – 2008 from Târgu Mureş (φ=46°32', λ=24°32‘,H =308m), Eremitu (φ = 46°40', λ=25°00‘,H =510m) and Gurghiu stations (φ = 46°46', λ=24°51‘, H =415m).

2. Annual variations of rainfall quantities

High territorial variations of annual average rainfall quantities appear on a relative small part of our area. We remark an increase of annual average rainfall quantities from Mureş Corridor to the main submontane area according to the morphometric relief change. In the western part of the area appear annual average rainfall precipitations of 500 – 600 mm (Târgu Mureş), and in the eastern extreme part, near the mountains, the precipitations reach 700 – 900 mm (Gurghiu).

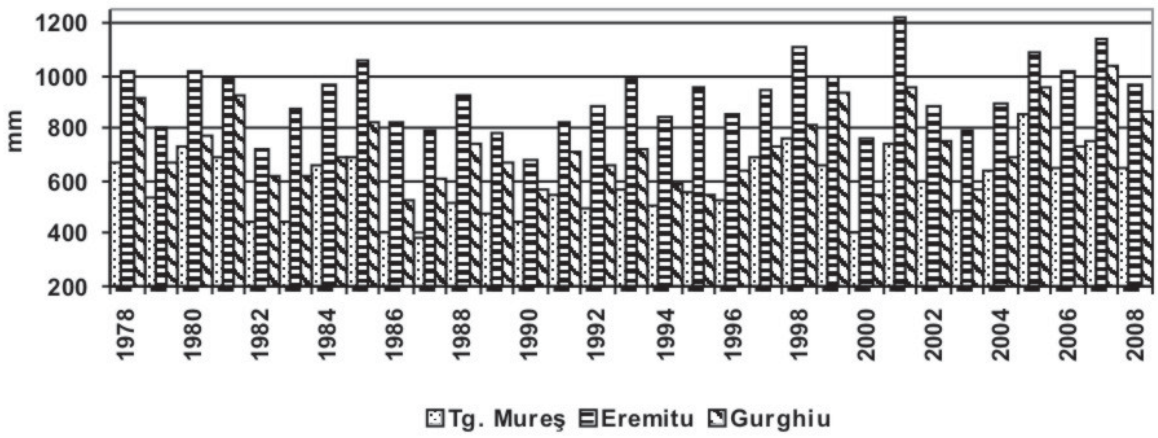

Fig. 1. Annual average rainfall quantities(1978 – 2008).

Annual rainfall quantity varies from a year to another, with negative and positive deviations from the multiannual average. Hence, the highest annual rainfall quantity of 1216 mm appeared in 2001 at Eremitu Station, what represents a 294,9 mm deviation from the multiannual average of 921,3 mm; the lowest value was of 384 mm in 1987 at Târgu Mureş Station, with 210,6 mm less than the multiannual average.

The advantage of analyzing gliding average from annual rainfall sums consists in conserving the period and trend of dynamic series, contributing to

highlighting maximum and minimum values, even though they attenuate the amplitude of cyclic, periodical and accidental oscillations (Fărcaş I., 1988).

The evolution of gliding averages for a period of 10 years that are lead with a year, brings forward the high rainfall values from Reghin Hills for the years 1991-2000,1992-2001, 1993-2002, 1994-2003, 1995-2004, 1996-2005, 1997-2006,1998-2007; in these years appeared rainfall quantities with even 50 mm/year higher than the multiannual average. The trend line presents a growth of rainfall quantities in these periods.

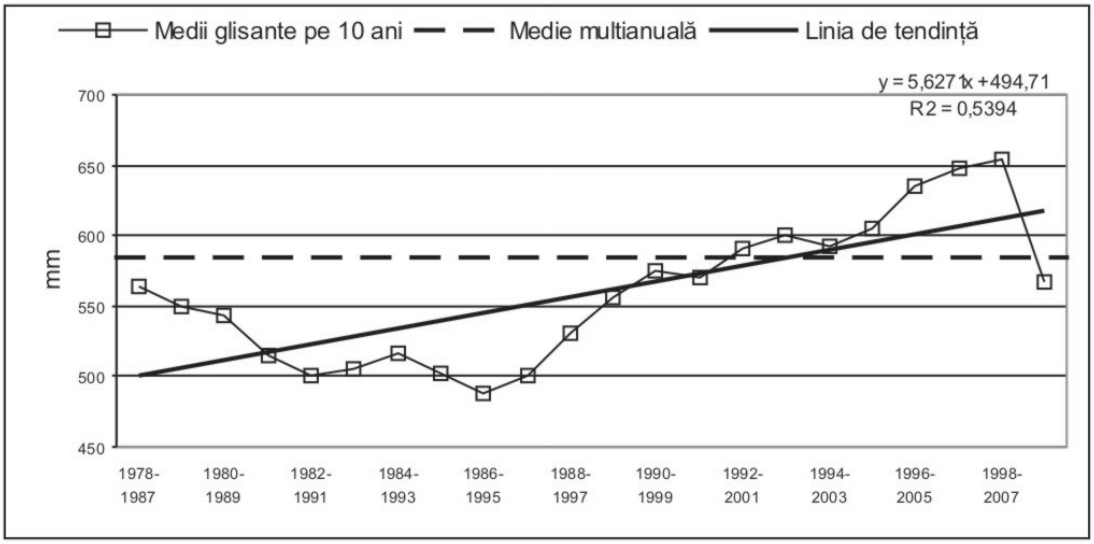

Fig. 2. Gliding averages of annual rainfall sums for a period of 10 years that are lead with a year at Târgu Mureş Station (1978-2008).

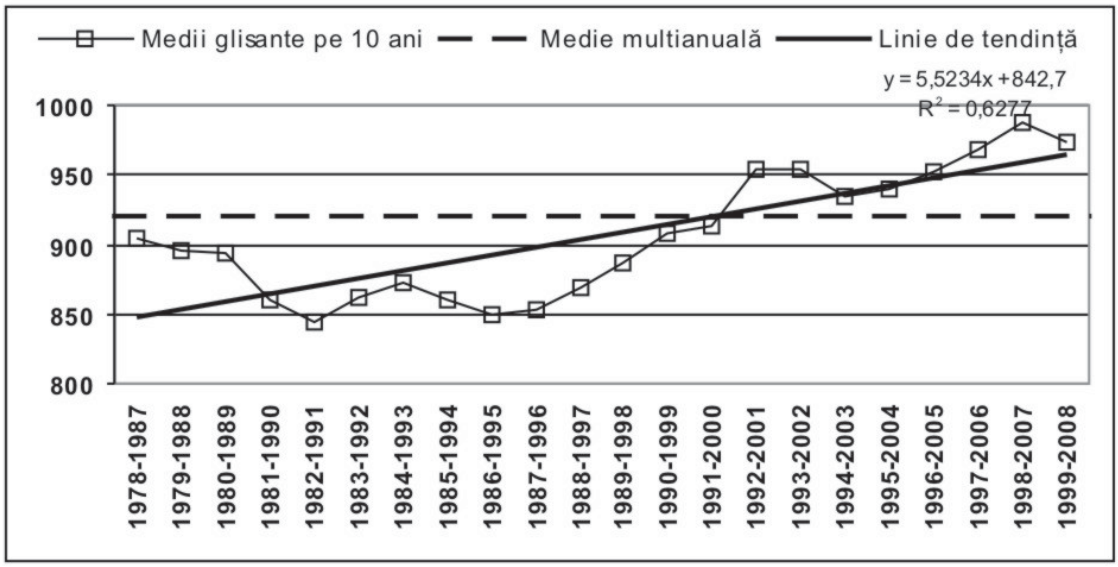

Fig. 3. Gliding averages of annual rainfall sums for a period of 10 years that are lead with a year at Eremitu Station (1978-2008).

Analyzing annual values variation of Rainfall Standard Anomaly we see that between 1978 – 2008, in most cases, the RSA index had values between -1,0 … 1,0, indicating the prevalence of rainfall normal years, with 67,8% at Târgu Mureş and Gurghiu, and 74,2% at Eremitu Station.

The years with a rainfall excess (RSA > 1,0) have a frequence of 12,9 – 19,3%; the lowest values (RSA < -1,0) have a frequence of 5 – 7 %.

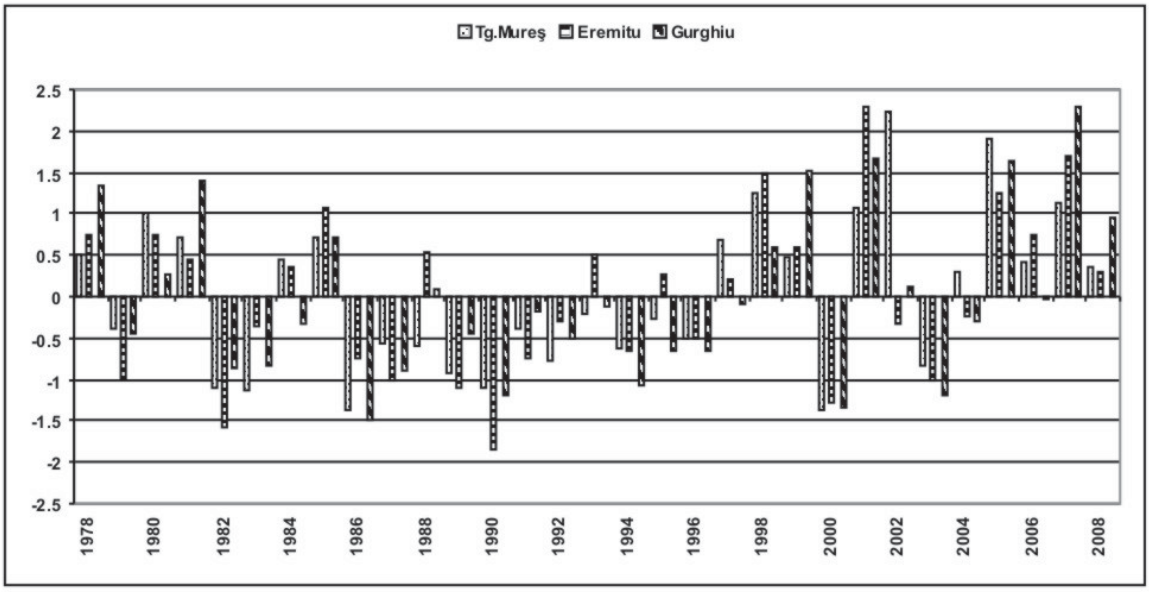

Fig.4. Annual variation of RSA values

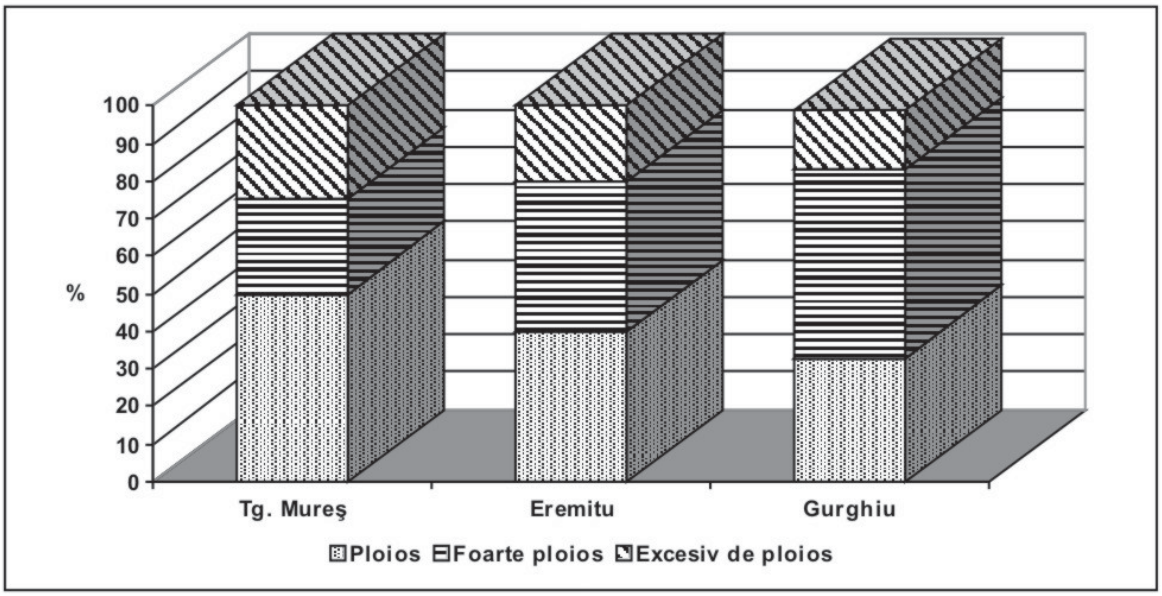

Fig.5. Frequency of exceeding rainfall years with different caractheristics according to RSA

Summing the frequency of rainfall exceeding years with different characteristics, we observe a higher frequency of *rainy* years – 47,4%, followed by years with *heavy rains* – 36,8%, and *exceeding rain* years – 15,8%.

3. Monthly and seasonal variations of rainfall quantities

After analyzing monthly values of rainfall quantities, we observe that there are present important differences from a month to another. The highest rainfall quantities appear in the year's warm season, from April to September, with 61 – 68,2% from the annual rainfall quantities.

Annual rainfall regime presents two maximums and two minimums. *The main maximum* appears in June, caused by intense cyclonic activity and convective movements determined by temperature rise; the highest rainfall quantities have an average of 81,1 – 108,1 mm, with a month maximum of 243,4 mm in 1985 at Eremitu Station. *The secondary maximum* appears in December, caused by moist air advection from North Atlantic area and by frontal activities at the contact of different thermal characteristics and origins air masses; it generates high cloudiness and heavy rainfall. Hence, the December multiannual monthly average quantity varies between 48,8 – 66,4 mm; maximum monthly quantity of 169,5 mm appeared in 1999 at Eremitu Station.

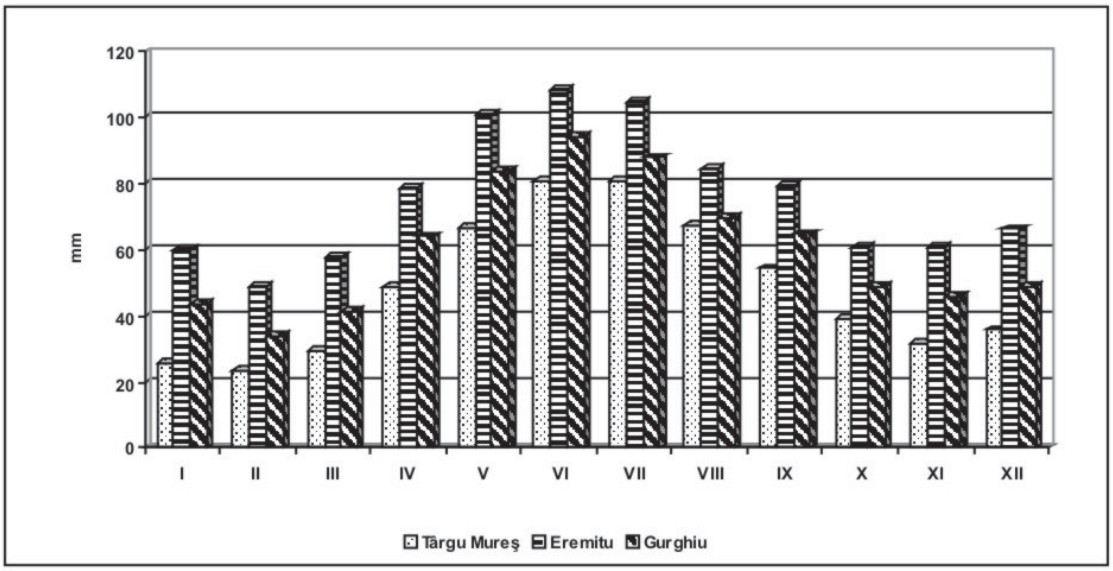

Fig.6. Monthly average rainfall quantity

The main minimum appears in February, with a monthly multiannual average of 29,5 – 48,9 mm; the lowest value, of 3,4 mm, appeared in 1994 at Târgu Mureş Station. The *secondary minimum* appears in November, with a monthly multiannual average of 31,8 – 60,9 mm; the lowest value, of 5,5 mm, appeared in

1986 at Târgu Mureş Station. After analyzing the monthly variation of rainfall monthly multiannual averages, we observe a considerable rainfall growth during March – June months, giving our territory a higher vulnerability to moisture excess phenomena and processes. The highest rainfall quantity growth is recorded in March – April (19,5 – 22,4 mm), and the strongest decrease appears between July – August (-11,3 mm and -20,1 mm).

The frequency and assurance degree of certain rainfall quantities evidence was made using the number of cases with different rainfall quantities, that were grouped into 8 representative value classes (from 25 to 25 mm). In winter months, the highest frequency has the rainfalls of 0,1 – 25 mm, with a frequency of 41,9% in December, 51,6% in January and 61,2% at Târgu Mureş Station.

Spring months present a higher frequency of rainfall quantities between 50,1 – 75 mm and 75,1 – 100 mm.

In June, the highest frequency is that belonging to rainfall quantities of 50,1 – 75 mm and 75,1 – 100 mm, with 32,2%, respectively 25,8%; the pluviometric individuality of this month is given by the high frequency of rainfall above 100 mm. The rainfall quantities of 100,1 – 125 mm have a frequency of 13%, those between 125,1 – 150 mm – 3,2%, and those above 150,1 mm – 6,4%.

In July, although the rainfall quantities are lower than those from June, still appears a high frequency of values between 75,1–100 mm – 29%, 100,1–125 mm – 16,1% and 125,1-150 m – 9,6%. Rainfall quantities above 150 mm have one frequency, that represents 3,2% and the lowest appearance probability – 3,2.

Autumn months present a high frequency of rainfalls values between 0,1-25 mm, with 13% in September, 38,7% in October and 41,9% in November; those between 25,1-50 mm share 41,9% in September, 25,8% in October and 48,3% in November. Rainfall quantities between 50,1-75% have a frequency of 22,5% in September – October and 9,6% in November. After comparing the results received from Târgu Mureş meteorological Station and Gurghiu and Eremitu pluviometric Station data analysis, is brought forward the frequency difference of characteristic rainfall quantities for each month between the western and eastern part of our area. So, Gurghiu and Eremitu pluviometric stations after comparing with Târgu Mureş Station, because of mountain influence, present a higher frequency for group values above 100 mm, thus explaining the higher month rainfall quantities in the sub mountain area.

After summing the characteristic pluviometric exceeding values for each month and every analyzed station, for the years 1978-2008, we observe that most rainy cases appeared in April - 17 cases (10,8%), February, June and September have 13 (8,2%), March, August and October – 12 (7,6%), May and December – 11 cases (7,0%).

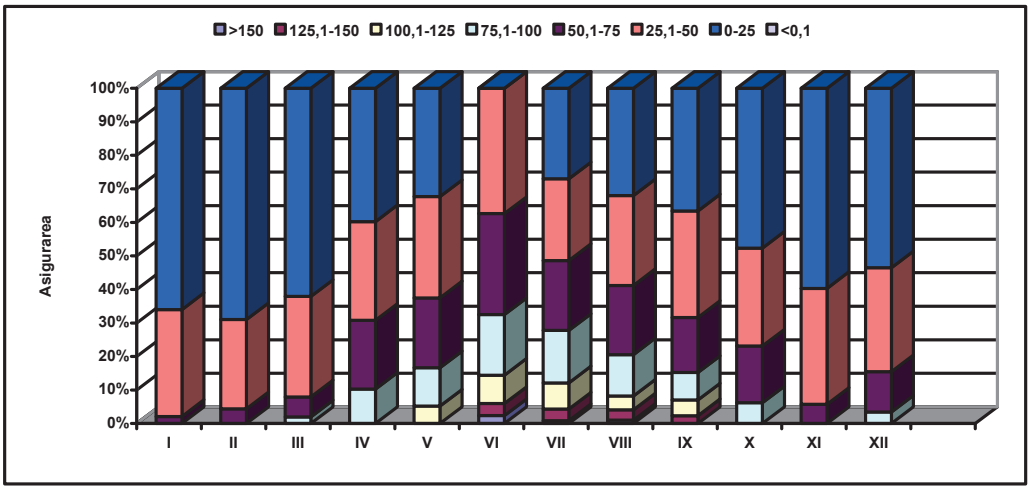

Fig.7. Monthly rainfall frequency and assurence degree at Târgu Mureş

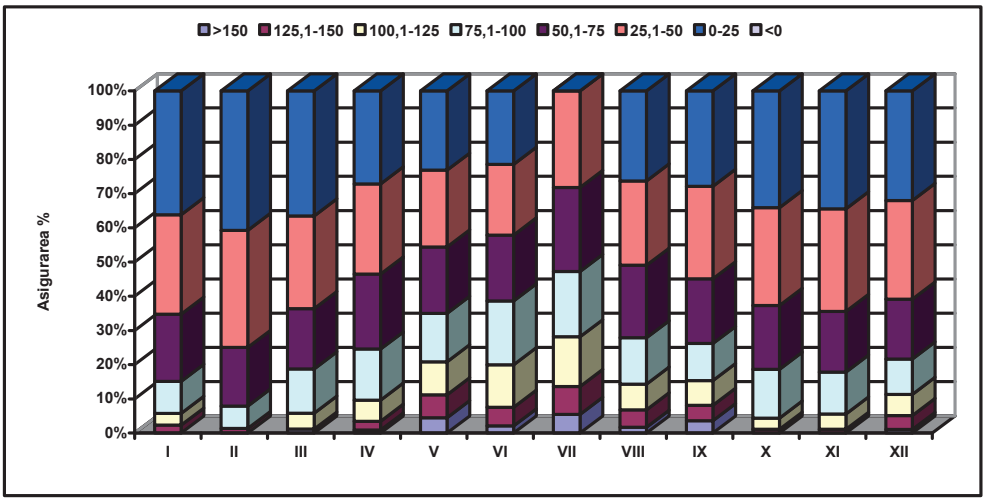

Fig. 8. Monthly rainfall frequency and assurence degree at Eremitu Station

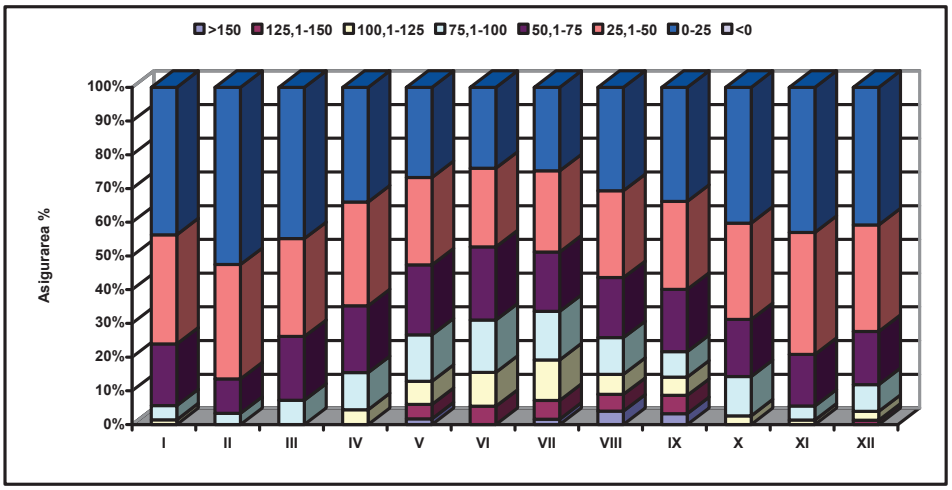

Fig. 9. Monthly rainfall frequency and assurence degree at Gurghiu Station

Analyzing the frequency of pluviometric exceeding months (Table 1), we observe a higher frequency for *rainy* periods (5,1-7,2%), followed by *very rainy* ones (3,0-6,5%), *excessively rainy* ones (0,5-2,7%) and *exceptionally rainy* ones (1,1-2,2%).

	Normal		**Rainy**		**Very rainy**		**Excessively rainy**		**Exceptionally rainy**	
Deviation %	**-1,0…1,0**		**1,1…1,5**		**1,5…2,0**		**2,0…2,5**		**>2,5**	
Station	**Nr.**	**%**	**Nr.**	**%**	**Nr.**	**%**	**Nr.**	**%**	**Nr.**	**%**
TG. MUREŞ	277	74,5	19	5,1	18	4,8	10	2,7	6	1,6
EREMITU	282	75,8	19	5,1	24	6,5	2	0,5	8	2,2
GURGHIU	275	73,9	26	7,0	15	4,0	6	1,6	4	1,1

Table 1. The frequence of exceeding rainfall months cu different cararctheristics according to RSA

From the whole four seasons, the highest frequencies of exceeding pluviometric periods appear in spring and summer – 25% from all cases, followed by autumn – 24,8% and winter – 24,2%.

Summing the frequencies of exceeding pluviometric periods with different characteristics by season, we observe more *rainy* periods during spring (45%), summer (50%) and winter (42,1%), and *very rainy* periods during autumn (56,4%). *Excessively rainy* and *exceptionally rainy* periods appear especially during spring – 10%, determining a higher land vulnerability in this season for humidity excess associated risks and processes.

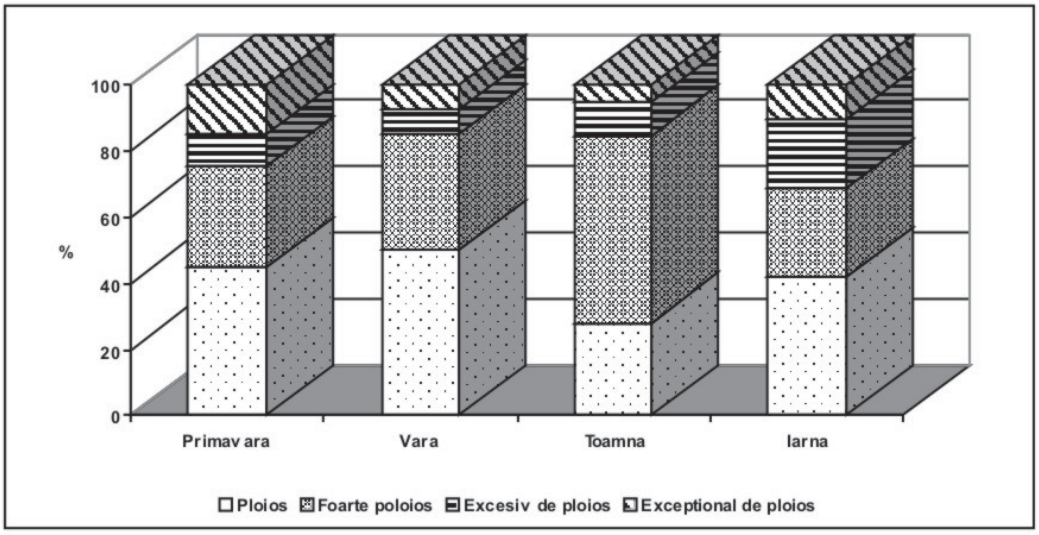

Fig.10. Frequency of exceeding rainfall periods with different characteristics on seasons

4. Humidity excess associated risks

The presence of humidity excess can generate some natural risks like: geomorphologic, hydric, pedological and ecological ones, with a negative impact over social and economical life:

- **Geomorphologic risks** and pedological ones associated with pluviometric excess effect land quality and morphology, accelerating linear and areolar erosion processes; their consequences are high material evacuation and building a degraded landscape through new torrent system (ravines, gullies, torrential organisms); also, long heavy rainfall periods can trigger landslides; washing of a great soil quantity from steep slopes; salt dissolution and washing from vertical during compaction processes; soil degradation through gleying processes etc..
- **Hydric risks** are connected with surface water level and discharge growth that can generate high waters and floods; underground water level rise over the topographic surface level brings soil saturation with water and so salt dissolution and soil desalinization.
- **Ecological risks** are associated with natural and human risks and are hard to define. They are represented by geographic landscape deterioration: landslides, lake silting, river bed alluviation, destruction or modification of local vegetation (short term), emergence of new plants (neobiota), organical and chemical water and land pollution, etc..
- **Antrophic and technical risks are** associated with pluviometric excess and floods; they are felt by the human society through the effects they have over rural and urban communities, economical constructions, electric and telecommunication networks; reduction of industrial production or disruption of some economical unities functions, difficulties in supplying with stocks or electric energy; distruction of some big agricultural land, etc..
- **Social risks** are determined by the goods destructions, danger of epidemics, people's evacuations from affected areas, panic around people, human casualties etc..

Conclusions

After analyzing the deviation values for rainfall annual average quantities from the multiannual average, we can observe that the values and frequency of positive deviation grow from west to east in our study area. Hence, the frequency of years with positive deviation has a value of 48,4% (Târgu Mureş) in the western part, and 54,9% (Eremitu) and 51,7% (Gurghiu) in the eastern part.

The highest positive deviation values from the annual average that appear in pluviometri exceed years have situate between +100 and +310 mm/year, with a

maximum of +309,8 mm/year (2007) at Gurghiu Station, +294,4 mm/year (2001) at Eremitu Station and +267,7 mm/year (2005) at Târgu Mureş Station. The number of years with positive deviation is 2-3 years, maximum values appeared between 2004-2008, with 5 years at Târgu Mureş Station and 4 years for Eremitu and Gurghiu Stations.

After analyzing the frequency of maximum values months for rainfall quantities, the months with the heaviest rainfall were May, June and July, with a frequency of 25,8% cases, and August with 22,5% cases; these months have the highest participation into the total annual rainfall quantity and the highest assurance degree, exceeding 50 mm.

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9. **** Tabele meteorologice TM-11 (intervalul 1978-2008)*