STUDY OF RAINFALL PERIODS IN THE CRASNA BASIN UNTIL THE CONFLENCE WITH ZALAU

OANA MOIGRĂDEAN

Abstract. - Study of Rainfall Periods in the Crasna Basin Until the Conflence with Zalau. The rainfall periods in the Crasna Basin were determined using the weighted anomaly standardized precipitation (WASP). We processed and analyzed data from the period between 1990-2000 from one meteorological station and eight rainfall stations. WASP values were calculated for intervals of one year and of six months (semesters). The frequency analysis was done on three domains of the precipitation periods (rainy, normal and dry). The rainfall risk characterization was studied on three groups: risk by excess, risk by deficiency and free of risk. By analyzing the resulting rainfall periods the wet domains have the predominant share followed by the normal and dry domains. The frequency analysis of the group with risk and without risk indicate a net predominance of situations without rainfall risk. In the spatial distribution of exceeding rainfall periods appear some contrasts, determined by the positions of stations and posts regarding the prevailing western air masses advections.

Key words: rainfall periods, classes, fields, rainfall risk groups

1. General considerations

The weighted anomaly standardized precipitation (WASP) is one of the most frequent used methods in the specialized literature, being recommended in the study of the droughts and of the rainy periods.

For the period between 1990 – 2010 the WASP values were calculated at a meteorological station (Zalau) and eight representative rainfall stations from the Crasna Basin until the confluence with Zalau. In order to make comparisons at the Zalau station the WASP values were also calculated for the reference period between 1961 – 2010.

We need to say that at the Mesesenii de Jos and Banisor posts there are no observations before 1990.

The WASP values were calculated for intervals of one year and of six months (the hot and cold semesters of the year).

Based on the calculated WASP values thresholds were established in order to assign marks to the analyzed intervals. In order to identify the marks we used the threshold-values recommended by the International Institute for Research and Predictability (Table 1).

The frequency analysis was done on three domains of rainfall periods (rainy, normal and dry). Rainfall risk characterization was studied on three groups: risk by excess, risk by deficiency and free of risk.

Table. 1. The rainfall marks according to the value of the weighted anomaly standardized precipitation

Value of WASP	Symbol of the class	Rainfall class (mark)	Rainfall domain	Rainfall risk groups
≥3,00	P_4	Extremely rainy	Rainy	Rainfall risk by excess
2,00....2,99	P_3	Very rainy		
1,00...1,99	P_2	Moderate rainy		
0,51...0,99	P_1	Little rainy		Free of rainfall risk
-0,55...+0,5	N	Normal	Normal	
-0,51...-0,99	S_1	Litte dry	Dry	
-1,99...-1,00	S_2	Moderate dry		Rainfall risk by deficiency
-2,99...2,00	S_3	Very dry		
≤-3,00	S_4	Extremely dry		

2. The weighted anomaly standardized precipitation calculated for intervals of one year

Out of the frequency analysis of the WASP value classes resulted that the studied period lacked extremely rainy and extremely dry years.

In the region the average frequency of the very rainy years, is low (3.17%). This class is absent in the South-Eastern part of the region (the rainfall stations Banisor and Starciu) and also at Borla. At the rest of the rainfall stations and the meteorological station Zalau, only one very rainy year was recorded (2010), representing a frequency of 4.76%.

The region average frequency of the moderate rainy years (15.34%) is exceeded by that of the rainy years (17.46%). Regarding these average values there are quite important differences (table 2).

At the rainfall stations Borla, Meseseni, Crasna and Simleu Silvaniei the rates of the frequency grow from the mark “very rainy” (4.76%) towards the “little rainy” one (19.05 – 23.81%). On the other side, for the rest of the rainfall stations it is not possible to establish a rule for the frequency evolution. At Zalau meteorological station the very rainy years appeared with the same frequency as the little rainy ones (4.76%), while the moderate rainy years predominated (33.33%). At Sarmasag the very rainy and moderate rainy years have equal shares (4.76%) while the little rainy ones have a greater share (19.05%). Equal shares can

be observed at Varsolt, this time for the moderate rainy and little rainy years (23.81%). At Banisor rainfall station, the moderate rainy years have the highest frequency (23.81%), followed by the little rainy ones (9.52%), while the very rainy ones are absent.

Table 2.The frequency on value classes of WASP for the anual rainfall (%).

Station	P4	P3	P2	P1	N	S1	S2	S3	S4
Zalau	0.00	4.76	33.33	4.76	28.57	14.29	14.29	0.00	0.00
Borla	0.00	0.00	19.05	23.81	23.81	14.29	19.05	0.00	0.00
Sarmasag	0.00	4.76	4.76	19.05	42.86	14.29	9.52	4.76	0.00
Banisor	0.00	0.00	23.81	9.52	28.57	23.81	9.52	4.76	0.00
Starciu	0.00	0.00	14.29	19.05	38.10	9.52	19.05	0.00	0.00
Meseseni	0.00	4.76	9.52	19.05	33.33	19.05	9.52	4.76	0.00
Crasna	0.00	4.76	9.52	23.81	33.33	14.29	14.29	0.00	0.00
Varsolt	0.00	4.76	14.29	14.29	38.10	9.52	19.05	0.00	0.00
Simleu	0.00	4.76	9.52	23.81	33.33	14.29	14.29	0.00	0.00
Average on region	**0.00**	**3.17**	**15.34**	**17.46**	**33.33**	**14.81**	**14.29**	**1.59**	**0.00**

Of all the WASP value classes the maximum frequency is held by the normal years from the rainfall point of view, representing at the level of the analyzed region, 33.33% of the years taken into account. Against the average situation, the frequency of this class varies between 23.81% (at Borla) and 42.86% (at Sarrmasag).

In the analyzed region there were no extremely dry years, while the very dry ones had a very low frequency (1.59%), with only one such year – 1990 at Banisor and 2000 at Sarmasag and Meseseni. The average frequency of the moderate dry years (14.29%) is very close of that of the little dry ones (14.81%). The frequency of the moderate dry years varies quite much in the analyzed region, from 19.05% at Borla, Starciu and Varsolt to 9.52% at Sarmasag, Banisor and Meseseni. Analyzing the frequency on rainfall domains one can notice the fact that at the level of the studied region the rainy domain predominates (35.98%), followed by the normal one (33.33%) and in the end by the dry domain (Fig. 1).

In most of the region the largest share is held by the rainy domain with higher values on Zalau Valley (42.86% at Zalau and Borla). At Sarmasag and Varsolt rainfall stations the normal domain predominates with values of 42.86%, respectively 38.10%. At Banisor, the dry domain appears with the maximum frequency (38.10%). An interesting situation can be noticed at Mesesenii de Jos, where all the domains appear with the same frequency (33.33%) (Table 3). For the most of the rainfall stations the shares of the rainy domain are greater than those of the dry domain. The differences stand between 14.29% (at Zalau) and 4.76% at Starciu and Varsolt. The

rainfall stations Banisor (where the dry domain predominates), Sarmasag and Meseseni (equal frequencies) wander off this rule (Table 3).

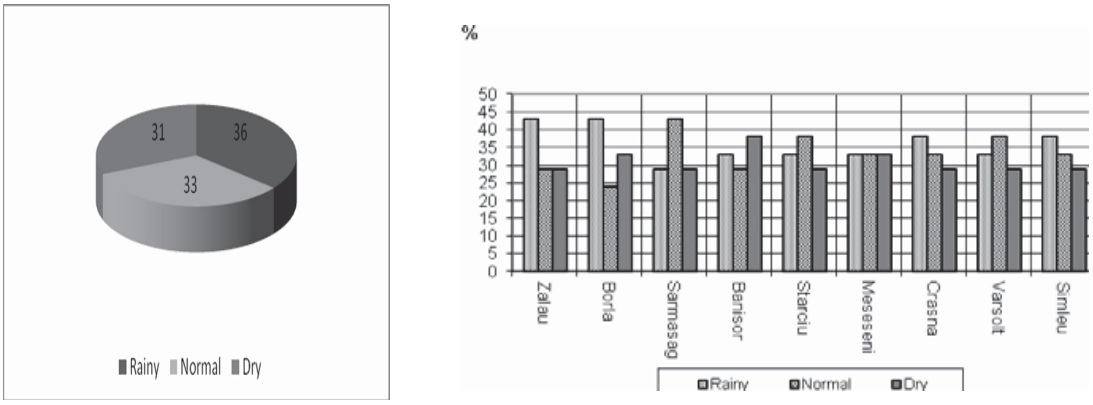

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Figure 1 The average frequency of the years on rainfall domains at he level of the Crasna Basin (a) and at the meteorological station and rainfall stations (b)

Table 3. The frequency on rainfall domains of the anual rainfall (%)

Domain / Station, Rainfall post	Rainy	Normal	Dry
Zalau	42.86	28.57	28.57
Borla	42.86	23.81	33.33
Sarmasag	28.57	42.86	28.57
Banisor	33.33	28.57	38.10
Starciu	33.33	38.10	28.57
Meseseni	33.33	33.33	33.33
Crasna	38.10	33.33	28.57
Varsolt	33.33	38.10	28.57
Simleu Silvaniei	38.10	33.33	28.57
Average on region	**35.98**	**33.33**	**30.69**

At Zalau meteorological station, along the reference period 1961 – 2000, one can notice resembling values of the frequency of the three rainfall domains. The normal domain predominates (38%), followed by the rainy one (32%) and the dry domain (30%). (Fig. 2)

The frequency on groups with or without rainfall risk outlines the share held by the years free of risk against the years with risk by excess or by deficiency (Table 4).

The average value on the region (65.61%) is overpassed at the rainfall stations Sarmasag, Starciu, Meseseni, Crasna and Simleu Silvaniei.

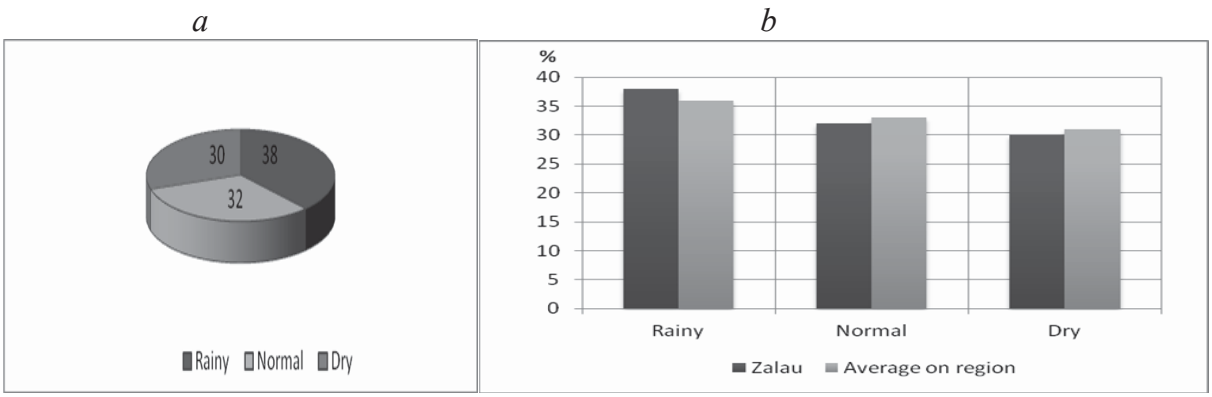

Figure 2. The frequency of the rainfall domains at Zalau on the reference period (a) and compared with the average on the region for the period 1990-2010 (b)

Table 4. The frequency on risk and free of risk groups ot the anual rainfall (%)

Group / Station , Rainfall post	Risk by excess	Free of risk	Risk by deficiency
Zalau	38.10	47.62	14.29
Borla	19.05	61.90	19.05
Sarmasag	9.52	76.19	14.29
Banisor	23.81	61.90	14.29
Starciu	14.29	66.67	19.05
Meseseni	14.29	71.43	14.29
Crasna	14.29	71.43	14.29
Varsolt	19.05	61.90	19.05
Simleu Silvaniei	14.29	71.43	14.29
Average on region	**18.52**	**65.61**	**15.87**

At the level of the region the frequency of the years with risk by deficiency (15.87%) is lower than that of the years with risk by excess (18.52%) (Fig. 3). The wanders off the average situation are determined by the different positions regarding the prevailing wet western air masses advections and by the local morphological conditions. At five rainfall stations, namely Borla, Meseseni, Crasna, Varsolt and Simleu Silvaniei, the frequency of the years with risk by deficiency equals that of the years with risk by excess. At Sarmasag and Starciu the frequency of the years with risk by deficiency (14.29 – 19.05%) overpasses the frequency of the years with risk by excess (9.52% - 14.29%), while at Banisor and Zalau the years with risk by excess are more frequent than those with risk by deficiency (Table 4).

At Zalau meteorological station, on the reference period, the situation is resembling, with the mention that the group free of risk (58%) loses ground against the group with risk by excess (26%). (Fig. 4)

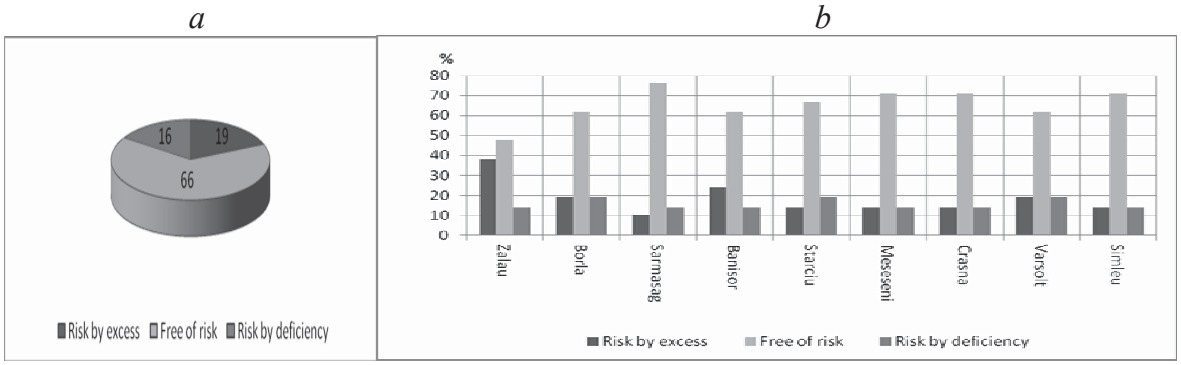

Figure.3. The average frequency of the years with rainfall risk and free of risk at the level of the Crasna Basin (a) and at the meteorological and rainfall stations (b)

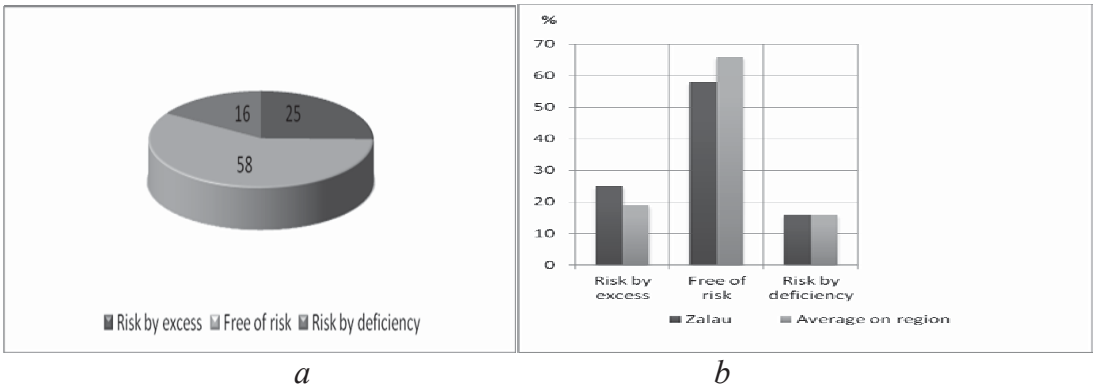

Figure 4 .The frequency of the years with rainfall risk and free of risk at Zalau on the reference period (a) and compared with the average on the region for the period 1990-2010 (b)

3. The weighted anomaly standardized precipitation calculated for semesters

The calculation of WASP for the hot semester (April-September) and the cold one (October-March) was done also for practical reasons, taking into consideration the assurance of the water supply for agriculture in the hot period of the year and the knowledge of the water accumulated in the soil and in the reservoir during the cold period of the year.

The hot semester

The frequency on value classes of WASP shows the absence of extreme classes and the predominance of normal cases, which at the level of the studied region show a value of 35.45%.

The very rainy hot semesters had a very low frequency (4.76%) as compared to the moderate rainy (9.52%-23.81%) and little rainy ones (4.76%-23.81%). At Zalau meteorological station the frequency of the little rainy hot semesters (23.81%) is very high overpassing that of the normal cases (19.05%).

The normal values class has the highest frequencies (42.86%) at Meseseni and Simleu Silvaniei and the lowest at Zalau (19.05%).

In most of the region the moderate dry hot seasons had a higher frequency (19.05%-23.81%) as compared to the little dry ones (4.76%-19.05%). As an exception, at Borla and Zalau, the moderate dry values class has equal frequencies with that of the little dry class (14.29%, respectively 19.05%). Also at Simleu Silvaniei the moderate dry hot seasons are less frequent (14.29%) than the little dry ones (19.05%). The very dry value class has low frequencies (4.76%), being present only at Borla (Table 5).

Table. 5. The frequency on WASP value classes for the rainfall in the hot semester (%)

	P4	P3	P2	P1	N	S1	S2	S3	S4
Zalau	0.00	0.00	19.05	23.81	19.05	19.05	19.05	0.00	0.00
Borla	0.00	0.00	14.29	23.81	28.57	14.29	14.29	4.76	0.00
Sarmasag	0.00	0.00	19.05	14.29	38.10	9.52	19.05	0.00	0.00
Banisor	0.00	0.00	23.81	9.52	38.10	4.76	23.81	0.00	0.00
Starciu	0.00	0.00	19.05	9.52	38.10	14.29	19.05	0.00	0.00
Meseseni	0.00	0.00	19.05	4.76	42.86	14.29	19.05	0.00	0.00
Crasna	0.00	4.76	9.52	14.29	33.33	19.05	19.05	0.00	0.00
Varsolt	0.00	4.76	14.29	4.76	38.10	19.05	19.05	0.00	0.00
Simleu	0.00	4.76	14.29	4.76	42.86	19.05	14.29	0.00	0.00
Average on region	0.00	1.59	16.93	12.17	35.45	14.81	18.52	0.53	0.00

Table. 6. The frequency on WASP value classes for the rainfall in the cold semester (%)

	P4	P3	P2	P1	N	S1	S2	S3	S4
Zalau	0.00	4.76	14.29	23.81	19.05	19.05	19.05	0.00	0.00
Borla	0.00	4.76	14.29	19.05	23.81	9.52	28.57	0.00	0.00
Sarmasag	0.00	0.00	19.05	9.52	28.57	19.05	23.81	0.00	0.00
Banisor	0.00	4.76	9.52	19.05	23.81	23.81	19.05	0.00	0.00
Starciu	0.00	4.76	9.52	19.05	28.57	14.29	23.81	0.00	0.00
Meseseni	0.00	0.00	23.81	9.52	33.33	9.52	23.81	0.00	0.00
Crasna	0.00	4.76	4.76	33.33	14.29	19.05	23.81	0.00	0.00
Varsolt	0.00	4.76	9.52	19.05	28.57	14.29	23.81	0.00	0.00
Simleu	0.00	4.76	9.52	4.76	42.86	19.05	19.05	0.00	0.00
Average on region	0.00	3.70	12.70	17.46	26.98	16.40	22.75	0.00	0.00

The frequency on rainfall domains underlines the fact that in most of the region the frequency of the normal hot seasons (38.10%-42.86%) is higher than that of the other domains.

At the rainfall stations on Zalau Valley and at Banisor the frequency of rainy hot seasons is higher than that of the dry ones (Table 6). At the rest of the stations the frequency of the dry hot seasons is higher than that of the rainy ones (Figure 4). Analyzing the frequency on rainfall domains at the level of the whole region one can notice the fact that the shares are quite close, the maximum values being held by the normal domain (35.45%), followed by the dry one (33.86%) and the rainy one (30.69%) (Fig.5).

At Zalau meteorological station on the reference period one can notice the predominance of the dry hot seasons (38%), followed by the normal (34%) and rainy ones (28%). (Fig. 6)

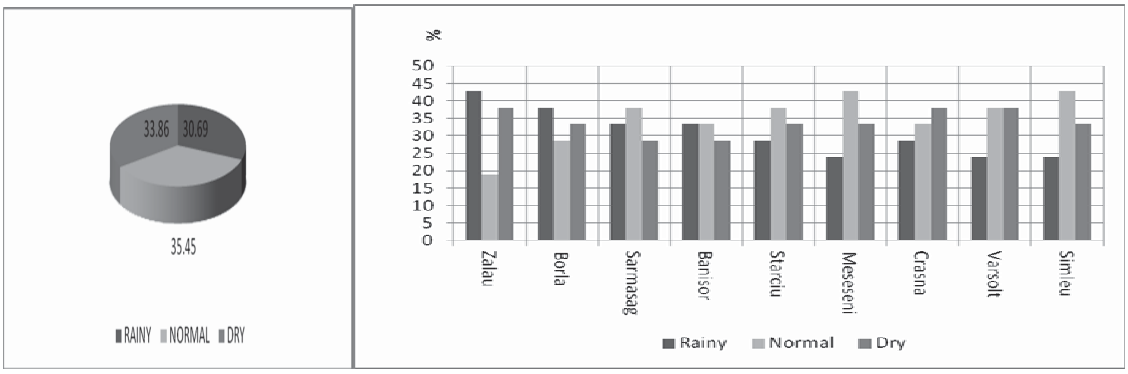

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Figure 5. The average frequency of the hot semesters on rainfall domains at the level of the region (a) and at the meteorological and rainfall stations (b)

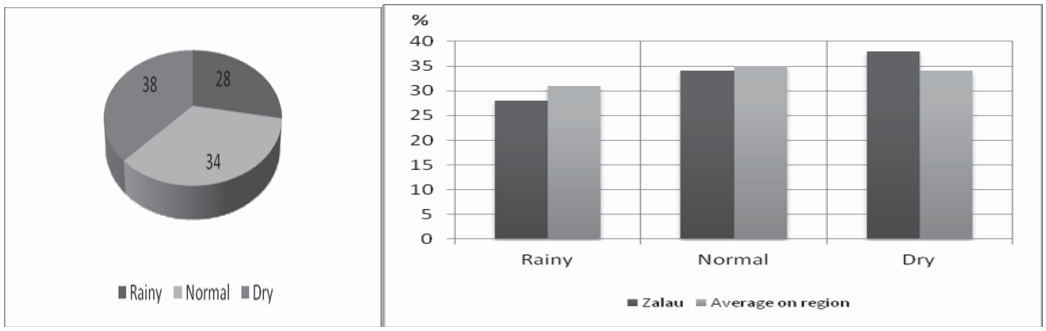

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Figure 6. The average frequency of the hot semesters on rainfall domains at Zalau on the reference period (a) and compared with the average on the region for the period 1990-2010 (b)

The frequency on groups with risk and free of risk underlines the fact that in the whole studied region the maximum frequency is held by the group free of rainfall risk. (Fig. 7)

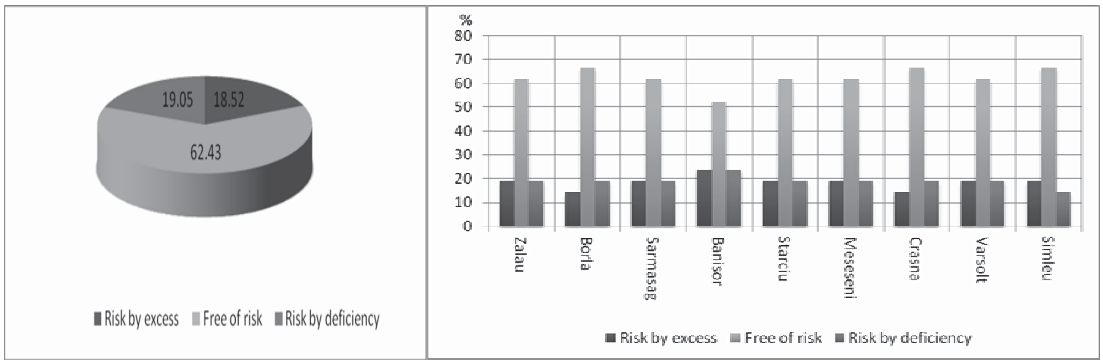

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Figure 7. The average frequency of the hot semesters with or free of rainfall risk in the Crasna Basin (a) and at the meteorological and rainfall stations (b)

Comparing the frequencies of the two risk groups one can notice the fact that in the most part of the studied region the shares of the risk by excess are equal to those of the semesters with risk by deficiency (19.05%-23.81%). At Borla and Crasna the frequency of the hot semesters with risk by excess is lower than that of the hot semesters with risk by deficiency, while at Simleu Silvaniei the risk by excess has a higher frequency.

At the level of the region, the risk induced by the heavy rainfall in the hot semester is less frequent that the risk induced by the absence of rainfall (Figure 5). At Zalau meteorological station the hot semesters free of risk arte the most frequent (66%) but the risk induced by the heavy rainfall is more frequent (20%), than that induced by the absence of rainfall (14%). (Fig. 8)

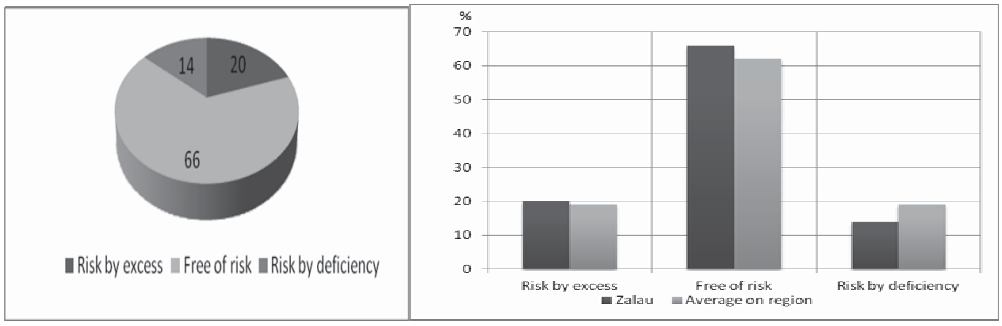

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Figure 8. The average frequency of the hot semesters with or free of rainfall risk at Zalau on the reference period (a) and compared with the average on the region for the period 1990-2010 (b)

The cold semester

The frequency on value classes of WASP shows the absence of extreme classes and the predominance of normal cases, which at the level of the studied region show a value of 26.92%, lower than that corresponding to the hot semester.

The very rainy cold seasons had low frequency (0%-4.76%) as compared to the moderate rainy (9.52%-23.81%) or little rainy (4.76%-33.33%) ones. At Sarmasag, Meseseni and Simleu the frequency of the moderate rainy cold semesters (9.52%-23.81%) overpasses that of the little rainy cases. At the rest of the rainfall stations the situation is reversed.

The normal value class has the highest frequency at Simleu Silvaniei (42.86%) and the lowest at Zalau meteorological station (19.05%) and Crasna rainfall station (14.29%).

In most of the region the moderate dry cold seasons had higher or equal frequencies (19.05%-23.81%) with the little dry ones (9.52%-19.05%). As an exception, at Banisor, the moderate dry value class has lower frequencies (19.05%) than the little dry value class (23.81%). The very dry value class is absent at all of the rainfall stations.

Analyzing the frequency on rainfall domains one can notice the fact that almost in the whole region, the greatest share is held by the dry domain with values between 38.10% (Borla, Starciu, Varsolt, Simleu) and 42.86% (Sarmasg, Banisor) (Table 6). At Meseseni all the rainfall domains have equal frequencies (33.33%), while at Crasna the dry and rainy domains appear with equal frequencies, clearly overpassing the frequency of the normal domain (14.29%). At Zalau meteorological station, the maximum frequency is held by the rainy domain (42.86%), overpassing that of the dry domain (38.10%) and of the normal one (19.06%). At the level of the studied region, the maximum frequency is held by the dry domain (39.15%), followed by the rainy domain (33.86%) and finally by the normal one (26.98%) (Table 6).

At Zalau meteorological station one can notice the predominance of the rainy cold seasons (36%), while the normal and dry ones appear with the same frequency (32%). (Fig. 9)

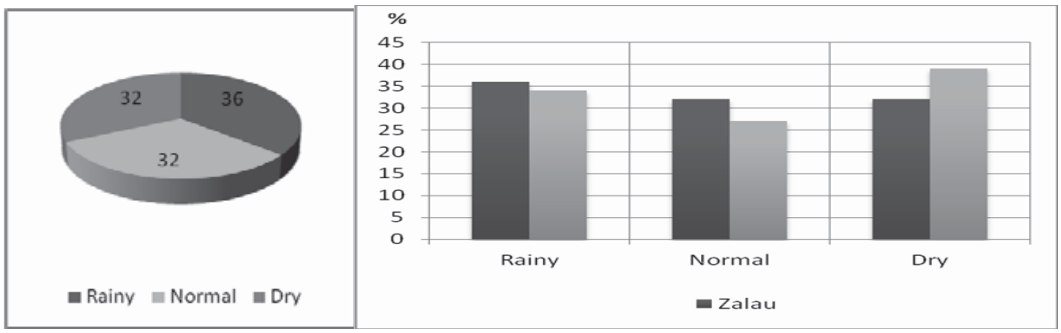

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Figure 9. The average frequency of the cold semesters on rainfall domains at Zalau on the reference period (a) and compared with the average on the region for the period 1990-2010 (b)

The frequency on groups with risk and free of risk shows a similar situation with that of the hot semester. In the whole region the maximum frequency is held by the group free of risk with an average frequency of 62.42% and with higher shares at Simleu, Crasna and Banisor (66.67%) and lower at Meseseni and Borla (52.38%). The range of variation of the group free of risk is the same in both semesters (14.29%).

Comparing the two groups of risk one can notice the fact that in most of the region the shares of the risk by deficiency (19.05%-28.75%) overpass those corresponding to the risk by excess (9.52%-19.05%). At Zalau and Meseseni the frequency of the semesters with risk by excess is equal with that of the semesters with risk by deficiency (19.05%, respectively 23.81%). At the level of the region the frequency of the group with risk by deficiency (22.75%) overpasses that of the group with risk by excess (16.40%) (Fig. 10).

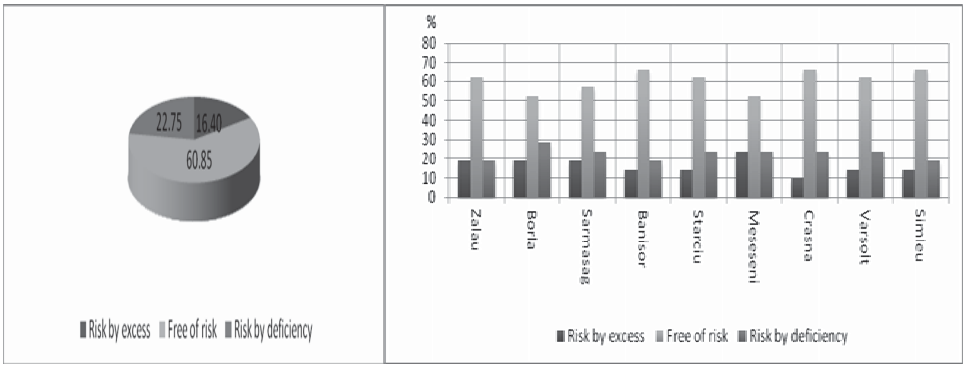

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Figure 10. The average frequency of the cold semesters with or free of rainfall risk in the Crasna Basin (a) and at the meteorological and rainfall stations (b)

At Zalau meteorological station the cold seasons free of risk (64%) predominate, followed by those with risk by excess and by deficiency with equal values (18%) (Fig.11).

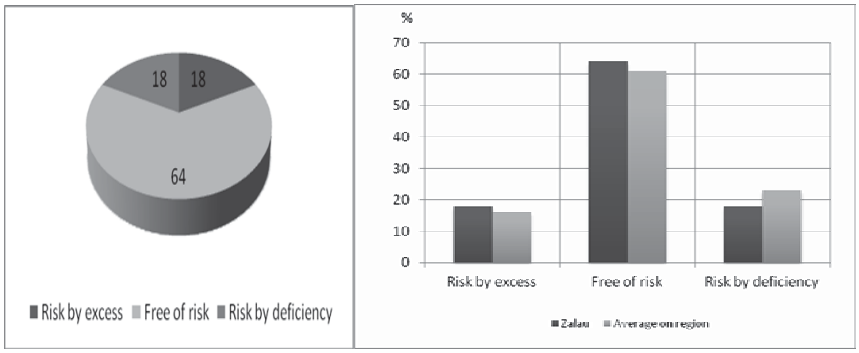

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Figure 11. The average frequency of the cold semesters with or free of rainfall risk at Zalau on the reference period (a) and compared with the average on the region for the period 1990-2010 (b)

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