PARTICULIARITIES OF FLOODS ON RIVERS IN THE TRANSYLVANIAN SUBCARPATHIANS AND THE NEIGHBOURING MOUNTAINOUS REGION BETWEEN TÂRNAVA MARE AND NIRAJ

D. RADULY[1], V. SOROCOVSCHI[2], CS. HORVATH[3]

ABSTRACT. –Particularities of floods on rivers in the Transylvanian Subcarpathians and the neighboring mountainous region between Târnava Mare and Niraj. In the first part of the paper are presented the general characteristics of the high waters and floods, emphasizing that the difference is mainly related to the flood wave characteristics (duration and form) and not the water volume. Then we present the geography of the study area and the main geographic characteristics which influence flood waves. We analyzed the monthly and seasonal frequency of flood waves highlighting the similarities and differences between the mountain and the neighboring areas, regarding the formation and development of floods. In the last part we analyzed statistically how many times did the areas hydrometric stations record values which were higher than the three threshold defense levels (attention, flood, danger).

Keywords: floods, floods types, regional distribution, Transylvanian Subcarpathians

1. Introduction

Floods account for the most spectacular stage of the runoff regime and through their speed and volume, for the most significant losses due to the natural phenomena in the studied area.

By definition, a flood is different from the high waters stage by the concentration of discharge in time, that is through sudden and short-term increases of levels and flows, and then by a relatively fast decrease of waters, which is, in general, slower than the increase. We must emphasize the fact that the flood is not different from high waters by the size of the maximum level/flow, but by the means of formation and the elements of the hydrograph (mainly duration and form).

[1] Babeş-Bolyai University, Faculty of Geography, 400006, Cluj - Napoca, Romania, e-mail: radulydaniel@yahoo.com
[2] Babeş-Bolyai University, Faculty of Geography, 400006, Cluj - Napoca, Romania, e-mail: svictor@geografie.ubbcluj.ro
[3] Babeş-Bolyai University, Faculty of Geography, 400006, Cluj - Napoca, Romania, e-mail: hcsaba@gmail.com

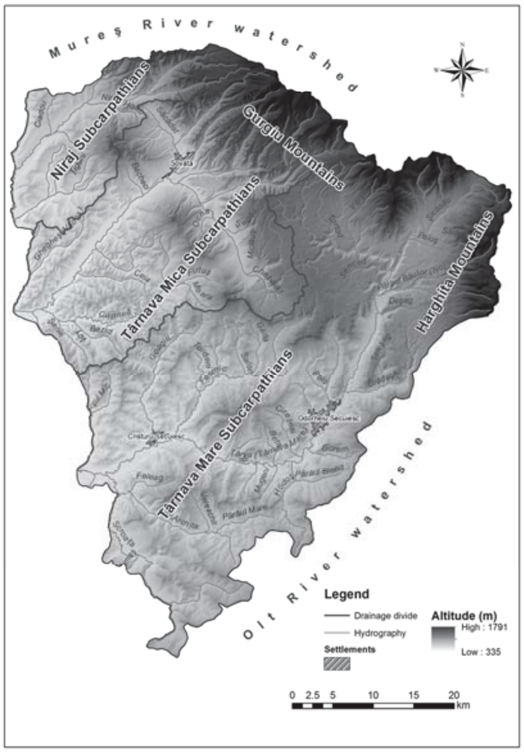

Figure 1. Geographic units of the study area

The studied region unfolds on a 2679 km^2 area, in latitude between the 46^0 02’ and 46^0 43’ parallels, and in longitude between the $24^0$45’ and $25^0$35’ meridians.

Within Romania, the studied region is situated in the Central Northern part, overlapping an area corresponding to the central and northern part of the Transylvanian Subcarpathians and to the western part of Moldavian - Transylvanian Carpathians (partially Gurghiu and Harghita).

From a hydrographic perspective, the region is integrated in the hydrographic system of the Mure river Superior course, corresponding to the basins of Târnava Mare, Târnava Mică and Niraj. (Fig.1)

This setting, the altitude and the exposure of the relief to the advection of the air masses from the west has a decreasing effect on the quantity of rain from North to South, respectively from East to West, with implications in the spatial distribution of the potential of river discharge.

The genesis of floods is linked not only to the physico-geographical conditions, but also to the surface of the hydrographic basins. Thus, we noticed that for the small basins Hodoş (46 km^2), Sovata (84 km^2), Feernic (145 km^2), Sicasau (147 km^2), the highest flows are caused by torrential rainfall, while in the case of larger basins Târnava Mare (1600 km^2, upstream of Vânători), Niraj (555 km^2, upstream of Cinta), Târnava Mică (461 km^2, upstream of Sărățeni), their weight decreases due to the balancing role that large basins have, and instead, increases the role of long-term rainfall and of the melting of snow.

The vegetal cover (especially forests) has an important regulatory role, especially for rivers whose supply is mainly made from the melting of the snow (Nirajul Mare, Nirajul Mic, Hosu, Târnava Mare, upstream Zetea, Şicasău). By extending the period of snow melt and delaying the superficial discharge, the forest prolongs spring floods. Likewise, by enriching the subterranean water layer, the forest increases the supply during summer and autumn low waters.

2. Methods and data used

Since the 10 hydrometric stations considered in the analysis of the floods in the basin have data rows on different intervals, sometimes interrupted, we have considered appropriate to examine the hydrologic phenomena on two analysis intervals: 1982-2005 and 1970-2995.

3. Results

3.1. Monthly and seasonal frequency of floods

Every year, depending on the action of the meteorological factors, which are linked to the dynamics of the atmosphere and to other factors which depend mainly on the characteristics of the active surface, during hydrological seasons, occur periods of low and high waters. Most floods occur during the period of high waters, but there are also floods recorded during the low seasonal discharge (Table 1).

Table 1. The monthly frequency of floods, in percentage, in the period 1982-2005

Hydrometric station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CINTA	3,8	0,0	**26,9**	**26,9**	7,7	11,5	7,7	7,7	3,8	0,0	0,0	3,8
NICOLEȘTI	0,0	7,3	14,6	**22,0**	9,8	14,6	14,6	12,2	0,0	0,0	0,0	4,9
SIMONEȘTI	2,4	7,3	**17,1**	14,6	9,8	**14,6**	12,2	7,3	4,9	2,4	2,4	4,9
ȘICASĂU	0,0	2,2	**17,4**	**17,4**	13,0	**17,4**	13,0	8,7	4,3	4,3	0,0	2,2
SASCHIZ	0,0	4,8	16,7	14,3	14,3	**19,0**	14,3	7,1	7,1	0,0	0,0	2,4
VARSAG	0,0	3,4	23,7	**27,1**	8,5	6,8	10,2	5,1	11,9	1,7	0,0	1,7
ZETEA	0,0	3,7	22,2	**29,6**	18,5	7,4	3,7	7,4	0,0	0,0	3,7	3,7
ODORHEI	0,0	4,7	**30,2**	25,6	16,3	4,7	4,7	7,0	2,3	0,0	2,3	2,3
VÂNĂTORI	2,9	0,0	17,1	**25,7**	14,3	8,6	5,7	8,6	5,7	2,9	5,7	2,9
SĂRĂȚENI	0,0	3,7	11,1	**37,0**	7,4	14,8	3,7	7,4	3,7	7,4	0,0	3,7

In case of most analyzed hydrometric stations, the maximum frequency of floods as noticed in the above table and in figure 2 corresponds to April (Nicoleşti, Vârşag, Zetea, Vânători, Sărățeni). This fact is explained by the corroboration of frontal rainfall with the increase of temperatures which determines the melting of the snow in the mountainous and plateau areas.

There are three hydrometric stations where the maximum number of floods was recorded in March: Simoneşti (17,1), Şicasău (17,4) and Odorhei (30,2%). These basins are located in the mountainous region. In June, the maximum number of floods is recorded at Saschiz (19,0%), and at Şicasău with a proportion of 17,4%, as in March and April (Table 1).

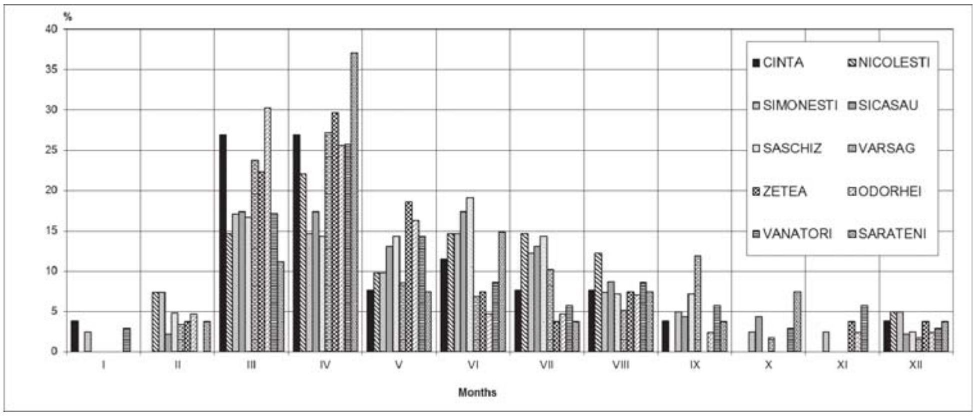

Figure 2. The monthly frequency of floods in percentage in the period 1982-2005.

Table 2. The seasonal frequency of floods in percentage in the period 1982-2005

Hydrometric post	Winter	Spring	Summer	Autumn
CINTA	8	**61**	27	4
NICOLEŞTI	12	**47**	41	0
SIMONEŞTI	15	**41**	34	10
ŞICASĂU	4	**48**	39	9
SASCHIZ	7	**46**	40	7
VARSAG	5	**59**	22	14
ZETEA	7	**70**	19	4
ODORHEI	7	**72**	16	5
VÂNĂTORI	6	**57**	23	14
SĂRĂȚENI	7	**56**	26	11

From table 2 which presents the seasonal distribution of floods one can distinctly notice that most floods occur in spring. In general, at the stations which control the mountainous area, the percentage of floods which occur in spring exceeds half the total number of floods. Only in Nicoleşti, Simoneşti, Şicasău and Saschiz, spring floods are a little lower than 50%. In Nicoleşti, Simoneşti and Saschiz, the somewhat lower percentage of spring floods and the increase of their number in summer are explained by the position of the hydrographic basins which are farther from the mountain, at the border with the Târnave Plateau (Figure 3).

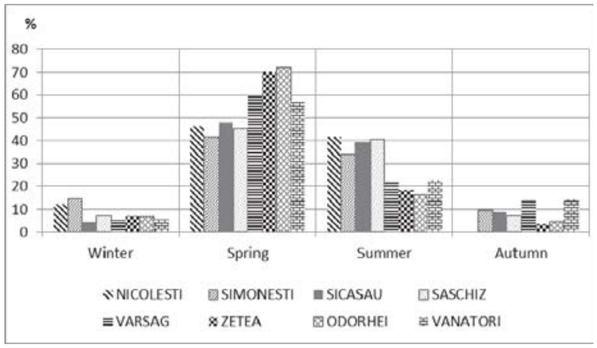

Figure. 3 The seasonal frequency of floods in percentage in the period 1982-2005 in the Târnava Mare Basin.

After comparing the two figures (Fig. 3 and 4), we notice that most floods are recorded in spring both in the basins mountainous region, as well as those in the neighboring Subcarpathian area. The farther the hydrologic basins are from the mountain, the weight of the nival supply decreases and this explains the increase of summer floods number caused mainly by the convective rainfall.

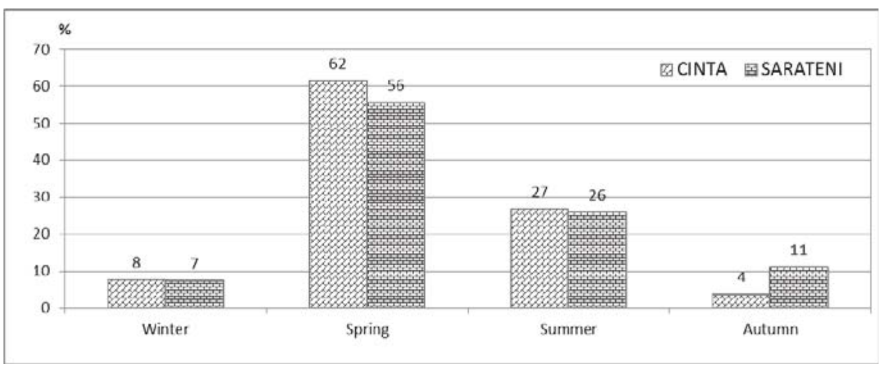

Figure 4. The seasonal frequency of floods in percentage in the period 1982-2005 in the Târnava Mică Basin (Sărățeni) and in the Niraj Basin (Cinta).

Whereas in the last period, 1982-2005, at Cinta there was an equal number of floods in March and April, in the period 1970-2005, we noticed that 23.1% of the number of floods was recorded in March, as compared to only 20.5% in April (Table 2). Likewise at Simoneşti, the maximum number of floods is in March, while at Vânători and Sărățeni the maximum number both for the period 1970-2005 as well as for 1982-2005 was recorded in April (Fig.4). In conclusion, there are no differences in what concerns the monthly frequency of floods in the two studied periods.

Table 3.The monthly frequency of floods in percentage in the period 1970-2005

Hydrometric post	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CINTA	2,6	2,6	**23,1**	20,5	12,8	12,8	10,3	5,1	2,6	0,0	5,1	2,6
SIMONEŞTI	3,1	4,7	**23,4**	9,4	15,6	10,9	12,5	7,8	6,3	1,6	1,6	3,1
VÂNĂTORI	1,7	0,0	13,3	**25,0**	15,0	8,3	15,0	10,0	5,0	1,7	3,3	1,7
SĂRĂȚENI	0,0	3,5	12,3	**24,6**	8,8	17,5	14,0	5,3	3,5	5,3	1,8	3,5

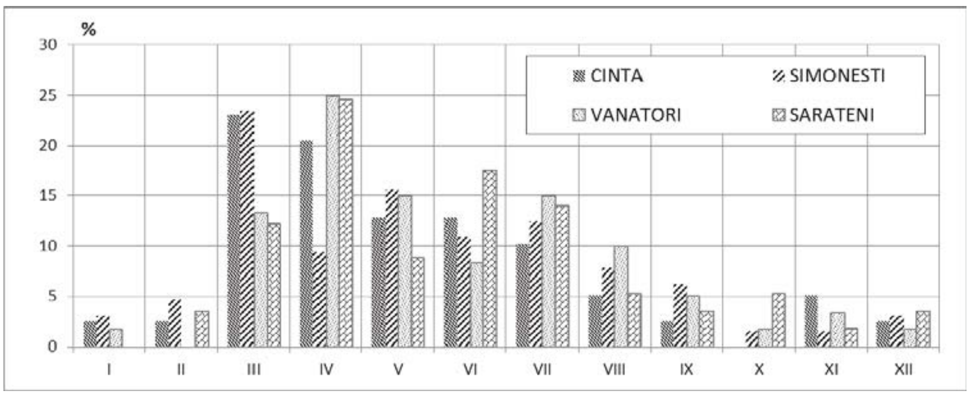

Figure 5. The monthly frequency of floods in percentage in the period 1970-2005

In what concerns the seasons, in spring there occur the most floods, followed by summer. The situation in the period 1970-2005 is shown in the table and figure below (Figure 6, Table 4).

Tabel 4. The seasonal frequency of floods in percentage in the period 1970-2005.

Hydrometric post	Winter	Spring	Summer	Autumn
CINTA	**7,7**	**56,4**	**28,2**	**7,7**
SIMONEȘTI	**10,9**	**48,4**	**31,3**	**9,4**
VÂNĂTORI	**3,3**	**53,3**	**33,3**	**10,0**
SĂRĂȚENI	**7,0**	**45,6**	**36,8**	**10,5**

Winter floods are caused both by the melting of the snow, as well as by liquid precipitations, determined by the rather frequent invasions of hot oceanic air masses from the North-West and intensified by the configuration of the relief, by frontal processes. Such a case was signaled in December 1995 when in the entire studied area there was a generalized typical winter freshet of mixed origin, the 40-70 mm of rainfall overlapped a preexistent layer of snow and caused it to melt.

Spring rainfall floods sometimes have a high efficiency in the formation process of superficial discharge, especially if during the winter and spring months the quantity of rainfall has been high. In this respect, we mention the floods in the years 1974, 1978, 1981, 1987, 1988 with the manifestation period March-May.

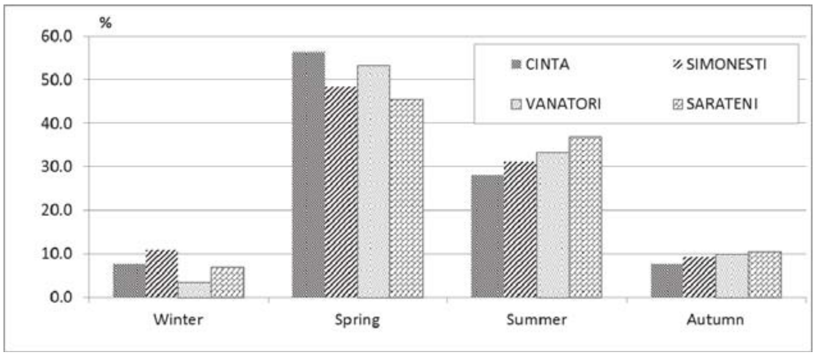

Figure 6. The seasonal frequency of floods in percentage in the period 1970-2005

The floods in the beginning of summer are generated by frontal rainfalls combined with convective rainfall. Following torrential rainfall there appear summer floods which can sometimes reach very high amplitudes, causing floods and material damage. In this respect, we mention the floods in the summers of the years 1975, 1983, 1988, 1991, 1998.

We must also mention the fact that we considered only those floods whose maximum discharge exceeded or was very close to the defense level and which, one way or another, caused more or less damages.

3.2. The frequency of exceeding threshold defense levels

In the period 1970-2005, there were 34 recorded floods which exceeded the alarm levels at Cinta, 83 at Simoneşti, 9 at Vânători and 37 at Şicasău. Of the 34 floods on Niraj, 10 reached and exceeded the flood level, and 23 reached the danger level.

On Feernic, the statistical data shows us that 91.6% of floods exceeded the 150 cm danger level. This shows us that Feernic has a very fast reaction time to external factors of the system, and that the current hydrotechnical works are not good enough anymore, the risk of flooding being very high.

On the rivers Târnava Mare and Târnava Mică, over 50% of the floods have reached the warning level and exceeded the flood level.

Conclusions

From the analysis of floods we can conclude that most of them occur in spring both in the basins in the mountainous area as well as those in the neighboring Subcarpathian's. The farther the hydrologic basins are from the mountain, the lower the weight of the nival supply, which explains the increase in the number of summer floods caused mainly by convective rainfall.

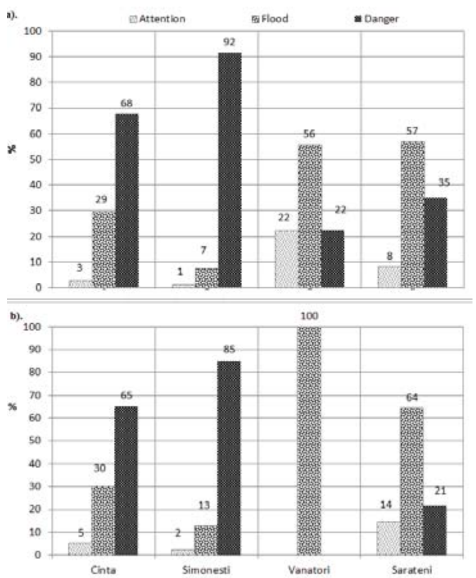

Figure 7. The frequency of reaching and exceeding threshold defense levels during 1970-2005 (a.) and 1982-2005 (b.)

After comparing the statistical data in the interval 1970-2005 and 1982-2005 (Fig. 7), we notice a reduction of exceeding's in the Danger Level on all four posts, the difference being taken over by the Flood Level and the Attention Level. Thus, we notice the impact of hydro-technical measures in preventing and combating floods in the three analyzed hydrographic basins.

REFERENCES

1. Horvath Csaba (2008), *Studiul lacurilor de acumulare din bazinul superior al Crişului Repede*, Edit. Cărţii de Ştiinţă, Cluj-Napoca.
2. Konecsny, N., Mătiuţ, Felicia, (2006), *Fenomene de risc asociate viiturilor propagate pe râul Târnava Mare şi pe afluenţi în cursul lunii august 2005*, în vol. Riscuri şi catastrofe, editor Victor Sorocovschi, an V, nr.3, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca, p.115-126;

3. Mac, I. (1972), Subcarpaţii Transilvăneni dintre Mureş şi Olt, Edit. Academiei, Bucureşti.
4. Pop, Gr. P., (2000), *Carpaţii şi Subcarpaţii României*, Editura Presa Universitară Clujeană, Cluj-Napoca.
5. Sorocovschi v., Konecsny C. , (1990), *Regimul scurgerii lunare a râurilor din Podişul Târnavelor şi regiunea limitrofă din est*, Studia, Univ. Babeş Bolyai, Geogr., t. XXXV, fasc. 2, Cluj-Napoca.
6. Ujvari, I. (1972), *Geografia apelor României*, Edit. Ştiinţifică, Bucureşti.