THE FLASH FLOODS ANALYSIS, REPRESENTATIVE FOR NIRAJ RIVER BETWEEN 1970-2008

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Abstract. The flash floods analysis, representative for Niraj River between 1970-2008. The need to know the characteristics of the flash floods is derived from the number and the intensity of floods occurred in the drainage basin of the Niraj river. Therefore, there were analyzed only the flash floods representatives for the years: 1970, 1995, 1998, 2001, 2008.

The classification of the floods was realized according to the genesis and the flash flood hydrograph shape for the period 1970-2008, before and after the completion of the drainage basin planning/management depending on climatic, morphometric and morphological factors.

Keywords: flash floods, floods, Niraj River, maximum flow.

1. INTRODUCTION

Maximum flow is the most important moment of the river flow because of the potential negative effects it might induce. Thus, for the economic and water management activities it's important to take into account the qualitative and quantitative flow characteristics, their way of occurrence, natural and anthropogenic factors which contribute to their appearance and evolution.

Forecasts predict that the frequency and intensity of floods will be constantly growing both in case of flash floods which are specific to summer season but also of mixed genesis floods (snow melt and spring rain) which are specific to spring season.[2] This is noticeable for Niraj River, subject of this article, which despite continuous development works continues to represent a flood risk for settlements nearby.

By „flash flood” we understand a sudden growth of both discharge and level of a river followed by a slow decrease of it (Pandi, G., 2010).

2. DRAINAGE BASIN DESCRIPTION

Niraj River drainage basin with an area of 651 km² is located in the center of the country, overlapping to western slope of the Gurghiu Mountains, to the area of transition from the mountain unit to the plain unit (represented by the piedmont accumulation of Gurghiu River), to the Târnava Subcarpathians (represented by the

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Mureş and Niraj hills) and to the Eastern Transylvanian Plain, with an average altitude of 539 m.

Niraj river drainage basin is at risk of flooding as a result of specific morphological and hydrological characteristics (its limit begins at an altitude of 1517 m and it decrease until 221 m at the confluence with Mureş River).

Niraj Valley has been an attractive demographic area since ancient times because of natural resources (wood, stone, clay, salt), the possibility of engaging in subsidence activities (livestock due to grazing and grassland extension); the valleys and fluvial terraces provided favorable conditions for human settlements, giving them a strategic position due to the roads that cross the region. Since then the inhabitants of these villages are exposed to floods that have induced damages and even loss of lives.

Niraj River has a length of 82 km and a significant number of tributaries (e.g. Săcădat, Hodoșa, Vărgata, Timirna, etc) with an asymmetry for right side tributaries until the confluence with Nirajul Mic and a left asymmetry downstream of The Miercurea Nirajului (Fig.1). Thus Niraj River receives a significant water quantity due to tributaries which have their origin in the mountains which have a specific power system.

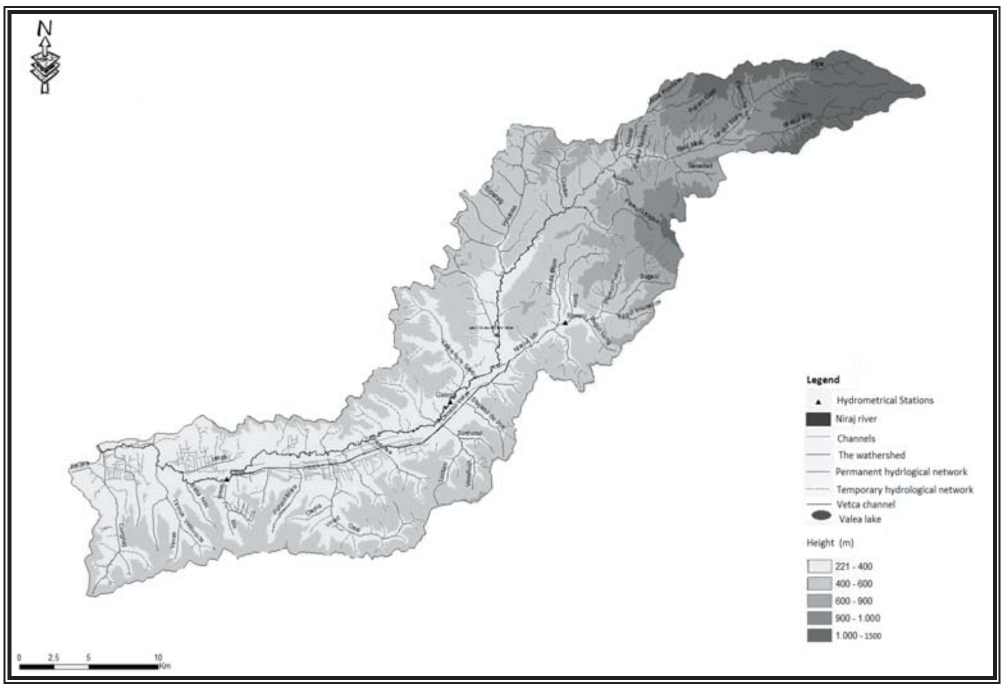

Fig. 1. ***Niraj drainage basin location***

3. SEASON FREQUENCY OF FLOODS DURING 1950-2006

To this end we statistically processed flow values recorded at Cinta hydrometric station during 1950-2006.

Seasonal flood frequency reveals predominance of mixed spring floods (with a frequency of 52%) due to a combination of factors such as: snow melting from the mountains associated with the spring rains, filling beds in conditions of low evaporation, soil saturation and the reduced development of vegetation. Thus specific floods of this period overlap with the spring high waters.

Rain floods arise as a result of advection of the air masses in the western sector which reactivate themselves after they exceed the Western Carpathians where it causes significant precipitation in quantitative terms. For the winter months there were registered 11% of cases, but for the summer months the frequency increased to 32% of cases. In the summer months due to strong thermal advection it was recorded heavy rainfall with high intensity that can not be absorbed by the substrate thus leading to the emergence of specific floods.

Mixed origin floods which occurred in winter months (with a frequency of 5%) are due to Mediterranean influences that lead to temperature increase and heavy rainfall. Thus, because of the high temperature the snow is melting and the river flow increase more if in that period rainfall is recorded.

Table 1. ***Flash floods quantitative parameters***

Nr.		Q max(m^3/s)	T cr (ore)	Vcr (mil. m^3)	Tsc (ore)	Vsc (mil. m^3)	T t (ore)	Vt (mil.m^3)	Vcr/ Vsc	γ
1.	1970 (10V-28V)	329,46	76	10.32	228	85.80	304	96.12	0.13	0.26
2.	1975 (2VII-6VII)	253,56	38	8.56	69	13.9	107	22.46	0.61	0.23
3.	1995 (26XII-6I)	34,59	77	5.90	101	5.51	178	11.31	1.07	0.51
4.	1998 (13VI-1VII)	62,82	132	12.43	72	8.66	204	21.09	1.43	0.45
5.	2001 (18VI-30 VI)	34,58	163	3.51	182	5.08	345	8.60	0.69	0.24
6.	2008 (21V-6VI)	30,19	32	0.86	228	8.83	260	9.69	0.97	0.34

The increased frequency of high waters and that of the spring flash floods (March - May) are due to the maximum pluviometric of the spring and to its overlapping over the specific thermic growth period; winter flash floods (October – December) are due to overlapping a warm period accompanied by rainfall.

The analysis of the flash floods shows that the majority of those kinds of floods occurs in the spring season, followed by summer, autumn and winter in the last place.

4. FLASH FLOODS QUANTITATIVE CHARACTERISTICS ANALYSIS

In the study of Niraj River flash floods recorded between 1970 – 2006 we chose one significant event for every type of flood depending on its genesis:

- 1970 pluvial flash floods (9 V-22V); 1975 (2VII-6VII) and 1998 (13 VI-1 VII);
- 1995 (20 XII 1995-1 I 1996) mixed origin flash flood;
- 2001 (18 VI-30 VI) and 2008 (20V-1VI) mixed origin flash floods;

4.1. Flash flood hydrograph analysis

Flash flood hydrograph analysis method it's an active method by which we can determine the quantitative characteristics of flash floods. The hydrograph shows the flow and level variation depending on time.

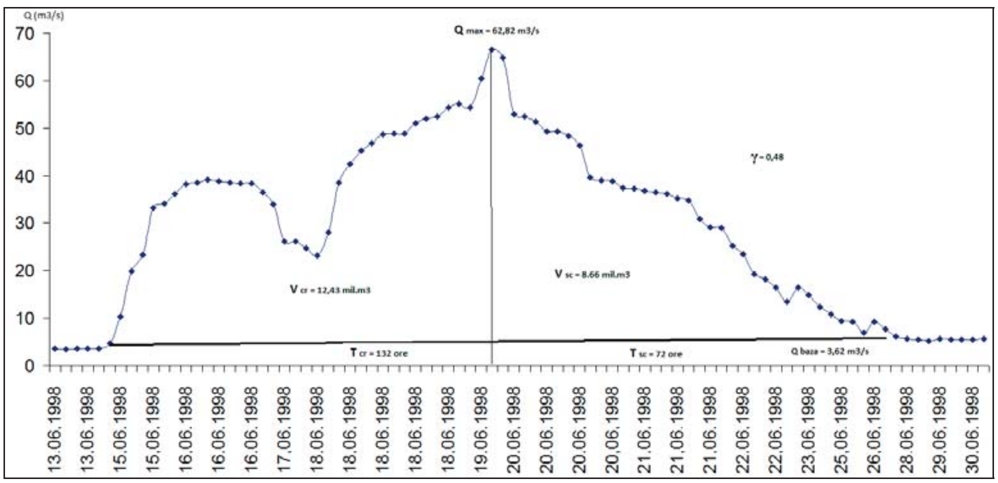

Fig. 2. ***The pluvial flash flood of 1998 (13VI-1VII)***

Analyzing the relationship between the growth and decrease volume of the flash flood that occurred in 1998, we can observe the slow development of the flash flood, expressed by the value 1.43 of the ratio.

The development of this flash flood has occurred slowly and it was expressed by the value 1.07 of the volume ratio.

From the flash floods analyzed above that of 1970 stands out because that year flash floods occured almost on every flow causing great floods. The triggering factor was the heavy rainfalls caused by the penetration of some air masses of tropical origin.

Târgu Mureş meteorological station recorded 103.5 mm quantity of precipitation between 12 – 15 May. Before this, i.e between 1 February – 10 May had rained a lot; that is why the riverbeds were almost full of water when the heavy rainfalls begun on 12 of May. Because of this, the flash flood shockwave could not be diminished. On 13 of May, at 5 A.M. it has been registered the biggest flow of 329.46 m³/s.

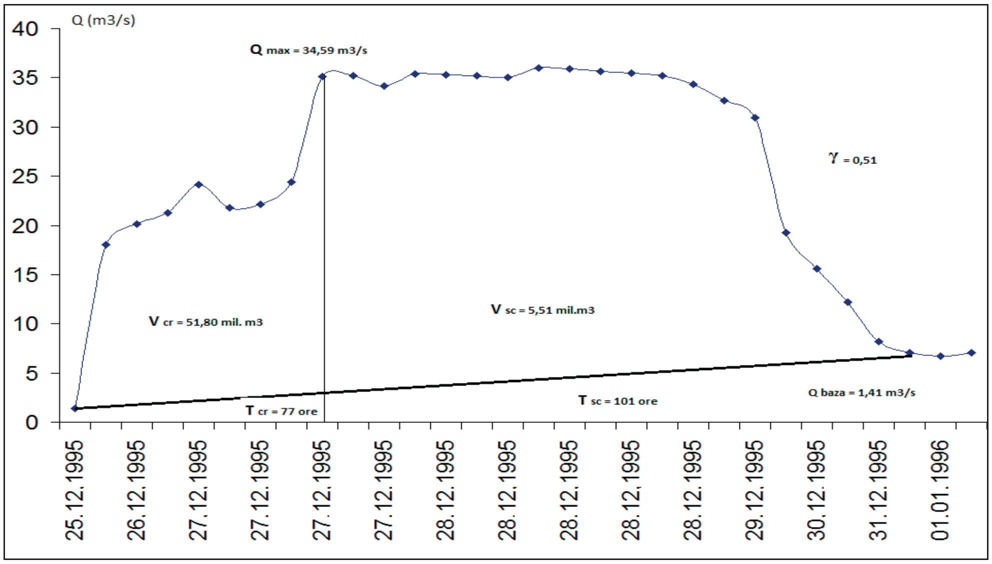

Fig. 3. ***The mixed origin flash flood of 1995 (20XII-1 I)***

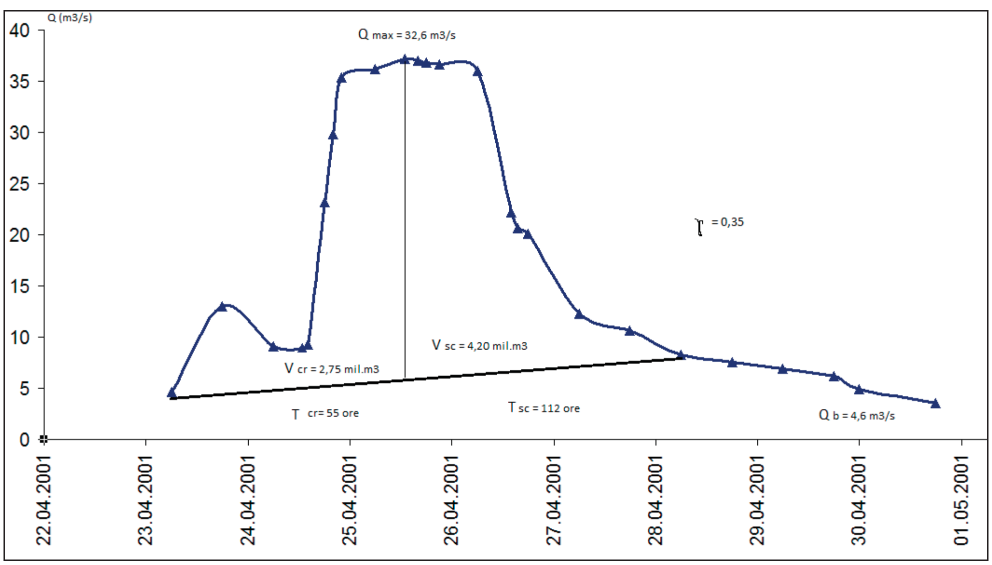

Fig. 4. ***The mixed origin flash flood of 2001 (18 VI-30VI)***

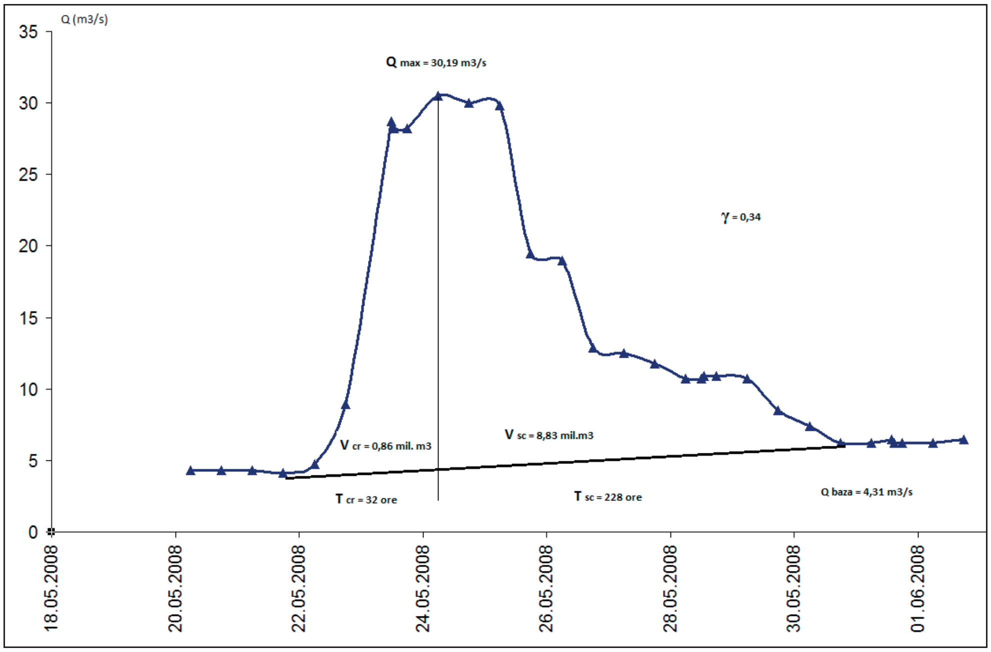

Fig. 5. ***The mixed origin flash flood of 2008 (20V-1VI)***

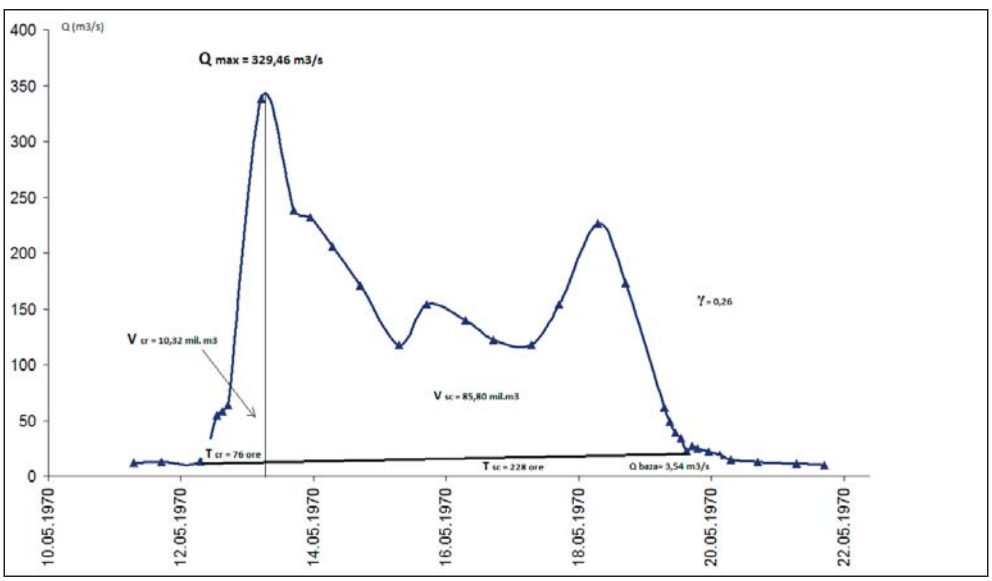

Fig. 6. ***The pluvial flash flood of 1970 (9V-22V)***

The 1970 and 1975 flash floods registered a ratio volume of 0.13, respectively 0.61, i.e. the speed of the flash flood was high.

For the 2001 and 2008 flash floods, therefore after the improvement program of the drainage basin, which consisted in the construction of a catchments area at Valea, the ratio volume reveals a decrease in the speed of the flash floods with values between 0.65, respectively 0.97.

Regarding the report between the period of growing and that of decreasing of the flow, it can be observed through its short growing period, compared with the decrease of flow in the three classes of genetic / genetic types of floods. For the pluvial flash floods the difference between the growth and the decrease period is small; higher values are registered for mixed origin flash floods. The explanation lies in the drainage basin characteristics at the time of flash floods: soil saturation, vegetation, the rainfall length and intensity.

In most cases, the report of the volumes shows a growing volume lower compared to the decreasing volume, which is influenced by the intensity of genetic factors, as it can be seen from the hydrograph shape factor.

Flash flood shape coefficient (γ) is defined as the ratio between the flash flood volume and the volume equivalent to the size of the rectangle flash flood circumscribed (on the hydrograph):

$$\gamma=Vt/(Qmax-Qb)*Tt$$

The lowest values were recorded for the 1975, 2001 and 2008 flash floods, i.e. in the case of the mixed origin flash floods. The greatest value of the shape coefficient (0.51) was recorded for the 1995 mixed origin flash flood.

Today there are two channels with an important role in diminishing the flash flood wave: the Vetca channel, which operates for more than 300 years and a newer one, the Valea Lake from 2004; so, the flash flood propagation time has increased.

Table 2. ***The chart reports between the flash floods lengths and volume***

Flash Flood	Tcr/Tsc (ore)	Tcr/Tt (ore)	Vcr/Vsc (mil. m³)	Vcr/Vt (mil.m³)
1970 (10V-28V)	0,33	0.25	0.13	0.10
1975 (2VII-6VII)	0,55	0.35	0.61	0.38
1995 (26XII-6I)	0,76	0.43	1.05	0.51
1998 (13VI-1VII)	1,83	0.64	1.43	0.58
2001 (18 VI-30 VI)	0,49	0.32	0.65	0.39
2008 (21V-6VI)	0,14	0.12	0.09	0.08

However, for the settlements located downstream of the Cinta station (Gheorghe Doja, Leordeni, Ungheni) the danger of flooding remains high, because of the many of the river development projects (dams, bridges) which led to

handcuff phenomenon and which is affecting the spread of the high waters and of the flood waves. This is also exacerbated by the slope decrease.
The previous flash floods analysis and the features of the current drainage basin will help us to identify the most efficient works for controlling and diminishing critical situations.

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