HIGH RISK HYDROLOGICAL PHENOMENA, THE FLOODS IN THE NIRAJ BASIN

***D. RADULY*[1]**

ABSTRACT – High risk hydrological phenomena, the Floods in the Niraj Basin. Since the beginning of time, people have wanted to know the threats they should protect themselves from, or the opportunities they should exploit in order to be closer to nature. For a long time, the Niraj Valley has been confronted with the danger of flooding which, usually in spring, threaten the houses, lives and activity of the people in the area. In order to protect the settlements on the Niraj valley from flooding, in 1988 the investment "Hydrotechnical improvements in the Niraj Hydrologic Basin, Mureș county" was promoted. It consisted mainly of the following:

- Making the nonpermanent accumulation Valea on Nirajul Mare river
- Recalibrating the Vețca channel in order to receive the full flows of Nirajul Mic river and of its own affluents.
- Arranging the course of the Niraj river between MiercureaNirajului and Unghenii in order to ensure the transition of the water flow with a 5% insurance, and the protection of areas with active erosion.

The moving forward of the work has experienced fast evolution as well as slow pace or even stagnation. However, it is certain that asfter 1999, when work was resumed, the number of dangerous floods was considerably reduced, as we shall see in ths article.

Keywords: hydrological risk, hazard, vulnerability, frequency, flood, flood hydrograph.

Moto

"Humankind rejects coincidences and the power of destiny. It keeps its fate in its own hands, imposes its own ideas upon it and freely acts as it has decided to."
(J.G. Fichte)

1. INTRODUCTION:

1.1. Definition and contents of the notion of "hydric risks"

Risk is defined as "the probability which an event has to happen" (Last, 1995), or "la possibilita che un evento venga" (Panizza, 1998). Usually, one resorts to the concept of risk when events are beyond the scale of human perception (e.g. very low probability, very long or very short time spans) or when doubt plays a key role in the environmental problem.

[1] Universitatea Babes-Bolyai, Facultatea de Geografie. E-mail: barbarosa152000@yahoo.fr

The combining of risks in a territory , be they natural, quasi-natural or anthropic risks, can lead to the apparition of areas prone to risks, and to the apparition of areas which are dominated by *frailty*.

Risk can be evaluated by three dimensions: the probability of coming true, its seriousness in case of happening and estimation of our level of the knowledge we have regarding the particular risk. Therefore, we can highlight risks whose dimensions are evaluated with sure precision, risks estimated highly approximatively and risks whose very existence is a controversial matter. In the same way, one can highlight the "predictible" risks in which the occurrence of the event is announced by preious signs, which are liable to be detected by supervision networks.

A risk corresponds to the probability of a loss (damage). The notion of loss is wide, for the reason that it contains human lives, the industrial, agricultural and cultural heritage, as a stability of political systems. Risk depends on the importance of the physical phenomenon (flood, cyclone, volcano, earthquake...) with its origin in losses and the probability/intensity relationship which define hazard.

But if risk depends on the importance of hazard, the risk seriousness and its effects depend on the vulnerability of the area, which is expressed by the effects/intensity relationship.

A risk is therefore, the result of the combination between the intensity of a hazard and vulnerability:

Risk = Hazard x Vulnerability

How do we define vulnerability? This notion proves to be complex, in that it encompasses various parameters. One can mark out economical vulnerability as well as human vulnerability. Economical vulnerability is structural (material damage, work, means of communication and dwelling damage, , the cease of economical activity...). Human vulnerability evaluates the prejudices that people suffer on both the physical and moral level (dead, wounded, missing or depressed people...). Vulnerability can also be defined through more subjective, humane and social unquantifiable parameters (losses which have sentimental value, psychological shock, technical unemployment, fear of hazard...)., which play an important part in the position that man maintains as far as hazard is concerned. This social notion of vulnerability is all the more important when human position to hazard evolves in time.

The periods in the existence of a river, when water flow is abundant or excessive, are characterized by high waters and floods, and according to their extent, by floods and more or less extensive flooding, more or less dangerous and detrimental (C. Diaconu, P. Șerban). The difference between high waters and floods exists and must therefore be explained, in order to avoid any confusion.

By the term *high waters* one defines the stages in a river's existence when flowing is generally at high levels. High waters are commonly either a consequence of the slow melting of the snow, or of low intensity but persistent rain.

The flood is different from high waters by a time concentration of the flow, that is by relatively fast increases of the water discharge and therefore the water levels, by the reaching of high water discharges, and then by a relatively fast decrease of the waters, which is, however, generally slower than the increase.

High floods represent one of the most important stages of the flowing down of rivers, for their extreme character, but also, more importantly for their direct and indirect consequences on everything that makes the environment. They are classified as being maximum flowing, and the characteristic elements of maximum flowing have been observed closely since the earliest times.

The documents which set the basis for the present article are: the hydrometeorological data the network of hydrometric stations and pluviometric posts respectively, received from the „Apele Române"S.A. National Company – The Mureş Water Management Department in Tîrgu-Mureş; the technical data referring to the Nonpermanent Accumulation and a range of books, magazines, newspapers, maps and atlases named in the bibliography.

2. GEOGRAPHICAL LOCALIZATION

The region studied in the present article is part of the Hydrographic Basin of the river Mureş**,** the Niraj being a left affluent of it. The hydrographic basin of the Niraj, with a surface of 555 km² and a medium altitude of 539 m (Sorocovschi, 1996), is lain on two fundamental units of relief: the Oriental Carpathians and the Hillock Depression of Transylvania, there exists between them a transition step: the Transylvanian Subcarpathians. The hydrographic basin of the Niraj borders on the Gurghiu and Mureş Basin in the north, the Mureş Basin in the east, the Târnava Mică basin in the south, and the Mures Basin in the west.

The Niraj, with a length of 79 km and the direction of water flow being east-west, is formed by the merging of two rivulets: the Niraj Mic and the Niraj Mare which spring from Gurghiu Mountains, from under the Secului crater (Sacca peak – 1777m). The springs are situated at altitudes of 1300m. The Niraj Mic is considered the origin (Ujvari, I – 1972).

The Niraj flows through the mountain heights, west of the Sovata-Praid Depression, which is closed by the alignment of a suspended synclinal marked by heights with mountainous altitudes (Becheci), the high altitudes being a consequence of them being protected by the remains of the volcanic coverlet (pyroclastic rock) which got to this area in the period of manifestation of the neogene volcanism. Moreover, the presence of volcanic agglomerate and the altitudes of over 1000 m in those areas determined a series of researchers to set the peaks mentioned in the mountainous area nearby.

Where the Niraj enters the Tarnave Plateau, (in this case the Niraj is no longer considered the northern limit of the Plateau, first because there appears a hydrographic convergence (the Niraj and the Niraj Mic) with all its consequences: alluvial cones, terraces and rather wide meadows), because in this area the Miercurea Nirajului Depression is sculpted, the river obviously changes its characteristics.

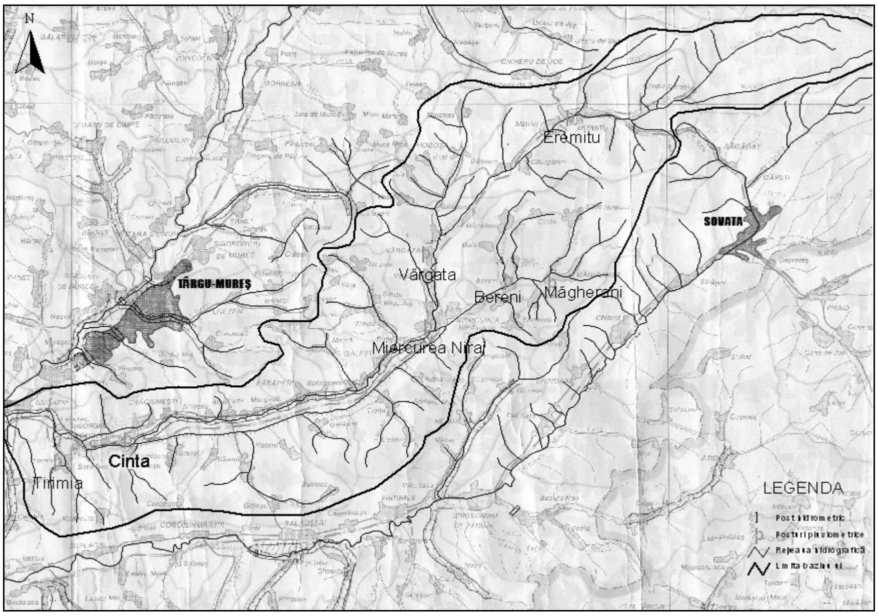

Fig. 1. ***The Hydrographic basin of the Niraj. Pluviometric and hydrological posts***

Downstream of Miercurea Nirajului, the river flows through the Niraj hills (Pop, Gr.; Sorocovschi, V.) which lie between the alignment of the Tirimia-Suplac settlements in the west, the Mureș corridor in the north, Periş-Teleac-Miercurea Nirajului-Neaua-Sângeorgiu de Pădure in the east and the Tarnava Mica corridor in the south (Pop, Gr.).

3. FLOODS

3.1. The frequence of floods in the niraj basin

Every year, depending on the action of the meteorological factors, which pertain to the dynamics of the atmosphere and to other factors which depend on the characteristics of the active surface, there occur, within hydrological seasons, periods with high waters or low waters. In the period of high waters there often occur most floods.

Table 1. ***The frequency of floods in semesters***

Hydrometric station	Warm season		Cold season	
Frequency	case no.	%	case no.	%
Cinta	32	72,73	12	27

For the 1970–2000 period, in the warm semester of the year, the frequency of floods was of 72.73%, and the frequency of floods in the cold semester was of 27.27% at the Cinta hydrometric station.

From the above table one can notice the clear predominance of floods in the warm semester – 32 recorded in the past 31 years, whereas in the cold semester, the total number of floods does not exceed 12.

Calculating the flood frequency by seasons for the same period, one notices the high frequency of floods in spring and summer months. The season with the highest risk of floods is spring, with more than half of the total number of cases recorded in the analysed period. At the opposite end is wnter, with only 4.54% of the total number of cases. The frequency of floods by seasons can be observed more clearly in the figure below.

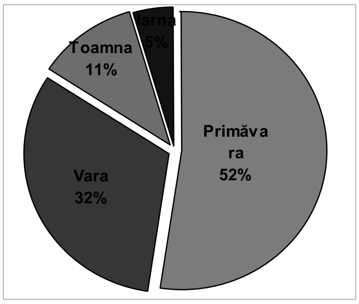

Fig. 2. ***The Frequency of floods by seasons***

The most frequent cases are those which present two floods a year. Nevertheless, there were years when the number of floods was more than 2. the highest number of floods was in 1989 (three floods, all during the summer), and the lowest number in 1999, 1986, 1981, 1975 (this being, however, one of the most catastrophic, together with the floods in 1970).

The months with the highest risk of floding are the spring months. In March, April and June there occurred 8 floods of the 44 recorded, and in May – 7 floods. January, February and August lacked in floods completely in the studied period. In May there occurred 7 floods and in July – 6 floods; in October and November there was one flood a month, and in September and December there occurred 3 and 2 floods respectively, as you can see in the figure no.3.

Table no. 2. ***the probability of flood occurrence with given or total rising time***

Hydrometric station	Rising time – days			Total time – days	
	<2	2,1–5	>5,1	5–10	>10,1
Cinta	29%	29 %	42,0 %	25,8 %	74,2 %

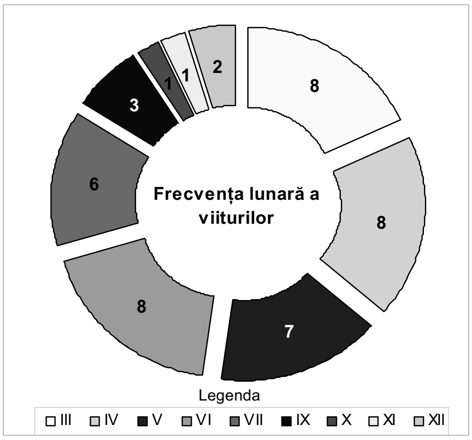

Fig. 3. ***The monthly frequence of floods in the Hydrographic Basin of the Niraj***

Analysing the total duration (Tt) of the floods and the rising time (Tcr), one can notice that floods with a total time span of up to 15 days are predominant (67%), whereas floods whose time span exceeds 20 days represents only 12.9% of the total 31 cases considered. On the other hand, floods with a rising duration of less than 5 days represent 54% of all cases. In this category we can mark out the floods with a rising duration of up to 2 days and those with a rising duration of between 2 and 5 days. Each of these last 2 categories of floods has a 29% weight.

3.2. Flood hydrographs: case study – the flood in 1997

The idea of a unitary hidrograph was put into practice in 1932 by the American hydrologist L.K. Sherman (Gh. Platagea, 1937), with the purpose of calculating and predictiting the hydrograph of pluvial floods. This method presumes that the pluvial floods produced by isolated heavy downpours, with a duration of 24 hours (or any other unitary duration), have a longitudinal prediction time which is constant or almost constant for the studied basin.

By its contents, the unit hydrograph method represents a particular case of the isochrone method (this method relies on the variation in time of rain and of the elementary flows on the partial collecting surface, where the maximum flow is formed).

The shape of the unit hydrograph depends especially on:

a) the dimension and configuration of the reception basin (F = 55 km²; longitudinal form).

b) the distribution of rainfall in a given time unit (especially for small basins).

Of the many floods that ave occurred during the past 3 decades, I have chosen as an example, the flood on 19th–25th April 1997, with its maximum peak on the 22nd.

In this case, we deal with a flood specific to spring, when the generating rainfal fell on a soil which had previously been well moistened by the melting of the preexistent snow. This can be clearly seen from the value of the discharge value which doubled from the flood in the winter of 1995 (α = 0,2), reaching α = 0,5 now. The total volume discharged durin the flood is 17,79 mil m³, starting from a base volume of 4,59 mil m³. The total time (Tt) of the flood was 348 hours, of which 80 hours represent the rising time (Tcr), and the difference of 268 hours – the diminishing time (Ts).

It is important to point out the fact that although in April in most of the Romanian plateaus and even in the Subcarpathians there is practically no snow, in 1997, in the Niraj Basin, the situation of the snow layer was as follows:

- Cinta : 1 cm (in the second ten-days period)
- Eremitu : 1; 13; 1cm (in all three ten-days period of the month)
- Miercurea Nirajului : 2 cm (in the second ten-days period)
- Vărgata : 4 cm (in the second ten-days period).

Together with the snow layer which melted entirely in the period between April 19th and May 1st, having a great contribution to the formation of the flood, the rainfall which preceeded the moment of the flood by ten days was of approximately 30 mm at Cinta, 35 mm at Miercurea Nirajului, Vărgata and Bereni, over 40 mm at Eremitu in the Subcarpathians, and more than 50 mm in Gurghiu Mountains (Fig. 4).

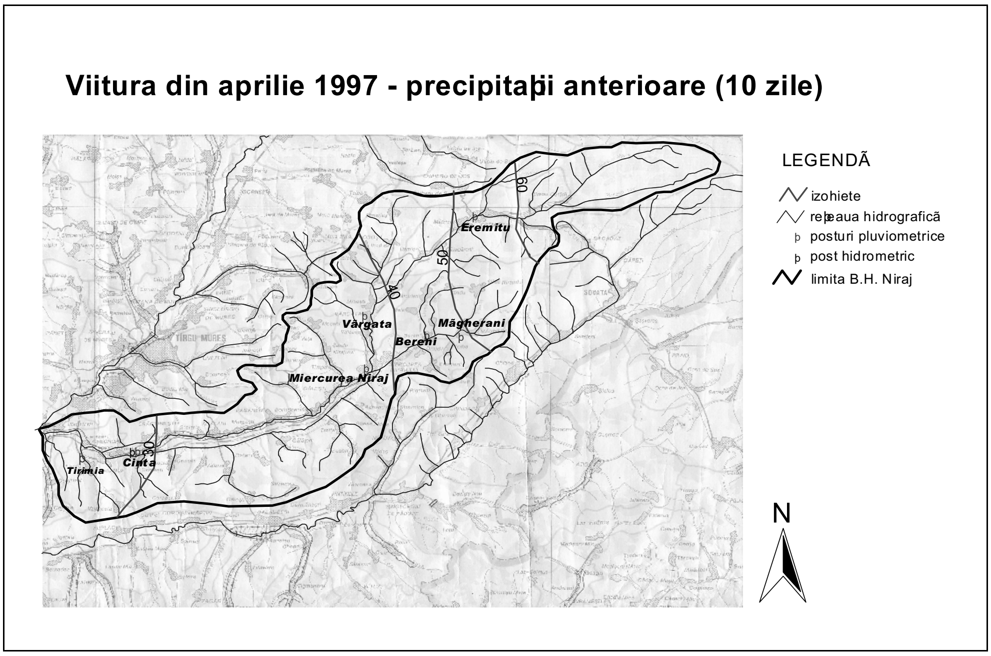

Fig. 4. ***The Niraj Basin, rainfall between 9th–19th April 1997***

The generating rainfall occupied the entire basin, concetrating mainly on the Miercurea Nirajului-Vărgata-Eremitu-Măgherani-Bereni area, where the rainfall quantity was of 50–60 mm. The same high value, over 50 mm, was recorded at Cinta and Tirimia as well (Fig. 5).

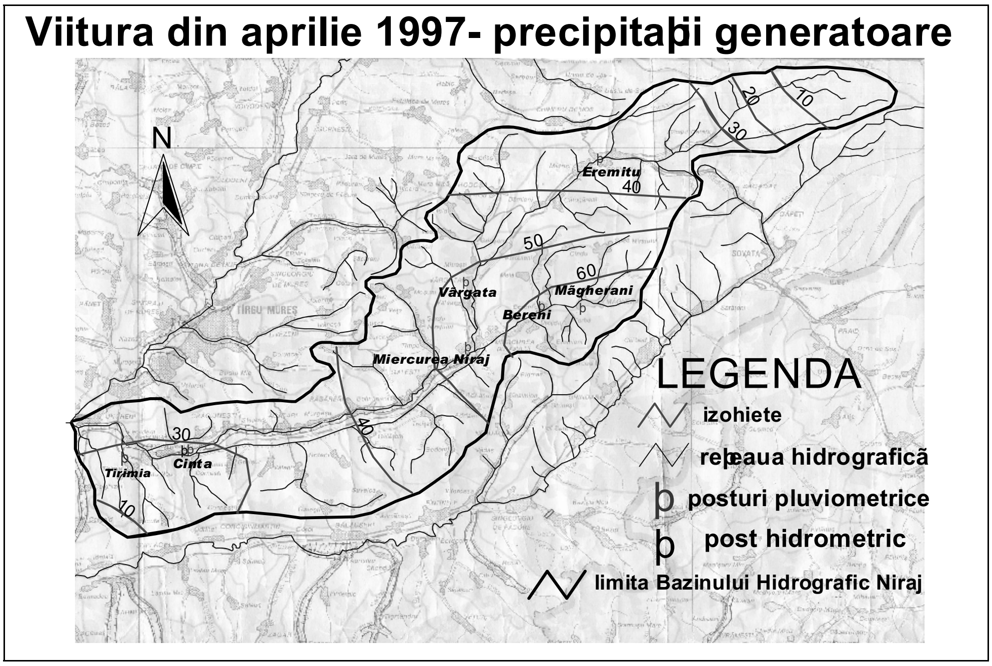

Fig. 5. ***Generating rainfall of the flood in 1997, 20th–22nd April***

The preliminary and generating factors of the flood in April 1997 can be noticed in table no. 3, below.

Table no. 3. ***The thickness of the snow layer, previous rainfall and generating rainfall of the flood – April 1997***

Pluviometric post	The thickness of the snow layer – April 1997 (cm)			Previous rainfall 9th–19th April 1997 (mm)	Generating rainfall (mm)
	Ten-days period				
	I	II	III		
Cinta		1		30	>50
Eremitu	1	13	1	>40	>55
Miercurea Nirajului		2		35	>55
Vărgata		4		35	>55

In what follows, we shall present the flood hydrograph, flood which has an initial base flow the value of 4,91 m³/s recorded on the 19th of April 1997 at 6 p.m. It is a typical case of simple flood with an accentuated rise in the flow until the

22nd of April at 2 p.m., after which there follows a period of flow diminishing until the 3rd of May 1997 6p.m., considered to be the final moment of the flood.

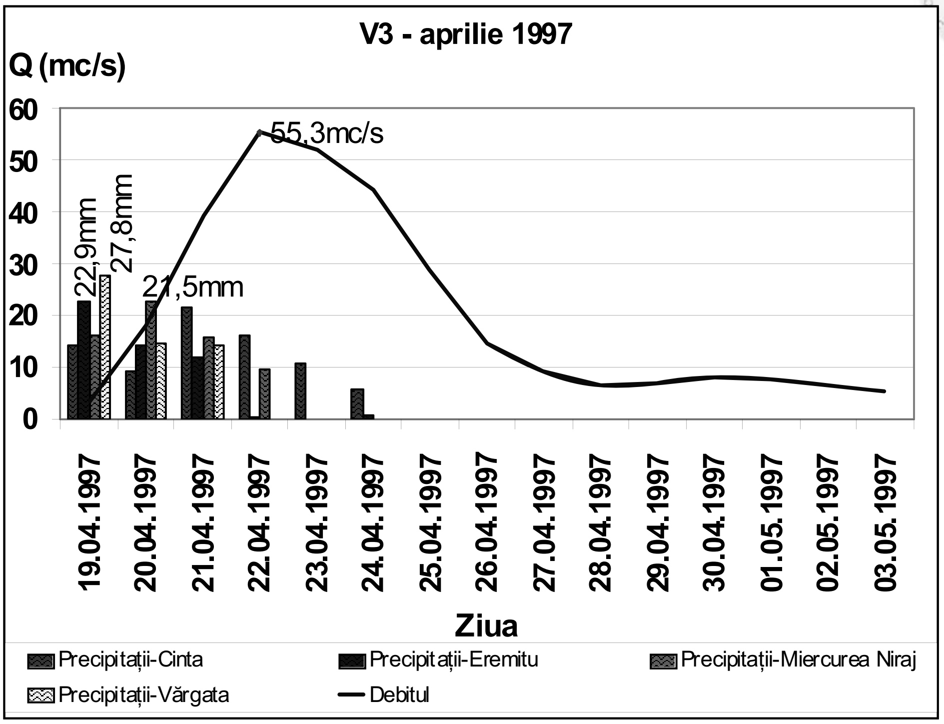

Fig. 6. ***The Hydrograph of the flood in 1997***

4. CONCLUSION

Between 1970–2005, 34 floods were recorded which exceeded the alarm level at Cinta. By far, the floods in 1970, 1974, 1975, 1981 or 1983 were the greatest. Of the 34 floods on the Niraj River, 10 reached and exceeded the flood threshold level, and 23 reached the danger level.

Table no.4: Alarm level, flood threshold level and danger level

	H/Q (cm / m3/s)		
Hydrometric post	Alarm level	flood threshold level	danger level
Cinta	350/34	450/51	500/123

By a comparative analysis of the data we have at our disposal, we can notice that in the past 23 years, there have been no exceedings of the insured flow of 1%, and the exceeding of the flow with an insurance of 2% and 5% has reduced considerably, especially due to the specific hydrotechnical operations in the Hydrological Basin of the Niraj. As for the impact of the hydrotechnical operations on the Niraj (the Valea nonpermanent accumulation, dammings, channels), the socio-economic effects of the floods in the Niraj Valley and the inhabitants' perception on risks, we shall speak about these in a future article.

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