# FLASH FLOODS IN THE ILIŞUA BASIN

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**ABSTRACT. – Flash Floods in the Ilişua Basin.** The Ilişua Valley is a right tributary of the Someşu Mare Valley and has its spring in the south-western part of the Tibleş Mountains. It is a perennial river, and its maximum flow sometimes exceeds the national multi-anual average. One manifestation of this high flow is represented by two types of flash floods: the ones caused by heavy rainfall and the ones caused by the both heavy precipitation and the melting of snow. These two types of flash floods have specific characteristics not only in terms of causes but also in the happening, the impact area and the scale or proportions of damage. These features are further explained in the analysis of two flash floods that have taken place on May 12-17, 1970 and June 20-21, 2006. The occurence of these extreme hydrological phenomena in the basin and their impact upon nature, people and infrastructure makes the need of more hydrological survey a fact.

**Keywords:** Ilişua Valley, flash floods, precipitation, causes, damage.

## 1. INTRODUCTION

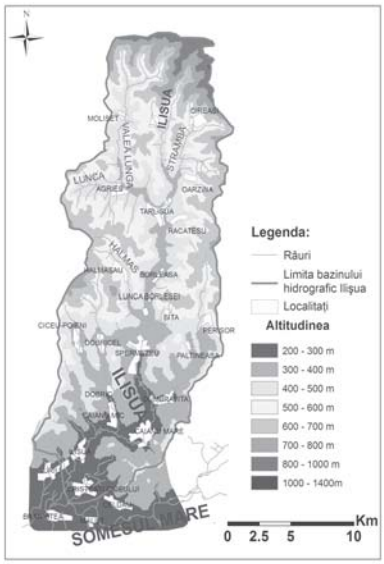


**Fig.1.** ***The Ilişua Basin. Hypsometric map (DAS-T)***

The Ilişua Valley, with its lenght of 52 km, stands out as the Someşul Mare Valley's most important right tributary. Its springs are situated on the southern side of the Păltiniş Peak, Tibleş Mountains, at 1020 m of altitude, whilst the point of confluence is located at 242 m of altitude, at Cristeşti-Ciceu. (Cocean and Danciu, 1994). The 778 m difference in altitude between the source and the mouth of the river, related to its lenght, reveals an average slope value of 15 %. As the slope decreases down stream, the values also decrease from 28% upriver, in the central part of the Ţibleş Obcine to about 4% in the medium-down stream, in the Suplai Hills (subunit to the Someşului Mare Hills) (Fig.1).

,,The Ilişua River, as a body of water, reveals a dentritic network with major tributaries (Răcăteş, Zâmbriţa, Hălmăsău,

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Sita, Dumbrăviţa, Dobricelului Valleys) perpendicular to the drainage direction, and minor ones, of low drainage potential, dip or antidip, found on the front or back of the cuesta, carved into Eocene-Oligocene formations" (Cocean. P, and Gabriela Cocean, 2007) or Badenian formations (downstream the Dobric-Dumbrăviţa line). It collects its waters from an area of 353 km².

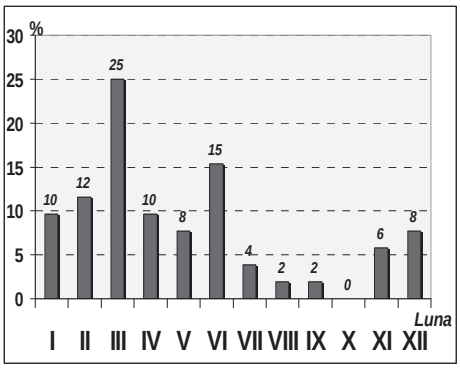


**Fig. 2.** ***Monthly peak flows in percentages (DAS-T)***

Precipitation, the climatic element of highest interest for the studying of flash floods has an average amount of 800 mm, with different values between the upper and lower basin (Agrieş 1000mm, Cristeşti Ciceu 600mm). Snow is present for 60-100 days/year.

The main soil orders, Luvisols and Cambisols, support rich vegetation associations such as natural grassland, oak-beech forests and conifer forests (spruce). The total area covered by forests of the basin consists of 11200 hectares (31.7% of the total land area), most of it concentrated in the upper basin.

The spatial distribution of human settlements has been influenced by the morfometric features of the landscape. Thus, the centres of villages have been placed in the fossil flood plain upstream, and on the 2nd and 3rd terraces downstream.

## 2. METHODOLOGY

The study of the flash floods that have occured in the area is based upon lengthy observation of the manifestation of the processes, their impacts and the antrophic response to these extreme natural phenomena. The circumstances and main features of flash-floods where identified after analyzing data and conclusions of the specialised departments of the The Someş – Tisa Water Directorate.

The analysis of the effects of these flash floods is based on the data supllied by the same departments of The Someş – Tisa Water Directorate but also by local officials as well as on the field survey done by the authors.

## 3. CONTINUITY OF EXTREME HYDROLOGICAL PHENOMENA

The geographical position acts like a conditional and amplifying factor for the development and evolution of flash-floods. Eastern Carpathians, in general, and Ţibleş Mountains as a constituent unit, due to their position that is transverse to the dirrection of the movement of air mases that penetrate the Intra-Carpathian space, favor the regeneration and long stagnation of atmospheric turbulences in the Transylvanian Basin.

The development and features of floods in the Ilişua Basin are influenced by several factors, with different degrees of influence. Thus, morphometric elements, spatial and temporal variation of regimen of the stream, litho-edaphic stratum are all causal factors, whilst the distribution of vegetation and human activity are factors of variable features, they can either favor the development of a flood, but also prevent it from happening, or at least diminish the impact of such a phenomenon. Meteorological elements like rainfall and melting snow act as the triggers for flash floods.

The flash floods that took place in this area are included in one of the two types known for the temperate continental climate: spring and winter floods, caused by heavy precipitation associated with the suddent melting of snow, and summer floods, caused by excesive rainfall. (Fig 2).

The ones that have taken place in 1875, July 1910 (Dobricului Valley, 23 casualties), May 12-17, 1970 and June, 20 th, 2006 are the most important floods in the area.

Measurements of meteorological and hydrological parameters are made at the only hydrometric station in the basin, located in Cristeşti –Ciceu, whilst in Agrieş only measurement of precipitation are made. Up until 1990, pluviographs were in function in both Spermezeu and Târlişua.

## 4. CAUSES

*The flash flood of 12-17 of May, 1970.* The hydro-meteorological context of this flash flood is marked by the amount of precipitation fallen between January 1 to April 30, 1970 that exceeded 200 mm. By late April, precipitation was still represented mainly by snow, due to low temperatures. In May, temperatures began to rise, reaching, between the 7th and the 13th, 29ºC. The temperature rising was due to the entering of tropical maritime air moving from North Africa passing over Italy and arriving into Central Europe, including the Transylvanian basin. (fig 3)

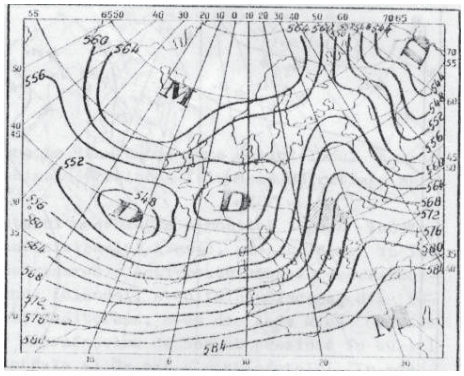

**Fig. 3.** ***T.A. 500 mb Map of May 12 (Anuarul meteorologic 1970)***

It then reached the mountain area causing temperature increase at higher altitude, up to the point of having positive temperature at night time, determining the sudden melting of snow.

During this period, weather conditions were unstable, with heavy rainfall accompanied by lightning. Since the beginning of May, up till the 12th, there was an amount of precipitation almost equal to the entire month multi-anual average.

On the 12th and 13th, a maritime polar air moved from the North Sea, and met the warm tropical air, causing a deep cyclonic center that had a surface pressure of about 995 mb. The great termic contrast between the two air masses was 10-15 degrees at ground level as well as in higher altitudine. Associated to the surface topography, it caused a strong vertical motion that formed large clouds. The result was the fall of heavy rain accompanied by lightning, increasing wind and hail, whilst in the mountains sleet and snow was reported.

On large areas, rain had a significant degree of torrentiality. Thus, in 72 hours (between the 11th and 13th of May) rain quantity increased up to 100,5 mm in Târlişua and 83.5mm in Spermezeu (Anuarul meteorologic 1970).

These weather conditions, that have also led to the melting of snow, in the context of soil moisture that had increased in the previous period and reduced evapotranspiration, were the main meteorological factors that caused the flash flood.

*The flash flood of 20-21 of June 2006* was caused by abundant precipitation. The days before the flood were characterized by unstable weather conditions and a great amount of precipitation, especially between June 1st and June 20th when the values were in the range of 28 l/m² in the lowlands of the basin and 53 l/m² in the higher areas. Flow levels and volumetric flow rate in the sections of gauging stations were still close to the average annual values of June.

On June 20th, hot air, accompanied by high temperatures entered the Someş basin area, causing an overcast sky, and associated with the high nucleus of very cold air, excesive rainfall unequally spread upon the area. (Fig 4)

The strongest impact of the collision between the two air masses was felt in the north-western part of Bistriţa-Năsăud County, especially in the Ilişua basin.

Thus, data from the two gauging stations reveal the very high intensity of the phenomenon. At Cristeştii Ciceului, on the lower stream, on June 20th, 60 l/m² were recorded, whilst on the upper stream, at Agrieş a similar amount was registred right before the gear was detroyed by the flood wave. (Şerban et al,2010)

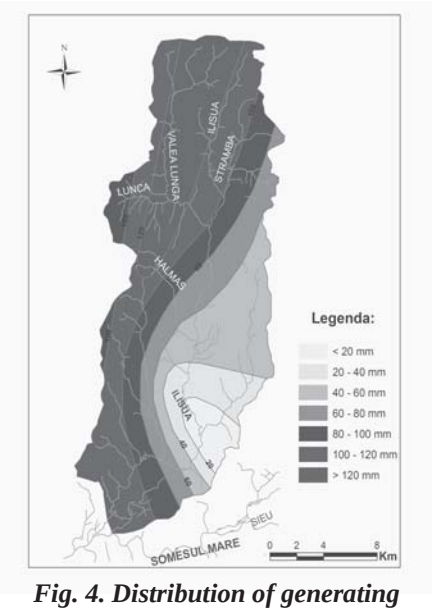


***Fig. 4. Distribution of generating rainfall (DAS-T)***

After the analysis of weather radar images, the estimated quantities have reached up to 125 liters per square meter in isolated spots, and above 100 liters per square meter in the upper section of the basin (DAS-T).

## 5. DEVELOPMENT

*The flash flood of 12-17 of May, 1970.* The abundant rain fallen from January up to April, resulted into the supersaturation of the soil. There has also been produced a substantial layer of snow in late April, which melted due to the positive temperatures in early May.

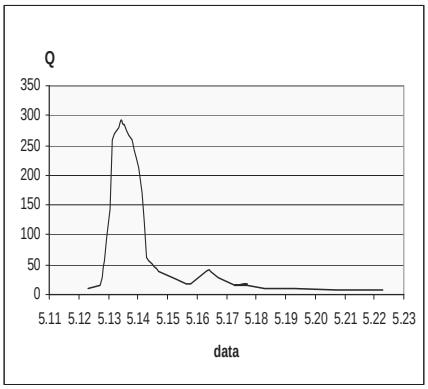


**Fig. 5.** ***The hydrograph for the 12-17 .V.1970 flash flood***

In addition, between the 10th and 12th of May, the amount of precipitation was of 47mm in Spermezeu and 52 mm in Târlişua, half of them registered in the afternoon of May 12th. Later on that night, torrential rain fell, reaching even higher values, of 59 mm in Târlişua and 63,8mm in Spermezeu.

Under the above circumstances, an incresed flow was reported at the Cristeşti – Ciceu station, starting in the morning of May 12th (11.6 m³/s), until 10am of the next day (294 m³/s).

We can distinguish three stages of the development of the flood:

1. the slow, primary stage – between 7am and 9pm, when the flow increased by 45.7 m³/s;
2. the explosive, medium stage between 9pm şi 3am, when the flow increased by 222.3 m³/s;
3. the slow, superior stage, between 3am şi 10pm, when the flow increased by 33.4 m³/s.

This last stage was followed by a decrease in flow for the next 56 hours, down to the amount of 18 m³/s (May, 15th, 6pm), following similar steps, but in reverse. Due to its features, the explosive, medium stage can be compared to a flash flood caused by heavy precipitation.

The events of May 16th, had a similar pattern: heavy rainfall during the night, especially in the upper basin, (20,7 mm at Târlişua), leading to an increase in flow up to 41.1 m³/s. The next days, there was a decrease of flow, and the returning to normal values for the period, 7 m³/s on June 22nd. (Fig. 5)

We must however underline the significant contribution of heavy rainfall in the mountains, and generally in the upper basin, to the formation and evolution of the flood. Correlations with values reported in the upper basins of nearby rivers, at Suplai, on the Ţibleş river, or Groşii Tiblesului on the Lăpuş river, sustain the idea that in the upper part of the basin, in Şendroaia, for instance, the values were potentially much higher than the ones in Târlişua.

*The flash flood of 20-21 of June 2006* was due to strong rainfall. Enhanced convective cores (over 25 l/ m²/hr) were present in the northern part of the basin, around 12.30am. They slowly moved southward, while others were forming upstream, amplifying the effect of the first wave of precipitation.

The result of this very heavy rainfall was the development of a flash flood, characterized by a very sudden increase in flow of all the rivers in the basin. The peak flow calculated for a median section was of 280 m³/s, corresponding to a production probability p = 0.7% - 0.8% (DAS-T).

The hydrograph recorded at the Cristeştii Ciceului gauging station (Fig 6), indicates a peak flow equal to 212 m³/s with production probability of 4%, while in volume it reached 7.72 million m³. The maximum flow registered in the station's section is smaller than the one from the upstream section, because of the flow reducing once the river discharged in the flood plain. (DAS-T)

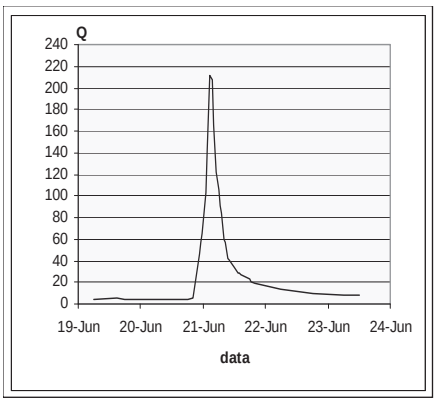


**Fig. 6.** ***The hydrograph for the 20.06.2006 flash flood***

Other features of this flash flood are the massive drain on the slopes, torrents and small valleys, strong erosion of topsoil and carrying of trees, shrubs and wooden material resulted from logging.

The movement of this heterogeneous mass consisting of water, wooden debris and silt was difficult in areas of confluence, bridges or windings, where it formed series of blockages. Behind them large volumes of water gathered forcing and tearing these blockages, and then advancing with increased flow downstream.

## 6. EFFECTS

*The flash flood of 12-17 of May, 1970.* In spite of the maximum flow of this flood and the long period in which water has been stored (23 h and more than 213 m³), its effects were not perceived as being severe or impressive. The reasons for this might be the following:

- higher degree of afflorestation (forests being very effective when long-term rainfall occures);
- the dispersed character of the settlement (it was only after 1970 that the concentration of the built houses towards the village center was imposed);
- modest economic development of the area, including of households;
- poor infrastructure and technical equipment.

*The flash flood of 20-21 of June 2006* was major in terms of effects, being perceived on several different levels:

- on a social level: casualties;
- on an economic level: from property damage to the destruction of houses, of infrastructure and damage of the utilities;
- on an environmental level: impacts upon vegetation, soils, the bacteriological and chemical changes of water;

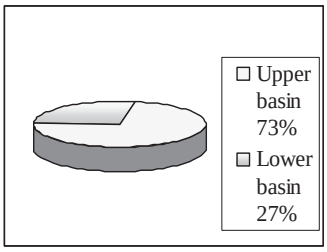


**Fig. 7.** ***Distribution of damage in the basin***

The total amount of damages has been estimated up to approximately 94 500 000 RON. One can note the concentration of damage in the upper basin, which corresponds broadly to the administrative area of Târlişua (Fig 7).

Among the social type of damage brought by floods, there is also the severe stress the population has confrunted, increased by the fact that both flash floods happened during the night. The state of stress has been compounded by the vulnerability of the area to the risk of large landslides.

## 7. CONCLUSIONS

Due to the location of the Ilişua Valley, hydrological risks, like floods or flash floods have a certain continuity in this area, proven by geomorphological landcape, archaeological evidence, local memory and of course, hydrometric measurements.

The two types of flash floods, the ones caused by abundant rainfall, and the ones caused by heavy snow melting when combined with heavy rainfall have both occured in the Ilişua basin.

In comparing the two flash floods, one can notice in regard to the causes the multiple factors of the first, among which the water saturated ground, positive temperatures that caused the snow melt, heavy rains of May 10-13 whilst the flash flood of 2006 was the result of particular abundant rainfall in a short period of time.

Although the first one had a more complex and prolong development, with its three stages, and the later one was quite simple and developed in just a few hours, their effects were very different, and very differently perceived. The vulnerability of the communities to the second flash flood was much greater, and so its effects were more destructive.

Given the continuity of hydrological extreme phenomena in the Ilişua basin, there is the need of more hydrometric stations or points, for the better supervision of the hydrological parameters, and thus for a better and a more efficient warning system.

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