Scientific Bulletin of Politehnica University of Timişoara

Transactions on HYDROTECHNICS

Volume 60(74), Issue 1, 2015

ANALYSIS OF MAXIMUM DRAINAGE AT THE HIGH FLOOD RECORDED IN THE PERIOD 15th-22nd MARCH 2005 IN THE HYDROGRAPHIC BASIN OF SOMEŞUL MIC RIVER

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Abstract: The present paper propose it self an analysis of the flooding occurred during the 2005 season on the Someşul Mic hydrographic basin which is located on the western side of Romania.A number of 13 hydrological monitoring stations from a total number of 17 were analyzed by taking into consideration the specific hydraulic elements on the flood.

During the analysed period a small quantity of rainfall occured but the most important element was the huge volumes of snow in the basin.

It can the considered than the resulted conclusions will be usefull for the future meteorological events (rainfall,snow)which can be occur and the necessary measures for water management in this hydrographic basin.

Keywords: rainfall, snow, hydrological stations , flooding , hydrographic basin, drainage

1. INTRODUCTION

This work tackles some important issues from the category of hydrographic hazards, issues regarding floods and high floods, their causes and consequences, and assesses the concrete situation of the high flood of 15th-22nd March 2005 in the drainage basin of Someşul Mic River.

The characteristics of the high flood waves in the period 15th -22nd March 2005 were analysed in a number of 13 hydrometric stations where the maximum drainage was the most important from quantity point of view. The hydrometric observers who serve these points made a high number of observations of levels, made flow measurements (with current-meter or with floats), marked on shores the maximum level of the high flood, as well as other specific activities in these emergency situations.

2.PHYSICAL GEOGRAPHICAL CHARACTERISTICS AND REGINALIZATIONS OF DRAINAGE BASIN SOMEȘUL MIC

The drainage basin of Someşul Mic River has an area of 3773 km^2 and a length of 178 km. The area of reception basin is 519 km^2. From administrative point of view, the drainage basin Someşul Mic stretches on the surface of Cluj county.

The basin of Someşul Mic River is located in the North-West of the country, bordering on Arieşului Basin at South, on Someşului Mare Basin at East, on Crişurilor River basin at West and Almaşului Basin at North. It deploys in the direction SE – NV in the hydrographic area Someş –Tisa, and we can clearly distinguish an upper sub-basin and a lower sub-basin. The upper under-basin is located in the mountain area or in relative vicinity of Apuseni Mountains, more exactly in Gilău-Muntele Mare and Bihor-Vlădeasa Mountains, and the lower basin in a plateau area up to the confluence with Someşul Mare River.

The upper basin is made of the sub-basins of Someşul Rece River and Someşul Cald River, with their tributaries, to which we can add from hydrological point of view the upper basin of Văii Ierii Valley (up to the dam Bondureasa) and its left tributaries - Calul and Şoimul, because of deviation of these rivers (which belong geographically to Mureşului basin) towards the hydroenergetic system Someşul Cald. This system sealed the connection between Someşul Rece River and Someşul Cald River, which apart from uniting in Gilău accretion, they have now two underground artificial links by which Someşul Rece River gives a large part of waters to its brother Someşul Cald River.

Someşul Mic itself is formed by the confluence of Someşul Cald River with Someşul Rece River, both of them having their springs in Apuseni Mountains. By its tributaries: Someşul Cald, Belişul, Someşul Rece, Răcătăul, Râşca Mare, Someşul Mic collects the rivers waters from the Eastern slopes of Apuseni Mountains. By its tributaries Nadăş, Chintău, Borşa, Luna, Lujerdiu, it drains the waters of the left slope developed in Someşan Plateau, and by

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its tributaries Valea Sărată, Gădălinul, Fizeşul, Unguraşul (Bandăul) it gathers the waters of North-Western part of Transylvania Plain.

3. HYDRO-METEOROLOGICAL CONTEXT OF THE HIGH FLOOD

By characterization of the hydro-meteorological situation at the beginning of the second decade of the month of March 2005, we can see winter phenomena on the streams in the region in the final stage of their evolution (ice formations on banks with quite reduced thicknesses). The daily average flows recorded around 10th March 2005 were quite low because of the low temperatures which characterized the first decade of the month and which led to the storage of a huge quantity of water under the form of ice formations which did not participate in the drainage process.

The thickness of the snow layer varied, higher in the upper part of drainage basin at the hydrometric station Smida where it was 135 cm (with an approximate reserve of water of 10.3 mil. m³ / basin), in Poiana Horea 100 cm, in Căpuş (at the rainfall station Dângău Mare it was about 50 cm), in the remaining areas it measured between 3-20 cm. We must mention that the thickness of snow was in many areas quite consistent, as a result of solid rainfalls in large quantities, which were recorded in the beginning of the period (12th-13th March).

In the upper basins of the rivers the snow layer was more significant and after the occurrence of the high floor the specialists from Waters Division Someş-Tisa Cluj-Napoca concluded that the water reserve in the region was quite underestimated. The data measured at that time indicated the following values: Smida-353 l/m², Poiana Horea-203l/m², Dângău Mare - 122 l/m², Recea Cristur – 31 l/m², Aşchileu Mare - 24 l/m², Aghireşu - 15 l/m², Căpuşu Mare - 6 l/m². We can see that in the lower basins of Rivers Lonea and Borşa the coverage with a snow layer of the land was superficial, with reduced values (below 5 cm). At the initial time they took into account this data regarding the water reserve from the snow layer, but it resulted that this data was significantly lower compared to the drainage values. They concluded that the afforested areas between the rivers (which occupy quite outstretched surfaces) stored a significant quantity of water, which could not be controlled and quantified to be taken into account in the elaboration of hydrological forecasts. With the sudden warming that followed, the water from the snow layer gave in and the characteristics of the snow layer changed very quickly.

The quantities of rainfalls in the interval were not very significant, they were normal for this period, but they contributed to the melting of the existing snow layer. They fell mainly in two stages: 12-13th March (most of them mixed and solid at higher altitudes, where they added to the existing snow) and 17-18th March (exclusively rains). They overlapped the thermal values on the increase, which led to the deepening of the high flood already started.

Table 1. Rainfalls 12-25.III.2005

Date	Smida	Poiana Horea	Răcătău	Someșu Rece	Capușu Mare	Aghireșu	Cluj	Apahida	Borșa	Bonțida	Luna de Jos	Fizeșu Gherlii	Salatiu
12	24,5	3.5	4,3	10.0	1,5	0,1					0,2		1,0
13	26,4	15.0	13,1		6,3	13,0	8.8	5,8	7,8	8,6	11,0	8,7	18,8
14	2,4	4.0	1,0										
15		2.0											
16													
17									4,8				
18	18,5	4.5	5,5	3.5	0,5		3.3		0,8	5,3	4,7	1,2	1,6
19	10,4	7.7	7,7	6.0	6,1	3,4	2.3	0,3		0,3	0,1	1,0	1,6
20													
21													
22													
23													
24													
25													

Table 2. Snow layer 12-25.III.2005

Date	Smida	Poiana Horea	Răcătău	Someșu Rece	Capușu Mare	Aghireșu	Cluj	Apahida	Borșa	Bonțida	Luna de Jos	Fizeșu Gherlii	Salatiu
12	82	76	19	2	4	9					2	3	5
13	140	125	36		10	13		1	2	4	1	4	9
14	148	114	34		6	11							3
15	135	100	26		4	8							
16	115	95	25		3	5							
17	95	86	15		3	3							
18	75	69	5										
19	6.5	51											
20	63	50											
21	63	48											
22	62	48											
23	60	45											
24	60	40											
25	58	40											

By studying carefully the data of meteorological nature coming from the observation points located on the studied territory, it obviously results that the triggering element of the high flood was the fast growth of air temperature. The thermal values recorded were higher than the monthly multiannual average of March in the entire region. During the period 10-20th March the air temperature had a pronounced ascending trend, heightened after 12th, under the influence of a hot and damp air mass of Southern origin (Mediterranean). The daily average was between s 3°C (in the beginning), reaching values of 11-13°C on 17-18th March. For the second decade of March in the region the daily average air temperature was 2,0-2,5°C, and the maximum average was around 7-8°C. The thermal maximum temperatures were reached in the afternoon of the days of 17-18th March, when values between 15-18°C were recorded, and the daily minimum temperature did not fall below 8°C. This sudden warming of the weather led to a very fast melting of the existing snow layer and later to its drainage. The accelerated melting of the snow layer, doubled by the rainfalls which were recorded in that period led to a fast growth of levels and flows in hydrometric stations. For start we must make a comparison with the monthly multiannual average values of March recorded during the years of observations. We can see that the current values range in the multiannual average characteristics from the beginning of the period, but for the entire month of March they were quite high.

5. HYDROLOGICAL CHARACTERISTICS OF THE HIGH FLOOD WAVE

By studying carefully the evolution of levels as they are presented in the table above, we can separate two distinctive time stages. The days of 15-16th March are characterized by more reduced variations of water levels whose origin should be examined in the daily cycle of air temperatures. The thermal values were normal for this period of the year and the snow layer in the higher areas gain in water gradually. We can see that in general the levels trend was constantly ascending, but without signalling a dangerous situation. In hydrometric stations the increases from these two days were recorded during the night under the form of small peaks, representing the propagation of melting over the day from the upper basins of the rivers.

The second stage is the high flood itself and begins on the afternoon of 17th March, when very high thermal values were recorded for this period. The afforested areas from the upper basins gave in in a fast pace a significant volume of water which was stored in the snow layer. The level peaks were recorded in the morning of 18th March, as a result of propagation of the high flood wave caused by the melting from the previous day and night.

We must mention that at that time there were rainfalls under exclusively liquid form (below 10 l/m^2), which accelerated the formation of the high flood.

Table 3. Elements of the high floods

No.	RIVER	HYDROMETRIC STATION	DEFENCE QUOTAS		H max High flood (cm)	EXACEEDED QUOTAS (cm)	Q max high flood m³/s	START OF HIGH FLOOD		END OF HIGH FLOOD	
								DAY	TIME	DAY	TIME
1	SOMEŞUL CALD	SMIDA	CA	100	120	+20	41.3	17	17:00	20	7:00
			C I	150		-					
			CP	200							
2	BELIŞ	POIANA HOREA	CA	80	101	+21	16.3	17	7:00	20	17:00
			C I	120		-					
			CP	150		-					
3	RACATAU	RACATAU	CA	180	60	-	2.65	17	7:00	22	17:00
			C I	200		-					
			CP	250		-					
4	SOMEŞUL RECE	SOMEŞUL RECE-SAT	CA	220	78	-	5.38	18	10:00	27	17:00
			C I	300		-					
			CP	370		-					
5	CĂPUŞ	CĂPUŞU MARE	CA	280	230	-	23.0	17	7:00	21	17:00
			C I	320		-					
			CP	370		-					
6	SOMEŞUL MIC	CLUJ NAPOCA	CA	200	118	-	64.7	17	7:00	20	17:00
			C I	280		-					
			CP	320		-					
7	NADĂŞ	AGHIREŞU	CA	100	165	+65	5.42	16	7:00	20	17:00
			C I	200		-					
			CP	300		-					
8	SOMEŞUL MIC	APAHIDA	CA	110	142	+32	121	17	17:00	21	7:00
			C I	150		-					
			CP	200		-					
9	BORŞA	BORŞA	CA	200	338	-	38.6	15	7:00	20	17:00
			C I	300		+38					
			CP	340		-					
10	GĂDĂLIN	BONŢIDA	CA	300	310	+10	10.9	13	7:00	20	17:00
			C I	350		-					
			CP	400		-					
11	LONEA	LUNA DE JOS	CA	270	367		49.8	17	17:00	20	7:00
			C I	320		+47					
			CP	370		-					
12	FIZEŞ	FIZEŞU GHERLII	CA	350	245	-	17.7	16	7:00	20	17:00
			C I	400		-					
			CP	450		-					
13	SOMEŞUL MIC	SALATIU	CA	200	297	+97	227	16	17:00	20	17:00
			C I	300		-					
			CP	400		-					

The level peaks were recorded in the morning of 18th March, as a result of propagation of the high flood wave caused by the melting from the previous day and night. We must mention that at that time there were rainfalls under exclusively liquid form (below 10 l/m^2), which accelerated the formation of the high flood.

As a result of the high flood it could be seen and performed the changing of limnimetric keys for the high waters at the hydrometric stations Luna de Jos, Borşa and Căpuşu Mare, in this last location it was necessary to retrace the defence quotas because of the constant phenomenon of riverbed sinking (which was necessary in order to avoid flooding a part of Gilău town from downstream, without reaching the attention quota at the hydrometric station Căpuşu Mare).

The careful examination of hydrographs highlights that it was a single high flood in all the hydrometric stations, with small oscillations because of propagation from upstream to downstream.

The average layer drained recorded values between 13.0 mm in the hydrometric station Aghireşu (end of basin station) and 32,2 mm at Căpuşu Mare (between the stations without influence of drainage).

In Borşa and Luna de Jos the numbers were close also because of the similarities between the two hydrometric stations. As expected the maximum occurred in the drainage basin with the highest average altitude, and there was a precise correlation between these parameters.

The values of drainage coefficients and drained layer are in admissible limits close to the normal values of these parameters from the drainage basin Someş.

St.Hm.	F(kmp)	L(km)	Qmax (mc/s) / Date	Qmed high flood (cm/s)	Average rrainfall layer (mm)	Drained layer flood Total/high mm)	W total (mil.m^3)	High flood W (mil.m^3)	Growth time/total	W base (mil.m^3)	Form coefficient	Drainage coefficient
Smida	103	66.5	41,3 /19.III.	13.7	86.1	50.8/40.0	5.24	4.12	29/106	1.12	0.33	0.46
Poiana H.	85.0	14	16.3 /19.III.	4.49	66.1	24.9/16.5	2.12	1.40	50/131	0.719	0.28	0.25
Răcătău	101	29.0	2.65 /19.III.	1.03	23.1	6.13/5.06	2.01	0.613	202/220	0.123	0.36	0.13
Gilău	328	49	5.38 /20.III.	1.99	20.0	3.67/2.75	1.20	0.902	48/168	0.302	0.37	0.14
Căpuşu Mare	111	60.0	23.0 /18.III.	9.38	80.0	32.2/24.7	3.58	2.74	23/106	0.839	0.41	0.31
Aghireşu	39.1	44.0	5.42 /17.III.	1.32	35.0	13.0/10.1	0.505	0.394	34/106	0.111	0.24	0.29
Cluj N.	1194	178	64.7 /18.III.	16.9	16.8	10.5/5.03	12.6	6.01	28/130	6.55	0.41	0.30
Apahida	1851	188	121 /18.III.	47.4	17.0	10.1/5.50	18.8	10.2	23/110	8.57	0.39	0.32
Borşa	178	38	38.6 /18.III.	11.1	45.0	29.5/23.5	5.25	4.18	74/131	1.07	0.29	0.52
Bonţida	280	29.0	10.9 /13.III.	3.79	14.5	9.28/6.91	2.60	1.94	12/192	0.663	0.34	0.48
Luna	172	31.5	49.8 /18.III.	24.0	86.1	33.1/26.9	5.35	4.63	20/62	0.719	0.48	0.31
Fizeşu Gh.	506	46	17.7 /18.III.	24.8	30.7	9.22/3.80	4.66	1.92	53/120	2.74	0.60	0.12
Salatiu	2588	37	227 /18.III.	99.6	24.1	18.6/10.5	48.0	27.1	53/134	20.9	0.44	0.43

The total duration taken into account was variable, more extended in Bonţida, with a high variable, more extended in Bonţida, with a high flood composed of two peaks ,one on13th ,the other one

19th (192 hours of which the growth time was 12 hours).

On Someşul Mic River the maximum drainage is influenced by the Hydrotechnical constructions that exist in Someşul Mic Basin. The affection degree of maximum drainage is very high for the entire Someşului Mic River because the Hydrotechnical constructions (dams), are located on a very large distance of the total length of the river, the retaining dams have a very high capacity of retaining the high flood culminations. The most influenced hydrometric station on Someşul Mic River, is Cluj-Napoca station, being the nearest to the last storage reservoir (Gilău Dam), and the hydrometric station with the lowest affectation degree is the hydrometric station Salatiu, which is nearest to the confluence with Someşul Mare River.

The affectation degree of maximum drainage drops from upstream to downstream with the increase of distance from the last accretion and with the increase of the surface of retention basin related to each hydrometric station (the drainage following section).

From the analysis of drainage in the analysed high flood it results that the flows (or hydrological values) obtained from observations and measurements were correctly obtained and we could make a good analysis of high flood volumes.

For a better analysis of the high flood elements in the hydrometric stations influenced (hydrometric stations Răcătău, Someş Rece Village, Cluj-Napoca, Apahida and Salatiu), we can reconstruct the maximum drainage depending on the accumulations and/or disaccumulations from the lakes during the high flood period and depending on the transfer of flows from one basin to another.

The reconstruction of the natural regime for the hydrometric stations mentioned is carried out by the following formulas:

- For hydrometric station Răcătău:

Reconstructed volume = Measured volume + Captured volume Răcătău

- For hydrometric station Someş Rece Village:

Reconstructed volume = Measured volume + Reconstructed volume in Fântânele + Captured volume in Someş Rece 2 – volume gain Iara.

- For hydrometric stations Cluj-Napoca, Apahida and Salatiu:

Reconstructed volume = Measured volume + / - accumulated volume / disaccumulated volume – volume gain Iara + Captured volume Gilău + Floreşti.

We recommend that you do not perform the analysis of maximum drainage in high floods in the hydrometric stations with a high degree of influence of drainage.

The non-closures on volumes are because of the functioning of storage reservoirs from the upper part of the basin.

The calculations confirm the regionalizations according to the drainage coefficient previously made by the hydrologists (between 0,35 - 0,60 for Clujului and Dejului Hills).

The rainfall layer was determined by isohyetal lines based on the values recorded at the hydrometric and reference gauges and rainfall stations from the territory.

The rainfalls from the period were relatively reduced in quantity. We could see from the calculations that the average layer drained by the basin was higher than the rainfall layer, and the clear conclusion is that the ***main role in the formation of the high flood had the water reserve from the snow layer that existed*** at that time. We estimated by isohyetal lines an average value for each basin which was taken into account in the subsequent evaluations. Because in the period 8-15th March the rainfalls were under the form of snow, they cumulated with the rainfalls from the period 15-22nd March and the values obtained are considered the calculated values of rainfalls which generated the high flood.

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