THE EFFECT OF THE SZAMOS RIVER FLOODINGS UPON THE VÁSÁROSNAMÉNY SECTION

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ABSTRACT. – The effect of the Szamos river floodings upon the Vásárosnamény section of the River Tisza. The examination aims to model the Tisza/Tisa flooding in 2001, taking in consideration the case, if the 1970 flood arrives on the Szamos/Somes River and meets the Tisza flood with a delay of a half day. If the tributary flooding discharge culmination crosses the Tisza flooding culmination, the flood increasing effect of the tributary is maximum. According the 75 years long data lines of the Tiszabecs section of River Tisza, it can be proved that the range of tide has got a rising tendency. Beacuse of the Ukrainian flood control system development, here the flooding rates decrease, but on the lower section the ~~flash~~ floods intensity increase. As the flood decreasing reservoirs are operated, the ~~flash~~ flood culminations can be reduced. The HEC-RAS 1 dimnensional modelling programme offers the possibility to analyse the effects of these interventions. Without any breaches in dike and with the significant discharges of the tributaries, an even 1 m higher water level than in 2001, or a 1000 m^3/s bigger maximum discharge can occur, but, in a less favourable case, even 1-2 m higher water level culminations and 50-60% bigger culminating discharges can occur.

Keywords: flood decreasing reservoir, 1 dimensional model, section, loop curve.

1. INTRODUCTION

The Tisza floodings produce damages usually on continuous, sometimes transboundary extending, wide areas. The examination aims to model the Tisza flooding in 2001, taking in consideration the case if the 1970 flood arrives on the Szamos (left side tributary) and crosses the Tisza flood with a delay of half day.

The Tisza belongs to the Danube catch basin, it springs from the Maramures Mountains and curving along 964 km, it reaches the Danube at Titel. The mountainory section of the river is the Upper-Tisza, which lasts from its spring to the Szamos inflow (Bogdánfy 1925).

According to The Tisza Tiszabecs section Hmax and Hmin water level data lines over 75 years, the rising tendency of the range of tide is defined, that doubled itself from 450 cm to 990 cm. It is most likely that the rising tendency is maintained in the future as well. We must take into consideration the fact that at every bigger flood, without exception, on the Ukrainian areas breaches of dike and dike covers occur, that have an flood decreasing effect on the Hungarian section of the Tisza. The Ukrainian flood control system development, probably excludes or diminuate the Ukrainian flooding, so that, the flood wave debit increases.

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Even if not significantly, but the change in area operating, especially the decrease of wooded area, can contribute to the flood level increase (Illés-Konecsny 2000).

Because of the determinant factors in the formation of the extraordinary floods and the instability of the future formation of the processes, beyond the safety height of the defensive line, supplementary „safety valves” are requested to be constructed in the flood control system. These could be the flood decreasing reservoirs, that – beside the increasing of the water transport capacity of the flood plain (recovery) – constitutes the base of the Vásárhely Project (VTT) development.

On the whole Hungarian section of Tisza, the standard flood marks usuallly don’t result from the same flood. The tributaries significantly influence the flood flow, or the forming water levels. If the estuary water level output, flowing down the tributaries, crosses the Tisza flood level top, the water increasing effect of the tributary is maximum.

This group of effects draw attention on the modelling of the last year and further expected events (Gauzer-Bartha 1999), the HEC-RAS 1 dimnensional modelling programme offers new possibilities to analise the problem.

2. DETAILED PRESENTATION OF THE ANALYSED SUBJECT

The modelling floods started in the upper boundary section of the Tisza and its tributaries are based on the earlier observed, real floods (in 1970. 2001). The formation, the extraordinary sizes, the discharge of the Upper-Tisza big flooding in March, 2001. were caused by the rainfall average of 132 mm in three days, the 70 mm snow melt water, as well as the less favourable conditions of the basin surface (Konecsny 2004).

On the Ukrainian and Romanian river sections, from Rahiv to Tiszabecs, the culminations exceeded the flood marks percepted before (the heighest one at Raho: 75 cm heigher). On the Hungarian section, the river culminated between Tiszabecs and Záhony, (7-56 cm) above H_{max}

The highest water levels until now occured between Tiszabecs and Vásárosnamény. In spite of these maximum values, the culminating flood levels and discharges in March 2001 were still behind the possible maximum level and discharge as regards the river geographical caracteristics.

Among the tributaries, the Szamos flood wave has a significant effect upon the Tisza, the biggest experience of the Szamos flooding in 1970 is, that the high level, the durability, the debit of the high waters exceeded those recorded so to date and this can occur any time (Lászlóffy-Szilágyi 1971).

The first general and technically appropriate flood control project was conceived by The River Engineering Office residentialy in Vásárosnamény, only at the end of the 19th century.

The flood disaster in May, 1970, totally upset the conceptions and objectives formulated in the Upper-Tisza-Region Water Management Frame Project, after all Tisza exceeded the heigh water mark (H_{max}) till then with 107 cm at Tiszabecs, with 12 cm at Vásárosnamény, the Túr exceeded it with 80 cm at Gabolc, the Szamos with 159 cm at Csenger and the home and the foreign breaches in the dike urged on the estuary flood control system development.

On the 4th-5th of May, intermittently, after a fast fall in temperature, 10-25 mm precipitation fell into the rivers catchment basin. Between the 8th and the 10th of May, mostly in the Tisza and Szamos mountainory basins, 30-40 mm rain imbued the surface, filled up the river beds. On the 12th of May, a new precipitation of a big intensity, concentrated, with the exceed of a 60 mm, or in some places, even 100 mm/day rushed on the catchment area (Hust 126 mm, Bistrița 117 mm). The rain zone extension multiple exceed the 29000 km^2 large Vásárosnamény subcatchment area of the rivers Tisza and Szamos (Konecsny, Bálint2004)

Due to the saturated soil surface, a big part of the fallen precipitations, was accumulated in the rivers, there hardly were any infiltrations. Due to the fast flow of the rivers Tisza and Somes, even on the 14th of May the boundary gauges indicated significantly heigher values above the previous high water mark.

Table 1. ***High water marks during the flood in 1970*** *(VÍZDOK 1970.)*

River	Gauge	Before 1970 max.(cm)	Time	In 1970 max. (cm)	Time	Difference
Tisza	Tiszabecs	573	1947	680	14/05/1970.	+ 107 cm
Szamos	Csenger	743	1888	902	14/05/1970.	+ 159 cm
Túr	Garbolc	560	1966	640	14/05/1970.	+ 80 cm

In the table it is remarcable that, on the Tisza, Szamos and Túr the culmination occured almost in the same time and the top floods reach Vásárosnamény almost all at once, there the 912 cm high water mark exceeded that of 900 cm in 1888 (table 1). It was characteristic, for the flood discharge, the fact that on the 13th of May, 1970 at 12 o'clock the Tisza gauge at Tiszabecs indicated still 250 cm – than was ordered the Ist grade alertness. On the 14th of May, at 6 o'clock in the morning, the water level increased up to 680 cm, 107 cm higher than the previous maximum.

The Szamos flood at Csenger, or rather at Komlódtótfalu on the right bank, on the 14th of May, at 8 p.m., reached the level of 902 cm, significantly higher than the high water mark up till that time (743 cm in 1888). The water level exceeded the levee crest level with 10-30 cm, or even 40-50 cm in some places. The overflowing water, gradually weakened the levee and broke it at the end. Beside the dike breach at Nábrád, the events on the Romanian section of the Somes decisevly determined the situation on the section between the rivers Tisza and Somes. There, namely, the river right bank dike broke through in 9 places, on a total length of 1113 m, and it transboundary flooded over the area between the two rivers (VÍZDOK1970*).*

3. GEOMETRIC AND LIMITING CONDITIONS-VARIETIES

The model data base includes the 199 km long Tisza section from Tiszabecs to Tokaj, as well as the 4 tributaries inflowing on this length (Borshava, Túr, Szamos, Kraszna). The total length of the river section taken into account exceeds 323 km (figure 1). The Tisza and its tributaries were approach with more than 500 cross-sections. In the model, 33 briedges have been built (figure 2), 1 flood decreasing reservoir. The HEC-RAS model (and the other 1D models) is suitable for entering cross-sections with indicated conventional distance-height point-pairs., as well as for operating the GIS (geographic information system) data base. The Tisza-Tokaj Section and the 4 tributary cross-sections were presented by means of the digital relief map.

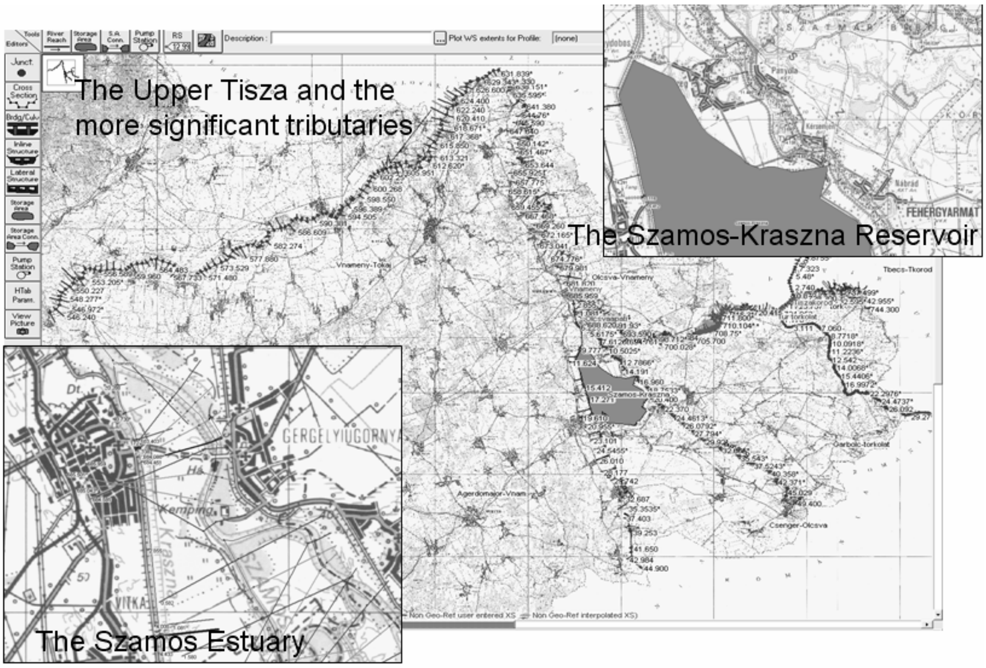
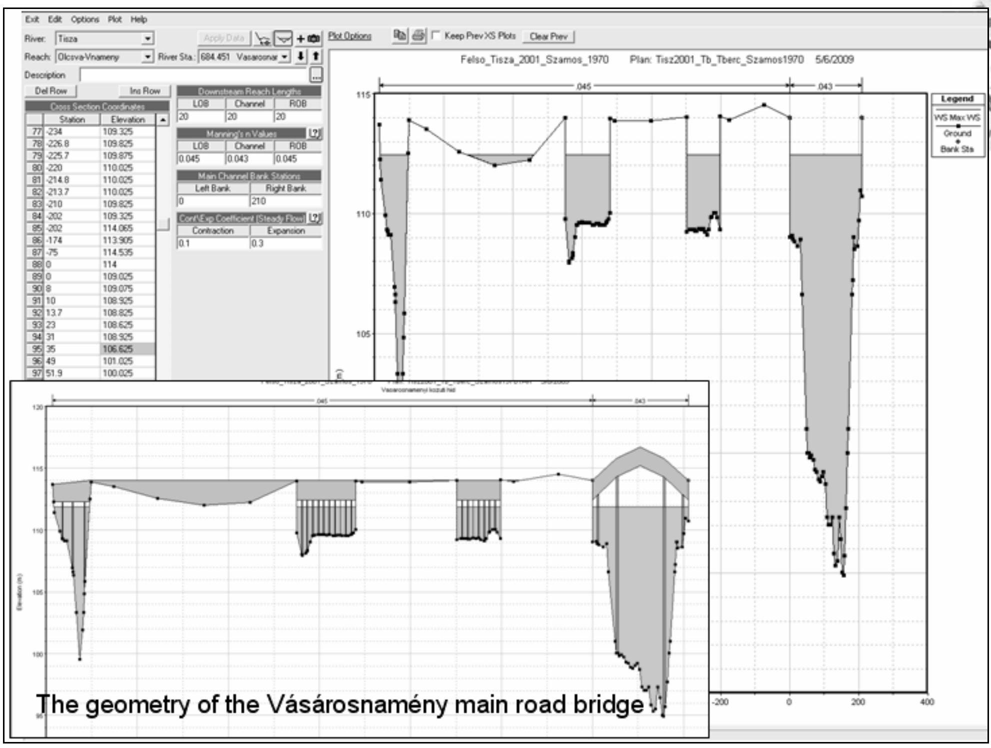


Fig. 1. ***The complete coordinate corresponding geometry of the modelling: with 1:100000 scaled map***

The HEC-RAS model, used for the detailed description of the river system, offers the possibility to regard the water-work effects, for example bridges, dam weirs, by pass valves, overflow sills, sluices, steps, bottom sills, side overflow sills and sluices, static reservoirs, to operate pumping water outlet or inlet.



River: Tisza
Reach: Olcsva-Vnameny
River Sta.: 684.451 Vasarosnar
Description:

Cross Section Coordinates

	Station	Elevation
77	-234	109.325
78	-226.8	109.825
79	-225.7	109.875
80	-220	110.025
81	-214.8	110.025
82	-213.7	110.025
83	-210	109.825
84	-202	109.325
85	-202	114.065
86	-174	113.905
87	-75	114.535
88	0	114
89	0	109.025
90	8	109.075
91	10	108.925
92	13.7	108.825
93	23	108.625
94	31	108.925
95	35	106.625
96	49	101.025
97	51.9	100.025

Downstream Reach Lengths

LOB	Channel	ROB
20	20	20

Manning's n Values

LOB	Channel	ROB
0.045	0.043	0.045

Main Channel Bank Stations

Left Bank	Right Bank
0	210

Cont\Exp Coefficient (Steady Flow)

Contraction	Expansion
0.1	0.3

Fig. 2. ***Display of the cross-sections in the model***

4. MODEL ASSEMBLAGE, THE VERIFICATION METHOD

During the model calibration I applied different roughness coefficients to regard the lines of cultivation on the flood plain and to calculate the bankfull discharge.

The cultivation categories on the flood plain, were defined according to the air photographs, the othophotos, or the results of the local inspections. The roughness factor was modified–conforming to the lines of cultivation on the flood plain- in cross direction. I defined the flatness (roughness) factors, belonging to them, according to the regulations of the Hungarian Standard, the values reccomended by Chow (1959) and used by the HEC-RAS, as well. Roughness factor-domains belonging to some lines of cultivation overlap each other, after all, for example, the „thin planted brushwood" and the „thick planted brushwood" cannot be strictly confined. On the flood plain – in cross direction – lanes marcd with equal flatness, to which the above flatness-categories values were ordered.

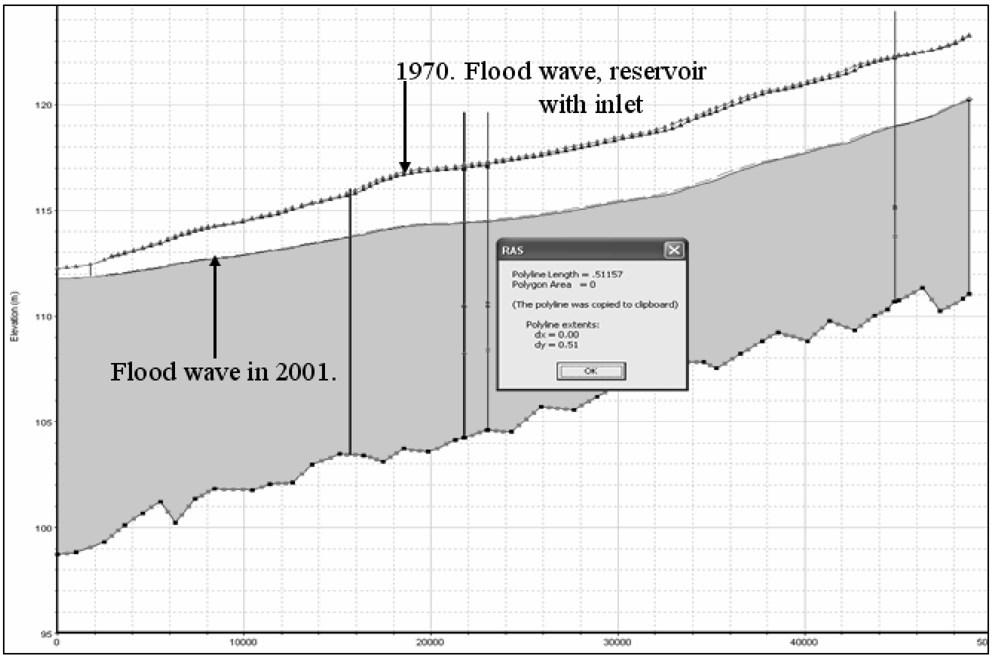
I performed the model heigh water calibration as I modified the flatness values ordered to the flood plain lanes. On the Tiszabecs-Tokaj section the absolut value of the difference between the levels calculated at the flood heigh water mark and those percepted was 0-10 cm, that one being a quite good result.

5. RUNNING OF INVESTIGATION VARIATIONS, RESULTS

I inquired the data required to the run of the model from the Hungarian Hydrological Data Base. In the first part of the calculations, the data base consisted of the hourly data of flood level (Z), discharge (Q) in 2001.

During the run of the model, I took the stage calibrated in March, 2001 into basis, I added the Csenger discharges in May, 1970, as Szamos upper boundary condition, so that the Szamos flood wave to reach the Tisza, Vásárosnamény section with a delay of a half day, compared to the Tisza flood wave in 2001, as taking in consideration the conditions of the catchment area, there are little chances that the two flood waves meet in the same time. The results obtained this way are illustrated in the graph below (figure 3). On the graph it clearly appears the effect of the Szamos-Kraszna reservoir between the rivers Szamos-Kraszna along the Szamos River and upon the Tisza, Vásárosnamény section. In the intake section (13+300 fkm) the drawing effect is 69 cm, the effect is significant until the estuary, in the Tisza, Vásárosnamény section the level difference is 34 cm.

In contrast to the flood waves in the recent years, significantly heigher culminations occured than the precedent maximums, if we take into consideration rainfall conditions similar to those in 2001 and we add to the maximum high water marks the Szamos flood wave in 1970, we obtain 50 cm higher marks than the maximums, the maximum debits are more than 1000 m^3/s bigger.



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Polygon Area   = 0

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     dx = 0.00
     dy = 0.51
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Fig. 3. ***Szamos Section with data from 2001 and 1970, with the opening of the reservoir between the rivers Szamos and Kraszna***

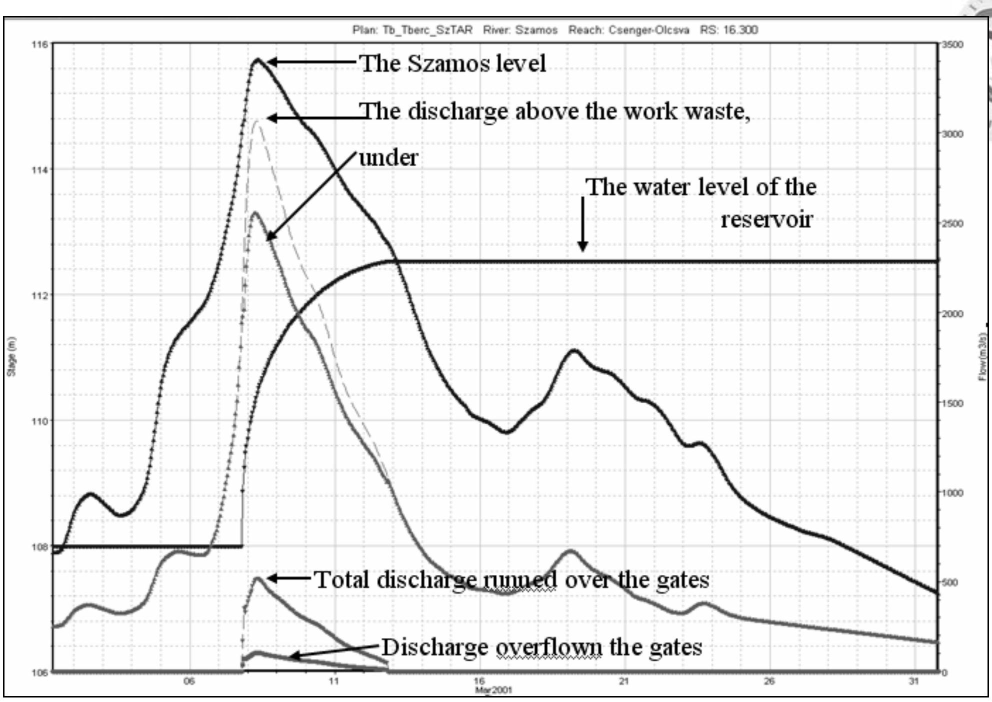

Fig. 4. ***The upload rate of the reservoir between the rivers Szamos and Kraszna and its effect upon the Szamos water level***

The decreasing effect of the reservoir between the rivers Szamos and Kraszna stands out long way downstream (for example, the Tisa level at Vásárosnamény is 30-40 cm, at Tokaj it is 15-20 cm), it is 60-80 cm on the section of water inlet.

The effect of the reservoir at the national boundary, upon the water outlet place, is less perceptible because of the bigger surface slope. By changing the outlet location and the gate size, more favourable effects can be reached on the upper sections. During the modelling, I built up the model with five inlet gates instead of the eight ones planned before, and it either succeeded in completing the reservoir with 115 million m^3 instead of 126 million m^3, near a 520 m^3/s maximum water inflow (figure 4).

Table 2. ***Running results in the Vásárosnamény Section***

Vásárosnamény	Water level (mBf)	Water level (cm)	Discharge m^3/s
March, 2001	111.41	943	4250
March, 2001 and May, 1970	112.45	1047	5220
March, 2001 and May, 1970 with the Reservoir between the rivers Szamos and Kraszna	111.95	1000	4900

Observation: *mBf = mean sea level above the Baltic Sea (meters)*

6. CONCLUDING REMARKS

The model vizually illustrates and it also tabulary displays the bankfull discharges and the water quantities flowing down on the flood plains, as well.

Without breaches in dike and with the significant discharge of the tributaries, it can occur an even 1 m higher, or 1000 m^3/s bigger maximum water discharge than the flood in 2001, but, in case of a less favourable rain fall dispersion and bigger snow melt water, even 1-2 m higher maximum high water marks and 50-60% bigger discharges can occur (table 2).

The software operates on good physical basis, it is easy to handle, it has a short running time, it desplays the data or the calculation results in a clear form.

The running results are graphically and tabulary well analysable, comparable, even if they are data concerning cross-sections, estuary sections, object d'arts, reservoirs.

During the investigated cases, if the Szamos flood wave from May, 1970 connects to the Tisza flood from March, 2001, the Tisza maximum high water mark at the Vásárosnamény section, is 1 m higher (112.45 mBf) than the 111.41 mBf. Level in 2001.

This can be decreased a half metre lower (111.95 mBf) by operating the between the rivers Szamos and Kraszna.The decrease does not following the rate of the flood waves in the last years, in the Vásárosnamény section, after four days lasting level output, the water level is still half metre higher than the III grade flood alert (109.98 mBf).

The HEC-RAS 1D model can be well applied in the operating control of the reservoirs along water flows, in the operational location of different object d'arts (Lónyai canal flood gate, pumping stations), in the anlysis of the scenarios of the problems that can occur in case of heigh waters (floodings, breaches of dike).

It is less applicable in the Upper-Tisza forecast, due to the big data request and shortness of running time.

The HEC RAS 1D model, being connected to the current hydrographic data service and information system (MAHAB, OTR), and using the results of the precipitation flow model, this way being continuously provided with daily operational data, it could be also appropriate for flood forecast on the Tisza whole home section.

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