

## HYDROLOGICAL FACTORS OF THE FLOOD AT SZEGED IN 1879

M. ANDÓ-I. VÁGÁS

For a hydrologist, a geographer and other persons who show interest in this theme, it is interesting to recall the hydrological data of the flood of the river Tisza which ruined Szeged and compare it with further changes which have taken place and have been averted since then.

Today, we should regard a flood like that in 1879 as natural and could avert it, without using any special means, with our modern defensive preparedness. However, we are helped in this by drawing a lesson from the flood catastrophe at Szeged in 1879.

A hundred years ago the technical possibilities of defence and of the hydrological science were incomparably more modest than the up-to-date ones. In 1879, the large dam-system of the Tisza – the great creation of I. SZÉCHENYI and P. VÁSÁRHELYI – has just been completed.

The height-and width-measurements of dams did not prove to be suitable even to give protection against the previous high floods, not to speak of the following man and animal living work. The movement of earth masses and transport with machines did not exist then. The main water-gauges, known today already existed a hundred years ago, as well. But there were no long observational series and no data from the older times when damming effects could not be felt, as yet.

For informing about floods they had no developed telecommunicationnal system except telegraphic connection. Telephone and radio were unknown, yet.

Hydrological science had neither a suitable theory nor practical experience of the fact how high the water level can be. First of all, not for the level be properly measured, but because they had no sure water-level or water-output data to compare them with. As far as we now know, cybernetics, discovered in the second half of the XX<sup>th</sup> century, is also a technical parameter which can be transformed into power, energy and money. We also know that the possible shortcomings of our informations can be balanced with a greater security than it seems to be necessary, Neither the government of our state in the autocratical period between 1849 and 1867, nor that in the time of the Compromise between 1867 and 1879, which had much more economic possibilities, could see the fact. Consequently entirely till the flood catastrophe at Szeged came, there was no central and financial power, to prevent the newer and newer records of the Tisza by heightening and widening dams most of which had grave destructions. They were unable to do the earthwork of dams and heightening and widening them with the lack of informations. So the catastrophe must have come inevitably.

Before summarizing the events in 1879, we may be interested in what could be seen in the first days of 1879 by an engineer knowing the hydrological data of this time about the Tisza or by an engineer standing at the present-day level of theory and knowing the data having existed then.

The known maximum water-level of the Tisza at Szeged preceding the XX<sup>th</sup> century was 630 centimeters measured in the course of the flood in 1772. (As related to 74,34 m above the level of Adriatic which is joint 0 of the presentday gauge.)

It was only exceeded, with 672 centimeters, on 29<sup>th</sup> of May in 1845 for the first time. This was soon approached by the 662 centimeters high culmination on 23<sup>th</sup> of May in 1853 and moreover it was soon still higher on 16<sup>th</sup> of April in 1855 culminating with 691 cm. The period of the Tisza's ancient and so-called natural water-level changes should be ended with that because of the fact that even in 1855 there was already no quite sure condition free from interferences. There is no datum for the ancient period to show that the water-level had ever exceeded 700 centimeters.

After this, the transitional period of "Tisza Regulation" and came the HWL oversteppings became more and more frequent. On 6<sup>th</sup> of May in 1867, the culmination of water-level was already 722 cm high, and there was another culmination, too with 670 cm on 7<sup>th</sup> of May in 1860.

The data of culminations were the following ones;

on 17 <sup>th</sup> of May	1868	697 cm
on 20 <sup>th</sup> of May	1870	646 cm
on 24 <sup>th</sup> of January	1871	680 cm
on 11 <sup>th</sup> of April	1872	649 cm
on 4 <sup>th</sup> of June	1848	696 cm

but it was higher than 600 cm nearly every year which actually happened only now and then before 1855.

These levels had not reached that of 1867. And it also happened, not so long after that the HWL became 786 cm on 6<sup>th</sup> of April in 1876 and 795 dm on 26<sup>th</sup> of May in 1877 preceding by 24 days the recent one with a 790 cm – high culmination. The record stood near 800 cm so that another 720 cm – high culmination followed the previous ones on 27<sup>th</sup> of April in 1878.

All these showed that the growth of flood-levels continued and the bulk of the culminations would not have been ended, yet. In Szeged, where the 500 cm-high water-level could be regarded as are, should have been taken precautions against a 700 but even a 800 cm-high water-level. Nobody could know whether it could be enough or not. If nothing else but this was known by the experts and leaders of Szeged, they should have tried everything for preventing the danger.

Unfortunately, the government then belittled the danger. Perhaps, with the present-day theoretically advanced statistical methods, more threatening conditions would have been seen, though not without any data.

Now, coming to the point of describing the flood in February 1879, it should be established that it was much better than the previous months and the fore-flood-waves of December and January caused a lasting high level in the bed of the Tisza. (Fig. 1.)

However, it became evident in the forthcoming one hundred years that there could be much more lasting and violent precipitations and much higher floods. As to



HW levels, between 1876 and 1975 the culmination at Szeged in 1879 proved to be only the twelfth one. It should not be neglected either, but seen with our eyes, cannot be told to be extreme, at all, taking into consideration the state of dams.

The cause of that the fore-flood-wave could start from the Upper-Tisza and its subsidiary streams could be the snow presumably thawed in consequence of the rise in temperature and rainfalls. It is sure that there was a large enough rainfall about 20<sup>th</sup> of December 1878. (Fig. 2.) The fore-flood-wave came from two branches; of which the first culminated with 860 cm at Vásárosnamény on 24<sup>st</sup> of December 1878 and the second one with 676 cm on 6<sup>th</sup> of January 1879. The further top-levels of culminations did not prove to be too high. The culminations of the water-level at Tokaj were 598 cm on 29<sup>th</sup> of December and 558 cm on 21<sup>st</sup> of January. The two branches of the flood had already joined at Szolnok and here the culmination was only on 18<sup>th</sup> of January with 697 cm. The Tisza culminated on 21<sup>th</sup> of January at Szeged with 658 cm. It was typical, that the culminations of Szamos at Csenger (664 cm and 585 cm on 24<sup>th</sup> of December and 3<sup>rd</sup> of January) as well as those of Bodrog at Sárospatak (452 cm and 526 cm on 30<sup>th</sup> of December and 10<sup>th</sup> of January) can be said comparatively high, but the river Kőrös had no culmination and the that of the Maros with 253 cm on 20<sup>th</sup> of January had taken place with a very reduced degree. Further troubles were caused not by the fore-flood - waves but by the fact that later the Tisza got so much water - supply till March which did not let go the water-level under 540 cm. This previous fullness of the river-bed was the foundation of the water-level of a newer and higher flood in the middle of February. The main-flood which obviously carried further molten ice, culminated with 785 cm on 15<sup>th</sup> of February 1879 at Vásárosnaményi one day later than the culmination of the Szamos at Csenger with 649 cm.

We can come to the conclusion that too much water could not start from precipitation but it was rather melte-snow. The dates of culminations mentioned above preceded the dates of the falling precipitations, The rains about 20<sup>th</sup> of February in the watershed area of the Maros could only be enough to heighten the water-level of the Tisza by their quantities. (Fig. 3.)

The flood started from Vásárosnamény, culminated at Tokaj with 735 cm on 20<sup>th</sup> of February. Meanwhile the Bodrog culminated at Sárospatak (625 cm) on 22<sup>nd</sup> of February, the Sajó also did it at Felsőszolca (470 cm) on 20<sup>th</sup> of February. The water in the two rivers mentioned above was too high to see it even with our eyes. As a rule, the result of that the Bodrog and the Sajó bring comparatively much water into the Mid-Tisza is that the movement of culmination slows down very much and the flood starts to be held up. Now, this happened this way; it stayed 14 days between Tokaj and Szolnok. The culmination at Szolnok took place only on 6<sup>th</sup> of March with a rather low (763 cm) water-level. On the other hand, a day before this day the dam had already broken through at Peteres, above Szeged. How could it happen that it neither reached Szolnok nor culminated at Csongrád, as yet (here the culminations was on 6<sup>th</sup> of March with 805 cm). Has Szeged got into a close danger? We can explain it only with taking the flood of the Maros originating from the precipitation which fell down about 20<sup>th</sup> of February and culminated at Mákó with 420 cm on 3<sup>rd</sup> of March. The 420 cm in Mákó also meant about a 900 m<sup>3</sup>/s water output. Then could not come more than 2000 m<sup>3</sup>/s can be made probable or rather from the quantity of water, lesser by 8-10% than this one, the 1/3 part was originated from the Maros! Beside this the Kőrös was also filled with much water. Its culmination was at Gyoma

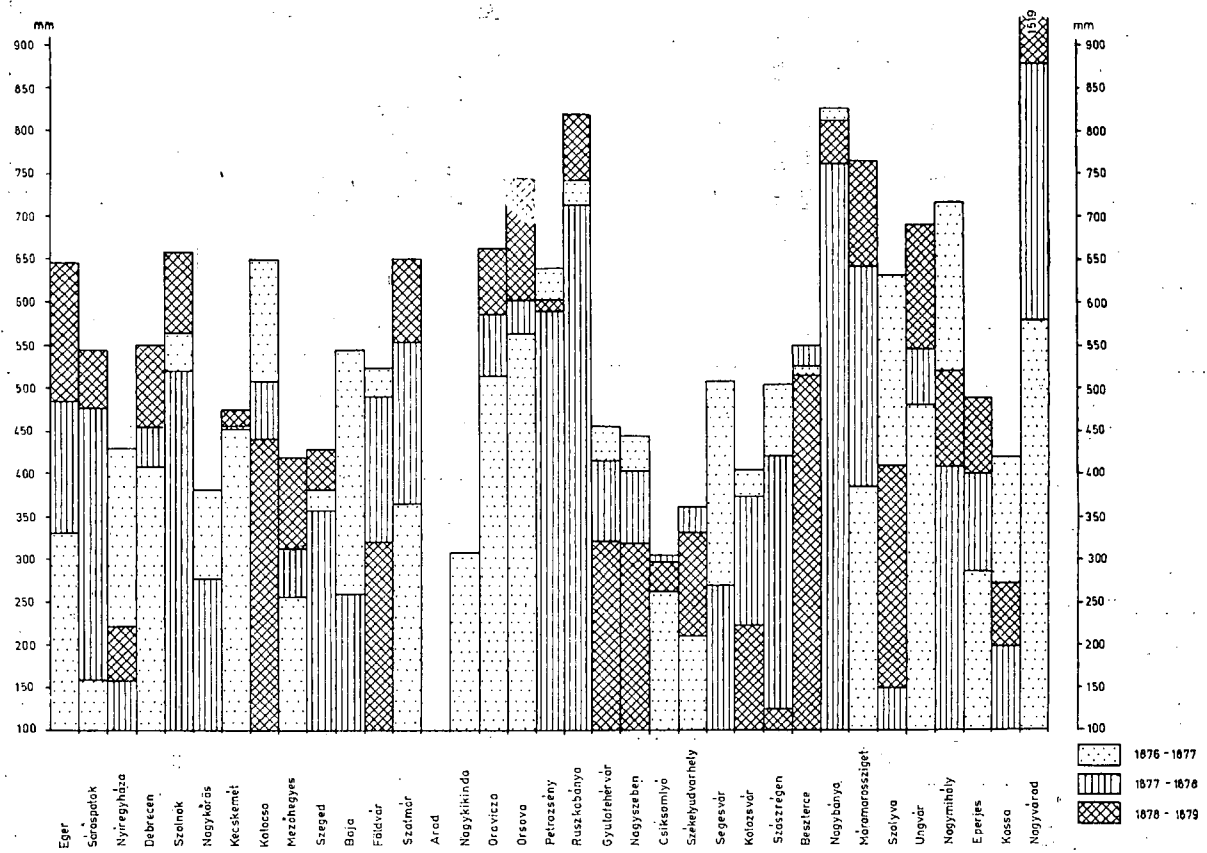


Fig. 2. Change in moisture in the Carpatian basin in the winter term caused by the great flood at Szeged in 1879. (Change in moisture in the decisive winter-term as compared to the quantity of moisture in the preceding years.)

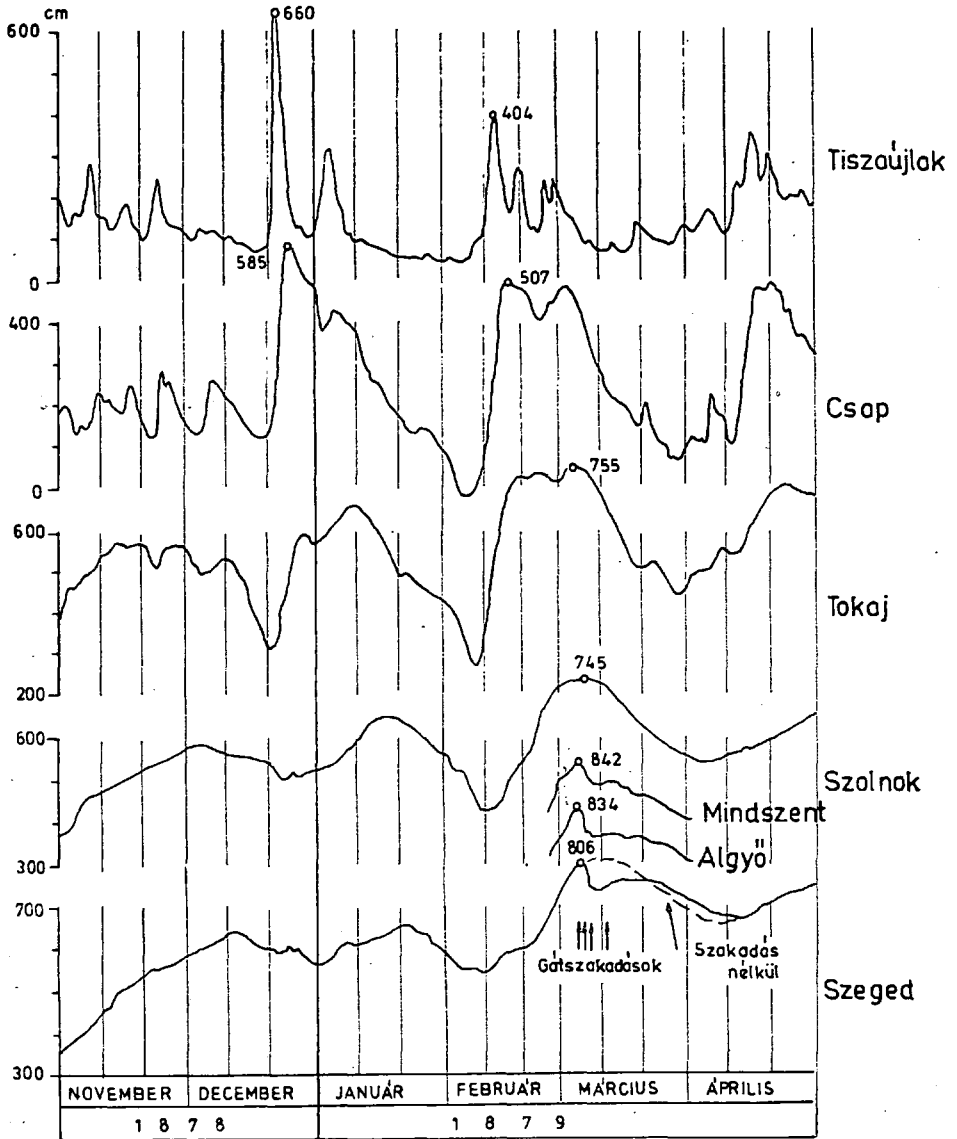


Fig. 3. Change in water-levels at the Upper-Tisza and in its affluents in the winter of 1878—79. (According to W. LÁSZLÓFFY)

on 2<sup>nd</sup> of March with 681 cm and this water reached Szeged about 5<sup>th</sup> of March. (Fig. 4.)

The Maros joining with the water of the Kőrös produced the dangerous situation before the culminated water could reach there. It was shown by the very fact that after the overflow at Petres the overflow of the water became static. There were other

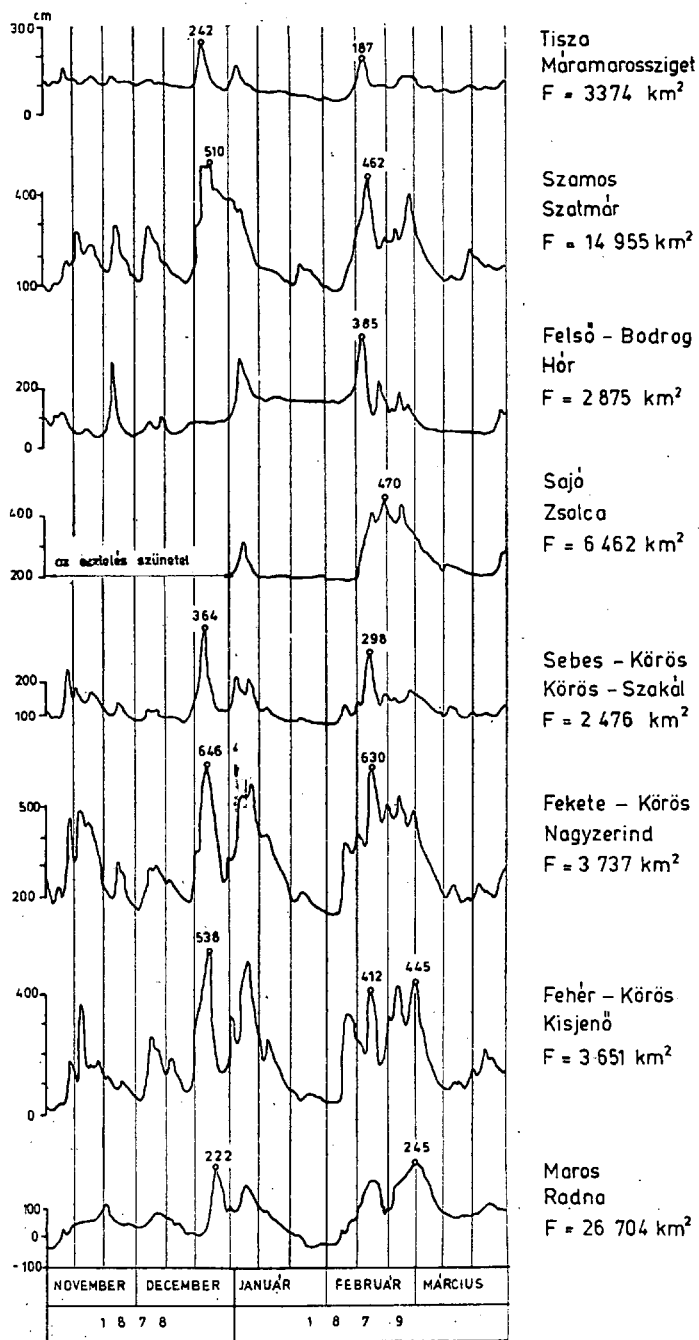


Fig. 4. Water-level changes in the Tisza, packing place in the preceding period of the "great flood" in 1879.

culminations at Mindszent on 12<sup>th</sup> of March and at Szeged on 15<sup>th</sup> of March (with 777 cm at Szeged).

The flood coming from the Mid-Tisza had only just then reached the Lower-Tisza. Of course, it is probable that the overflow of the water at Szeged perhaps retarded the date of a newer culmination but if the water-level of the Tisza could rise despite its overflow at Szeged, it is sure, that the flood which was necessary for it already arrived at Szeged from the Mid-Tisza after the catastrophe at Szeged.

Let's wonder about the fact many other important things to be described this thing which seemed to be a matter of secondary importance would not have been enough in themselves to cause the flood catastrophe of the Tisza at Szeged in 1879 without the simultaneous floods of its "sleeping partners", the Kőrös but especially the Maros. Everything happened in this way later on, too. At each culmination when the water-level of the Tisza reached special heights at Szeged, like in; 1895, 1912, 1932 and 1970, too, the high flood of the Tisza was added to that one of the Maros nearly at the very same time.

According to the estimations of Lászlóffy Woldemár, 200–350 m<sup>3</sup>/s water poured out to the flood area throughout the bursting of the dam, and later on it could also be 400–450 m<sup>3</sup>/s for the time being. Thus together 85–100 million m<sup>3</sup> water should have poured out to the inundation area. The water at Szeged returned to its bed only after 180 days. As far as we know, there were other four bursts at the banks of the Tisza, 17 in the river-system of the Bodrog, 26 on the White-Kőrös, 23 on the Black-Kőrös, 2 on the Twofold-Kőrös, 17 on the Speedy-Kőrös and 5 on the Berettyó. We can admit that the specialists of that age were right, attributing the bursts of the dam and especially the catastrophe at Szeged to the unsatisfactory sizes of dams and to their bad construction. The top of the dams were 2–2,5 m wide in some places. It is evident, the basic part of the dam could not have been too wide because of the fact that the height of the dam was also minimum. As constructional faults were also added to this, damming-system of that time had not been suitable for its aim.

A source of further troubles was that there was no second systematically built defensive line behind the main defensive line which burst at Petres. The cross-dams were not built out properly, then the railway-bank of Hódmezővásárhely–Szeged which incorrectly was built not for the aim of flood control did not prove to be suitable for retarding the higher water. For filling of this task, the round-dam of Szeged was built all around the town during the time of reconstruction. The effectiveness of the flood-control proves that it has not got any flood-loads since the time when the round-dam was built.

During the following years of 1879 and the safety which was given by the defensive dams perhaps occurred at the first time in 1970 that a second flood could also reach the town. The Tisza constantly hides such treats, that there are culminations by 3–4 meters higher above certain points of the town here and there, if we don't keep our flood-defence on the level of this age. We are not allowed to forget even if the Tisza – as it has already happened two times since 1879–does not exceed the 700 cm during a period of 15–20 years.

Let's outline the changes of the HWL's (HWL=highest water-level, record water-level) on the water-gauge in Szeged. Beside the breach in the dam on 5<sup>th</sup> of March in 1879 the maximum of the flood reached as much as 806 cm, which – as it is known – led the flood destroying the town. Only just following the rebuilding the



food reached the newer, HWL with 845 cm on 15<sup>th</sup> of April in 1881 and its further growth by 2 cm already led to 748 cm on 18<sup>th</sup> of April in 1888.

It happened as that a further rise of the water-level, calmed down for a longer time just after 12<sup>th</sup> of April in 1895 with its 884 cm. Namely, a repeated growth of it was only on 12<sup>th</sup> of May 1919 (916 cm), on 15<sup>th</sup> of April in 1932 (923 cm) and the very last time on 2<sup>nd</sup> of June in 1970. The growth of level of HWL's is natural even for the fact that we register data to this line only in case of a fresher record.

The upper limit, which can be expressed with numerical values, should not be interpreted. Well, it cannot be drawn up meteorologically or in physical way. Statistics as science suggests that following one record-level after the other will gradually get rarer in the course of times, but it theoretically never ends.

Today, we don't think the water level of 1020–1040 cm heights to be unreachable at Szeged to parry of which we have all the possible means. The only necessary thing for it is, that the heavy spring-or late-spring rains will be kept back in following down the watershed area on the way to the subsidiary streams, to prevent that the culminating floods – especially those of the Tisza and the Maros – meet at the mouth of the river more exactly then ever before.

After all, we can find out of the estimation of the hydrological data with both the methods of that times and today in the period preceding 1879 that the ensuing of the flood- catastrophe at Szeged was presumable. It was foreseen with more less accuracy by the specialists. They called the attention of the responsible leaders of the country in advance for it.