3.1. WATER QUALITY RELATIONS OF FLOODS OF RIVER TISZA

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3.1.1. INTRODUCTION

We followed the phases of different water-quality components during a year at two water-sampling points of the river Tisza. During our work we set the target to show the relations between the studied water quality indexes and the water-level of the river and to analyse their nature with special interest in the features of the great floods of the latest years. By choosing between the water-sampling points it played a great role to have up-dated information about the waterquality of the river Tisza leaving the area of the Kisköre reservoir, as the water supply of the river Tisza is the sole drinking water basis of the city Szolnok.

3.1.2. MATERIAL AND METHOD

We followed the runs of different water-quality components (electrical conductivity, flowing-material content, hydrogen-carbonate ion, number of thalluses of saprophytes at 22 °C, number of coliforms, number of planktonic bacteria) from 1st July 1998. untill 30th June 1999. The water-chemical analyses were carried out daily at Pusztataskony, twice a week at Szolnok, the water-bacteriological analyses in every second week at Pusztataskony, and weekly at Szolnok. The determination of chemical and biological components were carried out on the basis of analytical standards listed in the qualificatory standard MSZ 12749:1993 (Surface water water-quality, quality characteristics and qualification).

3.1.3. RESULTS

The annual measuring results of some water-quality components are indicated on case-historical graphs. The essence of it is, that the values of the water-quality indexes measured at the two water-sampling points are showed using the phases of water-level of the river Tisza as the background of the events. This type of data representation provides a picturesque and well understandable information about the periodical changes of the river. The graph of the changes of the values of conductivity and water-level (Fig. 1) shows the close correlation between the electrical conductivity and the water-level.

It can be seen on Fig. 1, that that the electrical conductivity of the water is decreasing in the case of rising in the water-level while increasing in the case of low-water. The concentration of the hydrogen-carbonate ions of the water changes the similar way. Futher on we defined the determinatory coefficient (R^2=0.9021) between the two variants, which characterized the closeness of the joint. It means, that the change of one of the parameters explains by 90% the variation of the other.

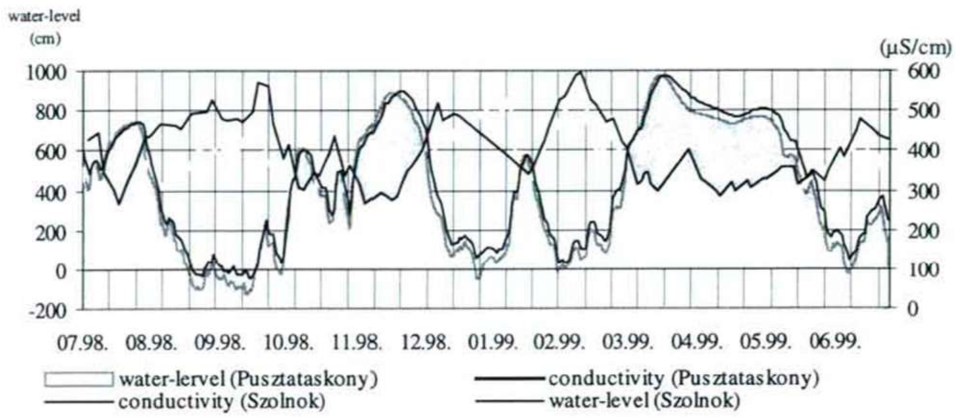

Fig. 1. The relation betveen the values of conductivity and the water-level measured at two sampling-points of the river Tisza

We can observe a similar periodicity on Fig. 2 too showing the phases of floating-material content and water-level.

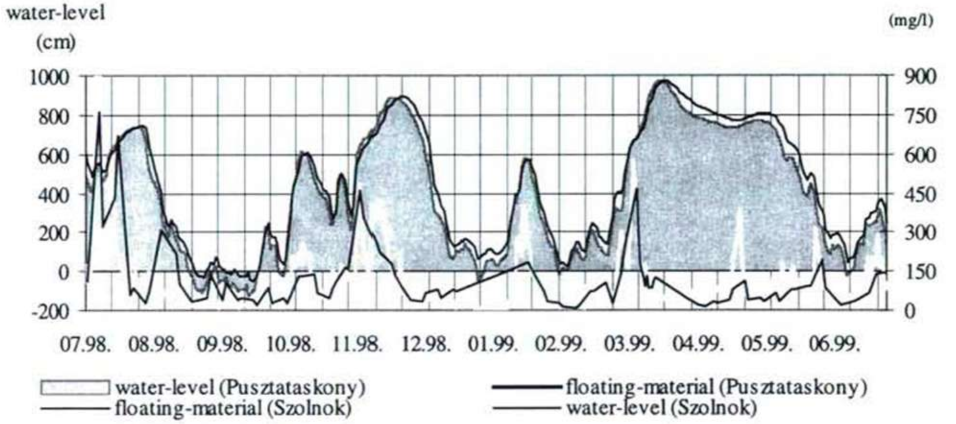

Fig.2. The relation between the floating-material content and the water level at two sampling-points of the river Tisza

The maximum values of the concentration of floating-materials can be observed at the starting phases of each flood, which is then followed by a sudden drop. As the quantity of the floated siltage is affected mainly by the quantity of the rainfall fell onto the cathment-area and the siltage wased into the water by it, by the speed of the waterflow and the sedimentation of the floating-materials (so called hydrological factors) (Bogárdi, 1971) so it is understandable that the floating-material content shows a saltatory increase at the starting phase of the floods. The floating-materials washed-in by the rainfall fallen onto the cathment-area contains a great amount of organic materials, which is well demonstrated by the close correlation of the COD_{pa} and the floating-material content. It can be seen from the results of the regression- and correlation-analyses carried out by a similar way, that in a certain case there is a closer relation (R^2=0.9024) between the two observed components, for ex. HCO_3 and the conductivity, than between the measured values of COD_{pa} and the floating-material content (R^2=0.8772). The relations of the functions similar to these can be adaptable for predictious aims too, and can be played important roles in the controll of the results of the measurements.

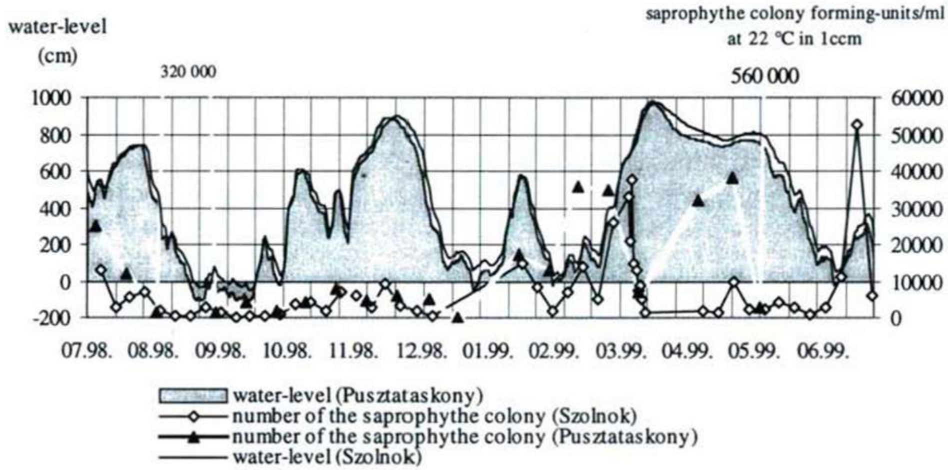

Fig. 3. The relation between the values of number of the saprophythe colony forming-units and the water-level measured at two sampling-points of river Tisza

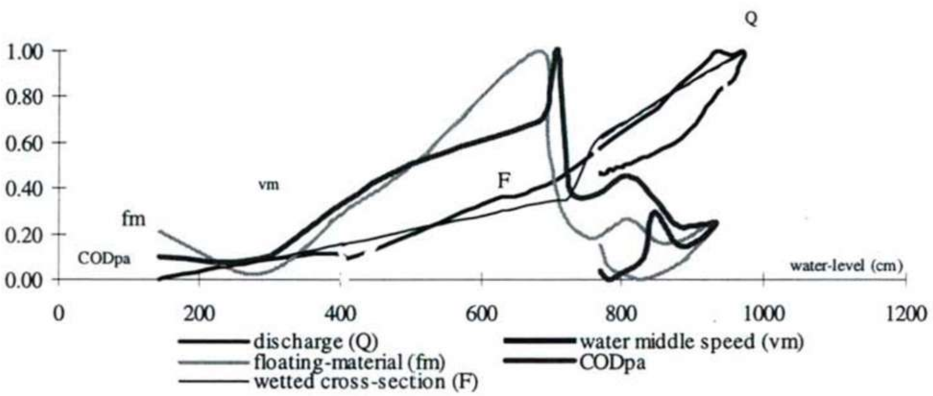

Fig. 4. Charasteristic curves of river regime of some hydrological indicators at the river Tisza (Szolnok) between 24.04.-26.02. 1999.

By analysing the case-historical graphs we noticed, that a periodical changes of the observed water-quality components can be monitored in the case of an individual flood.

So we concluded to analyse the action of a flood more thoroughly. The water-level historical loop-curves (Dvihally, 1963) proved to be the best for this purposes. Let's see for ex. the actions of the flood between 26th February and 24th April 1999 through the example of the floating-material content and the COD_{pa}.

The phases of the values of five observed parameters measured at Szolnok standardized by expansion (by Podani, 1997) can be followed during a run of a flood on Fig. 4. It can be seen, that the culmination of the values of each parameters follows each-other in a determined chronological order. By the rising of the water-level the first is the concentration of the floating-materials reaching its maximum value, which is then followed by the COD_{pa} and the mean-speed (v_m) of the water-flow. We can observed at last the culminations of the discharge (Q) and the water-level. The graph can be devided into two well separated parts: the ascending an the descending line. In the optimal case – when the starting and the final water-level of the flood is equal – two values of floating-material content (etc.) belong to each water-level value, and these values meet at just one point. On account of this the graph traces a loop.

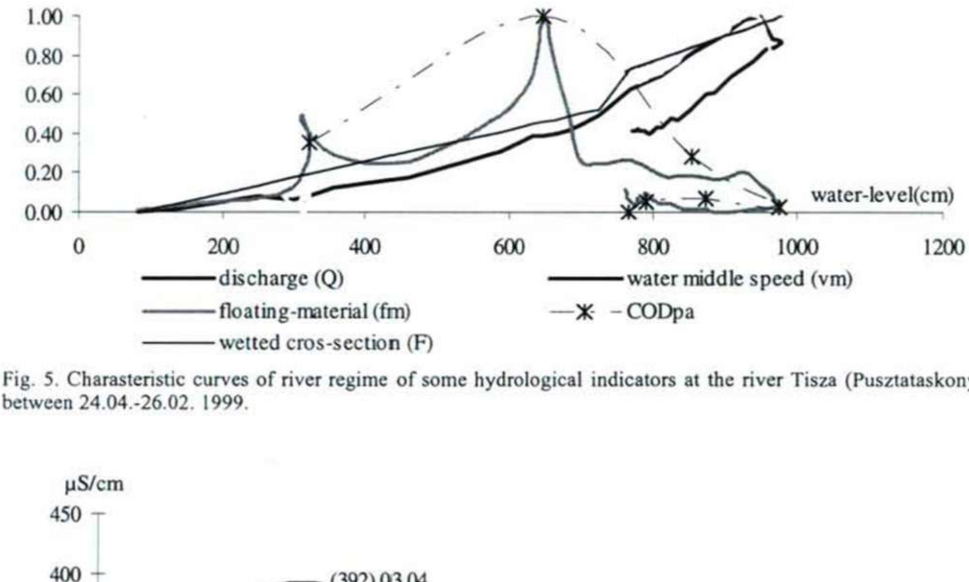

Fig. 5. Charasteristic curves of river regime of some hydrological indicators at the river Tisza (Pusztataskony) between 24.04.-26.02. 1999.

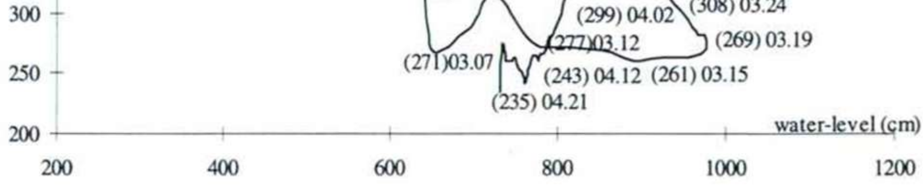

Fig. 6. Charasteristic curves of river regime of conductivity at the river Tisza (Szolnok) between 04.21.-03.03. 1999.

In the nature there can not be observed such a regular flood of course, as during a flood there are usually more floods piling up together, so the starting and the ending points of the graphs do not meet at the same water-level. The phases of the five measured parameters of this same flood at Pusztataskony can be seen on the Fig. 5. By comparing to the previous figure we can observe that the events described above followed each other in similar order. The measurements of COD_{pa} at Pusztataskony were carried out only once a week, so we do not have daily data about the phases of this parameter. Because of this we joined the stars marking the results of COD_{pa} measurements with unconnected line on Fig. 5 so it is just an additional information.

The number of the saprophyte colony forming units shows the size of the bacterium-flora depending on the presence of the quickly demolishable organic materials and which demolish it. To propagate these bacteria at 22°C the saprophyte-bacterium stand of the water can be traced. The number of the psychrophyl bacteria is significantly increasing in the ascending phase of the flood (Fig. 3), as the saprophyte-bacteria can be multiplied on the organic particles stuck to the surface of the floated siltage. In this case a great number of of psychrophyl bacteria joins to the high values of COD_{pa}. A great increase in the abundancy of the bacteria was observed in the descending phase of the flood (at Pusztataskony). During this period with outstanding internal-water quantity the number of bacteria can significantly be affected partly by the disadvantageous quality of the internal-water pumped into the river, and partly because the river washes in a great amount of organic materials during recedeing from the flood-plain, and if the water-temperature is favourable the bacteria could be multiplied in great quantities (Fig. 3).

The number of saprophytes which can be measured in the water is decreasing because of the little washing-in, and because of the sedimentation of the bacteria together with the floating-materials during low-level. In the work of B. Tóth (1997), K. Szilágyi (1995), and Hegedûs (1980) the relation between the planktonic number of bacterium, the discharge and the floating-material content is well studiable. It can be observed during low-level, that when the floating-material is subsiding (and the greater part of the bacteria forming units at 22°C), the number of planktonic bacteria defined by the AODC method is increasing. It is interesting, because this later method – although the number of saprophytes at 22°C can be advised as an alternative of the AODC method, according to the literary data - is far more precise, as not only the heterotrophes with active metabolism can be included, but those bacteria as well which are living, but do not show active metabolism.

The number of planktonic bacteria of the river Tisza is varied between 0.38-2.1 million cell/ml during the observed flood period. During flood the number of planktonic bacteria is increasing, and the bacterial biomass is quite high (B. Tóth, 1978). The dominants are the small coccuses, while during a long-lasting low-water level the rod- and filiform forms are also appearing in greater number. The coliform bacterium is a rod-shaped facultative fecal indicator bacterium. They can revive nitrate into nitrite, dissociate lactose during formation of acid and gas, and multiply well at 37°C. The coliform bacteria indicate the organic-material loading getting into the water from outside, so their number is increasing together with the quantity of the organic-materials getting into the river Tisza on the occasion of a flood. The highest number of coliform bacteria was observed in the descending phase of the floods, as the quantity of the organic-materials originating from the flood-plain and from the internal waters is significant.

3.1.4. Discussion

The case-historical graphs prooved cleanly, that the actual value of the water-quality indicators are greatly depending on the hydrological state of the river (Tisza). The water-level, the discharge, the flow-speed, the quantity and the distribution of rainfall fell onto the cathment etc. are all determinative factors of the waterquality indicators. That's why it is important, that the results of the water-quality analyses will be always defined in the mirror of the hydrological state of the observed river.The close correlation between the values of the conductivity and the concentration of HCO_3 ions may seem to be surprising by the first approach, as the hydrogencarbonate ion does not belong to the mobile ions by its size. As the electrical conductivity is the sum of the conductivities of all ions being present in the solution, it seems to be certain, that cations getting into the water by the dissolution of carbonated rocks generate the rise of the conductivity.

When we analyse the phases of the electrical conductivity during a run of a flood (Fig. 6), we can see, that at the beginning of the flood we measured relatively high values, later on a significant thinning was observed, what characterized the river untill the culmination of the flood. The receding of the river was happened beside a new increase in the values of the conductivity on account of the concentration of the water. The salt-concentration of the water of the river Tisza and its phases are depending on the quantitative relations of the springs supplying the river and being rich in soluted mineral salts, together with the "thinning-waters" originating from thaw and rainfall (Juhász, 1976).

At thaw, or at the time of a heavy rain the rainfall agushing from the catchment is nearly pushing the more thick salt-contented water in front of it in the river-bed. It is followed by the spring-water gained higher discharge in the meantime mixing with the rain-water arriving continuously (Bancsi *et al.*, 1977). So at the starting phase of the flood we meet a thick water, then later on - untill the culmination - a thiner rain-water, and at the descending phase a mixture of the higher discharged spring-water and the rain-water.

The explanation of the phases of the floating-material content (Fig. 2) is a very complicated task. At first we have to clarify two abstractions: the siltage-carrying ability of the water is the upper limit of the quantity of the siltage carryable by the waterway, which are determined by the hydromechanical factors. The quantity of the siltage carried actually is much less, so the waterways are always carrying less siltage, than as much as they could (Bogárdi, 1971.). It can be seen well on Fig. 4., that the mean flow-speed of the water (v_m) and the quantity of the floated siltage (floated-material f_m) only at the starting phase of the flood increases together. The curve of $f_m$reaches its maximum value earlier, than the v_m which can be explained by the decrease in the quantity of the wased-in siltage. The sudden fall back of the v_m can be explained by the specialities of the bed-profile of the observed segment of the river. As the *F* curve shows, at the water-level of 750 cm the river steps out of its main bed and expands on the flood-plain, which leads to the sudden decrase of v_m, while the discharge *(Q)* is continuously increasing. Passing through this breaking-point the v_m is increasing again by the rise in the discharge, but in a less slow measure, than in the main riverbed. In the descending phase both the Q and the v_m is continuously decreasing.

The different between the values of the two parameters measured in the ascending and in the descending phases is originating from the different in the water-level fall of the surging and the retreating river. The number of the planktonic saprophyte and the number of coliform bacteria are dominantly increasing in the ascending phase of the flood, but we observed the the saltatory increase of the abundancy of the bacteria in the descending phase of the flood at every group of bacteria analysed by us (August 1998., May 1999. at Pusztataskony) The cause of this is probably that, that after the flood the river retreating back from the flood-plain and the over-lifted sewages are washing a great amount of organic materials, fecalic and other contaminants into the water, what the psychrophyl saprophytes, the coliform and Clostridium-type bacteria can utilize in a different way in the case of favourable conditions.

3.1.5. SUMMARY

The analysis of the case-historical graphs produced on the basis of yearly data flashes light onto the necessarily frequent changes in the water-level of the river and in the examined parameters. It can be seen, that the electrical conductivity of the water is decreasing in the case of rising in the water-level while increasing in the case of low-water. The concentration of the hydrogen-carbonate ions changes the similar way. The maximum concentration of the floating-materials can be observed at the starting phases of a certain flood. The curves of the graphs of the yearly changes of COD_{pa} and floating-materials are similar, which indicates the close correlation between the two components. The number of the psychrophyl bacteria and the number of coliforms are significantly increasing in the ascending phase of the flood, but the maximum values of the abundancy of the bacteria was measured in the descending phase. During this period with outstanding internal-water quantity the number of thalluses of saprophytes are significantly affected partly by the disadvantageous quality of the internal-water pumped into the river, and partly because the river washes in a great amount of organic materials during recedeing from the flood-plain, and if the water-temperature is favourable the bacteria could be multiplying in great quantities.

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