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BIOLOGICAL WATER QUALITY OF THE TISZA BETWEEN TOKAJ AND TISZAFÜRED

(ON THE BASIS OF STUDIES CARRIED OUT BETWEEN THE PERIOD 1971—1980)

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Abstract

A comparison is given of the results of the water quality studies carried out between 1971—1980 in the two characteristic segments of the Tisza (Tiszatardos and Tiszakeszi). The evaluated 10 years' period can be divided into 5-yearperiods, characteristic of basically differing water qualities: with values mostly under 500 m^3/s between 1971—1975; and values above 500 m^3/s between 1976—1980 — on many occasions essentially surpassing even 1.000 m^3/s.

The comparative evaluation of the two 5-year-periods unambiguously refers to the fact that the water quality of the Tisza is fundamentally determined by the water output, with the increase of which at the same time there is also a higher amount of biologically accessible nutriments. However, it should not be left unconsidered that between the period 1971—1980 there was a substantial increase in the utilization of chemical fertilizers having N and P effective agents, which show decisive influence on the development of the nutriment concentrations and their loading, respectively.

On the basis of the evaluated water quality characteristics, it can be determined that significant decomposition took place in both segments, bieng more expressed in the Tiszakeszi segment than in that of Tiszatardos. The cause of this may first of all be in the washing ins originating from areas belonging to the channel section between the two segments.

The biological water quality of the Tisza: beta-alphaoligohalobic, beta-limnotyped; oligo-mesotrophic (in Winter: atrophic, in the growing season: eupolytrophic); between betamesosaprobic-alpha-mesosaprobic; not of toxic type.

The algae population maximums are firstly characterized by the domination of diatoms (Bacillariophyceae). The changes in the chlorophyll a content at the time of subsiding of the algae population maximums are unambiguously in correlation with the changes of the total algal count within the longitudinal segment.

From the plant-nutriments, the dissolved reactive phosphorus should be regarded as a limiting factor, compared to the participation ratio of which the ratio of nitrogen is over 7-folds and that of carbon is close to 20-folds.

On the basis of the comparative evaluation of the two segments it can be determined that the water quality of the Tisza is acceptable in general, nevertheless, the results characteristic to the unfavourable conditions cannot be neglected either.

Introduction

To characterize the water quality of the Tisza channel section (practically between Tokaj and Tiszafüred) belonging to the field of activity of the Northern Hungarian Water Conservancy Directorate, the results of a 10 years' study were evaluated at two segments:

Tiszatardos, where its water quality is determined by the pollutions brought from the upper course and by the water quality of the Bodrog;

Tiszakeszi, where its water quality — beyond the foregoings — is influenced by the water quality of the Sajó and by the sewages from the area of Leninváros.

The two selected segments are thought to be suitable to characterize the water quality of the Tisza arriving to and flowing out of our district. Naturally, during the course of the evaluation the results of other studied segments belonging to our range of activity were also taken into account (see supplemented map), (as well as casually the features of periods before 1971 and after 1980) — which, according to sense, are referred to in given cases.

The review on the special literature dealing with the water quality of the Tisza (in certain cases being greatly detailed, in other cases being unfortunately scanty) was purposely avoided, since this present study wishes to evaluate exclusively the results of the water quality examinations of the ÉVIZIG. (Northem Hungarian Water Conservaney Directorate).

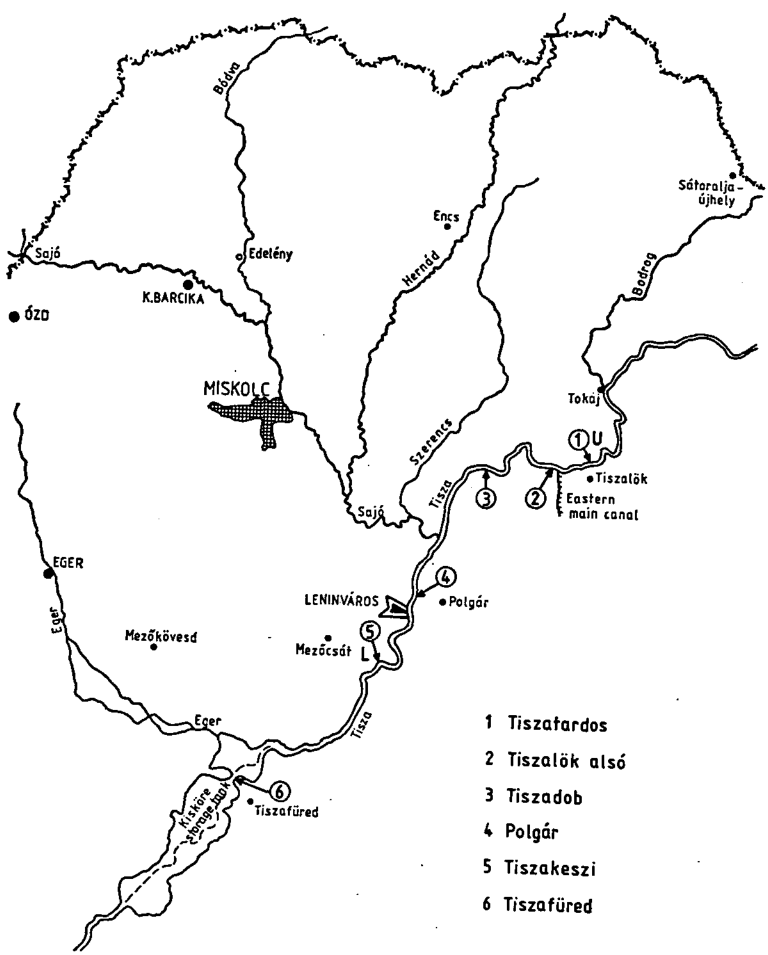

Fig. 1.

Materials and Methods

The Laboratory for Water Quality Examinations of the Northern Hungarian Water Conservancy Directorate carries out regular studies on the control of the Tisza's water quality. Being the "basic network sampling areas" determined by the National Water Conservancy Board, the studied segments (see supplemented map) are tightly connected to the study areas of similar object of the Water Conservancy Directorates along the river Tisza.

Our studies were carried out regularly every month on one occasion, thus the 10 years' period could be characterized by the comparative evaluation of 120 study results per segment.

The water samples were as far as possible taken from current line, 20 cm below the water surface, taking into consideration the general rules of water sampling, and also the probable local or periodical changes of the conditions.

The studies were performed with the aid of the COMECON project (1975) as well as the methodological collections by FELFÖLDY (1974) and SZILÁGYI (1982). The methodological instructions regarding algological studies and the books of determinations used have already been reported in an earlier publication of the author (1981), therefore these shall not be listed here.

In the original essay, the changes of the more important water quality characteristics were also evaluated by author according to the statistical method of the "totalized or remaining behind frequency". Since this would not fit into the frame of the present paper, the original manuscript

Reviewing and evaluation of the study results

In the first part of this paper the changes in time and space of the more important water quality features are compared in the case of the two segments. During the course of the evaluation, author found it noteworthy that compared to the first (1) 5-year-period (1971—1975) the water quantities belonging to the various studies were essentially greater in the second (2) 5-year-period (1976—1980). This also necessitated the calculation of the "loading" of the more important water quality characteristics. (Regarding that due to the banking up at Kisköre, no series of data are available concerning water quantity for the last past years at the Tiszakeszi segment, this activity could only be accomplished in the segment of Tiszatardos).

In the further part of this paper — in compliance with the selected topic — the more important water quality characteristics are evaluated according to the property-groups of biological water quality. (The biological water quality of the Tisza — abstaining from taking up a position in the question of principle — was evaluated on the basis of the project utilized in the water conservancy practice.) In this subject, the quantity and ratio compared to each other of the nutriments (carbon — nitrogen — phosphorus) essential for the plants are discussed separately. Here the evaluation is given of the changes in the dissolved oxygen content, which is inseparable from the biological happenings going on in the water.

The changes in time of the water quality in the two 5-year-periods refer to the fact that compared to the years 1971—1975, in the case of NO_3^-, COD_p and COD_k, there was a significant decomposition in 1976—1978 in both segments. The average concentrations of NH_4^+, BOD_5 and TDM were practically unchanged. Defined in numerals, the more important changes are the followings:

	Tiszatardos (g/m³)			Tiszakeszi (g/m³)		
	1	2	Deviation	1	2	Deviation
NO_3^-	4,76	5,92	+1,16	5,74	7,46	+1,72
COD_p	3,95	5,86	+1,91	6,03	6,52	+0,49
COD_k	13,0	18,2	+5,2	19,5	21,5	+2,0

The changes in space of the water quality in the two selected segments refer to the fact that compared to the Tiszatardos segment, in the case of NO_3^-, COD_p and

COD_k, significant decomposition took place in both 5-year-periods at the Tiszakeszi segment. The NH_4^+, BOD_5 and TDM changes were of slighter degree.

The more important changes expressed in numerals are the followings:

	1971—1975 (g/m³)			1976—1980 (g/m³)		
	U	L	Deviation	U	L	Deviation
NO_3^-	4,76	5,74	+0,98	5,92	7,46	+1,54
COD_p	3,95	6,03	+2,08	5,86	6,52	+0,66
COD_k	13,0	19,5	+6,5	18,2	21,5	+3,3

(The given numerical values are the average concentrations of five years).

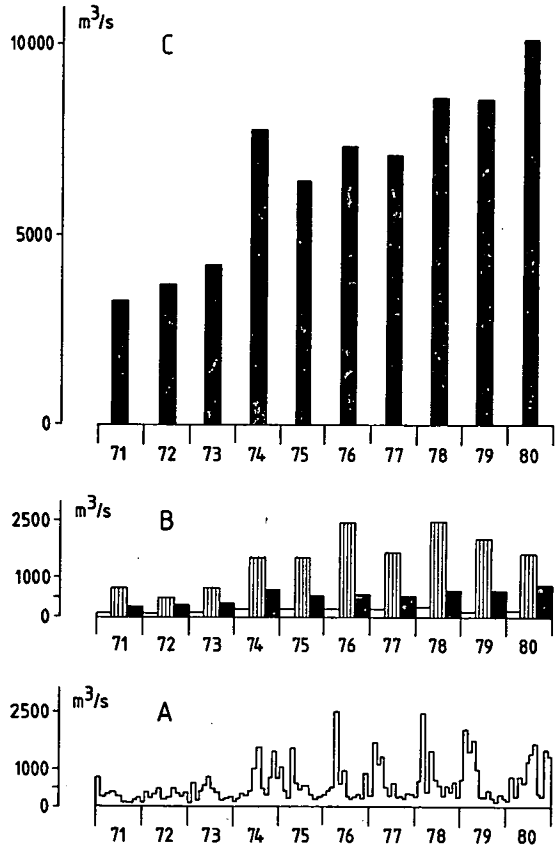

Fig. 2. Characteristic water quantities of the TISZAi n the years 1971—1980.

Beyond the comparison of the two 5-year-periods, the yearly development of the more important water quality characteristics in the two selected segments deserves attention: Table 1 shows the annual minimum-maximum and average values besides each other.

The basically differing water outputs of the two 5-year-periods in the segment of Tiszatardos are observable in Figure 2. It can well be seen that in the period between 1971—1975 the water quantities could be characterized by values mostly under

500 m^3/s (the average value of the 5-year-period =423 m^3/s), however, between 1976—1980, a great part of the water quantities had values above 500 m^3/s (the average value of the 5-year-period = 699 m^3/s), in many occasions with values essentially exceeding 1.000 m^3/s. It follows from this, that the increase in concentration of the more important water quality characteristics changed in conformity with the increase in the quantity of contamination material. To prove this, the "momentary" quantity values of the certain contamination material were calculated (="loading") — on the basis of the water quantities and contamination material concentrations belonging to all the 120 study time-points of the 10 years' period. The values gained in such a way were totalized yearly. The results are shown on Table 2.

The annually totalized values were also summed up and averaged in each 5-year-period, then -considering the values of the period between 1971—1975 as 100% — the characteristic changes between 1976—1980 were calculated.

The followings should be emphasized from the Table:

— the totalized value of the water outputs at the time of samplings was the lowest in 1971 (the lowest water output — 103 m^3/s — of the 10 years' period was in this year), and was the highest in 1980 (the highest — 2500 m^3/s — water output of the 10 years' period was in 1976 and 1978, resp.); the degree of change between the two 5-year-periods was: +65%;

— the g/m^3 and g/s values of the various water quality characteristics — with few exceptions — were likewise the lowest in 1971 and the highest in 1980. Comparing the two 5-year-periods — with the exception of NH_4^+ — the minimums were found between 1971—1975 and the maximums between 1976—1980.

To analyse the relationship between the water output — concentration — loading, author drew several diagrams on the basis of the 120 studies of the 10 years'period, and evaluating these the following determinations could be made:

— in the case of those water quality characteristics, where the concentration showed well measurable increase (NO_3^-, COD_p, COD_k), the "loading"-increase indicated the occurring changes even more expressedly; in the case of the water quality characteristics where the concentrations practically did not, or only less expressedly change (NH_4^+ — BOD_5 — TDM), the "loading,,-increase made the unfavourable shift of the water quality evident;

— the relationship between the concentrations of the evaluated water quality characteristics and the water output — with the exception of the COD_p and TDM — was found to be loose, and undistinctive, respectively. Namely, the taken up value pairs were found situated in an unorganized mass in the co-ordinate system (in the case of COD_p the location of one part of the value pairs refers to the fact that with the water output increase, there was an increase also in the COD_p concentration; however, in the case of TDM the total value pairs refer to the decrease in the concentration contrary to the increase in water output);

— it is striking, however, that the connection between the water output and the "loading" showed direct proportional relationship in the case of each evaluated water quality characteristic, namely, the increasing water quantities were accompained by the increase in the amount of contamination material.

The previously described alterations can well be seen on Figures 3, 4 and 5c.

During the course of evaluating the results, several other figures were also prepared for the purpose of studying the evident or expectable relationship of the certain water quality characteristics. On the basis of their evaluation — without the demonstration of the certain figures — the followings are thought to be important to emphasize:

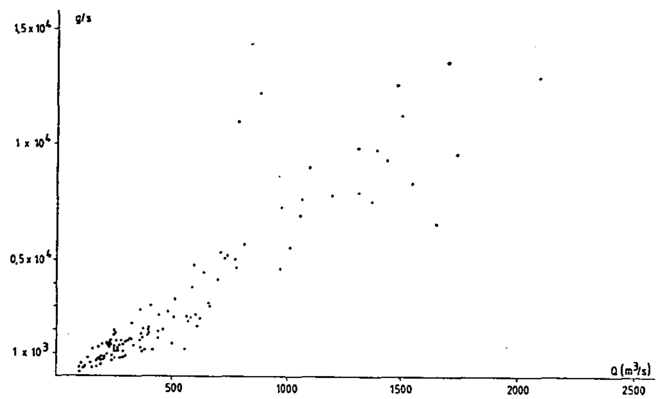

Fig. .3 Relationship between water output and nitrate amount at Tiszatardos between 1971—1980.

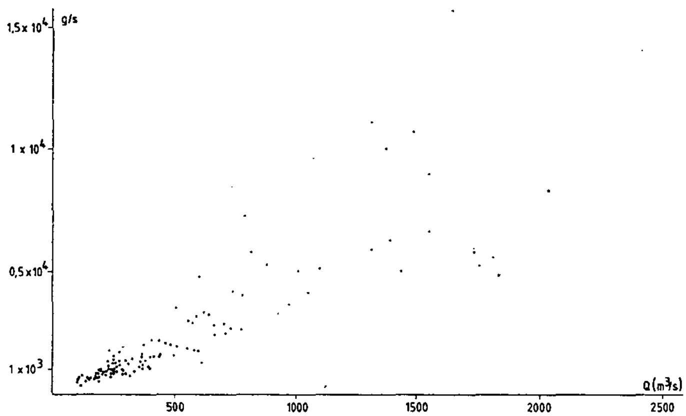

Fig. 4. Relationship between water output and COD_p amount at Tiszatardos between 1971—1980.

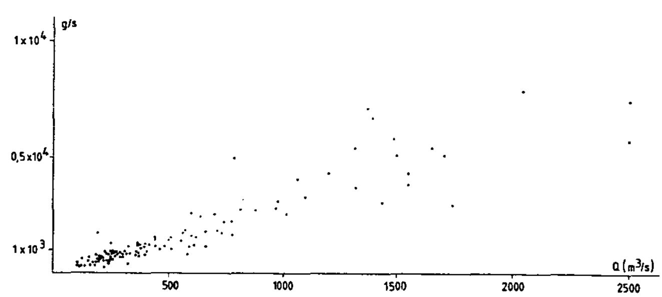

Fig. 5. Relationship between water output and BOD_5 amount at Tiszatardos between 1971—1980.

— the TFM concentration and "loading" are equally in relationship with the water output — with the exception of a few cases — the increase in water output is accompanied by the increase in TFM;

— there is no relationship between the O_2 content and the COD_p, the value pairs are situated in the co-ordinate system in an unorganized mass. This also concerns the relationship of the O_2 and the BOD_5, as well as the O_2 and the NO_3^-;

— the dot mass of the COD_p and BOD_5 value pairs shows a certain degree of proportional ratio;
— the concentration of the TFM and COD_k shows a loose relationship; with a good approach, the "loading" shows a relatedness of proportional ratio, referring to the fact that the COD_k "loading" increased with the growth in TFM.

The biological water quality of the Tisza

"The biological water quality is the complex of those factors, which determine the life of the water eco-system, developing and maintaining them" (FELFÖLDY 1974). Accepting this determination, it is easily conceivable that the biological water qualification of the water area does not exclusively mean the evaluation of the biological studies, but inevitably comprises the evaluation of the total characteristics being in connection with the equatic living world:

Halobity: its total dissolved matter content can in general be characterized by the values belonging to the beta-alpha-oligohalobic province, but the maximums in certain segments belong to the alpha-oligohalobic province. Its composition is characteried by the domination of the Ca^{++} and HCO_3^- ions, furthermore by the $+CO_2$ content; that is beta-limnotyped water-course.

The relationship between TDM and water output is detectable on Figure 6.: it can be seen that the concentration of TDM is of slightly decreasing nature with the increase in water output, and its loading is of increasing nature in a proportional ratio with the water output.

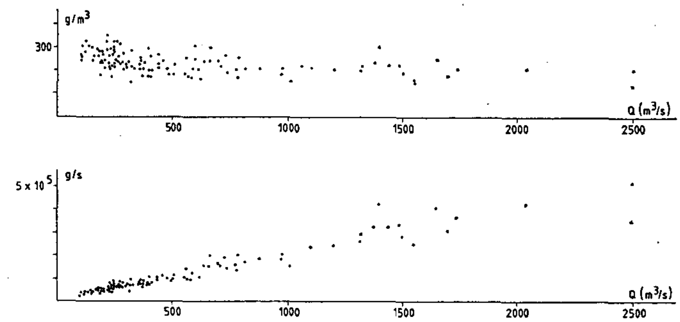

Fig. 6. Relationship between water output and TDM at Tiszatardos between 1971—1980.

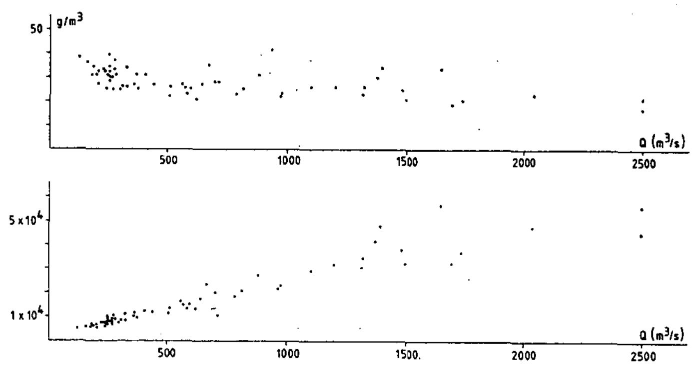

Fig 7. Relativnship between water output and carbon ($=HCO_3^-$ — C) at Tiszatardos between 1976—1980.

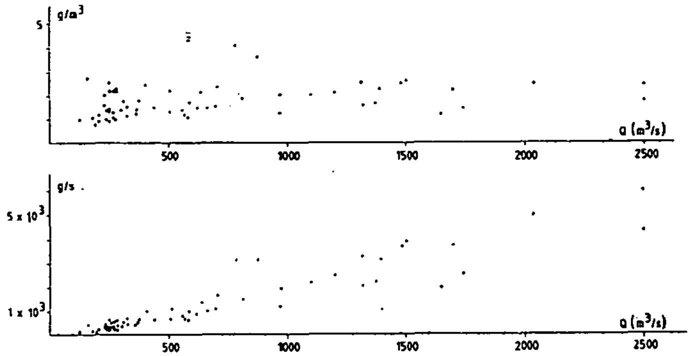

Fig. 8. Retationship between water output and mineral nitrogen at Tiszatardos between 1976—1980.

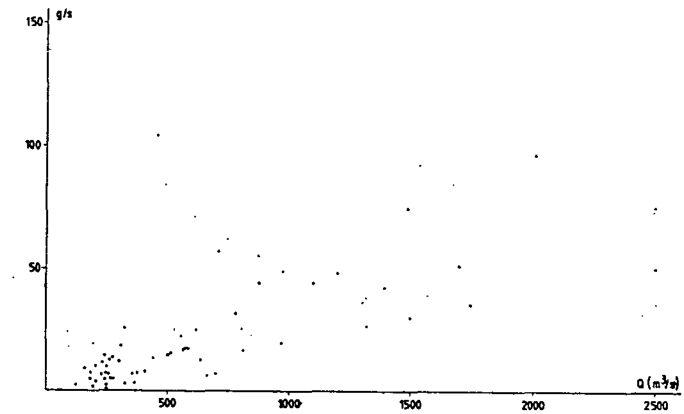

Fig. 9. Relationship between water output and phosphorus ($=PO_4^{3-}$—P) at Tiszatardos between 1976—1980.

Trophity: in the water of the Tisza there are generally sufficient amounts of nutriments (C—N—P) — accessible by the plants. The relationships between the nutriments and the water output are observable on Figures 7, 8 and 9. The amount of nutriments is dependent on the water output, changing in proportional ratio with is.

These nutriments form the possibility of eutrophization, while the actual degree of this is indicated by the chlorophyll a content. Among the nutriments, the most important is regarded to be the dissolved reactive phosphorus (PO_4^{3-}—P), the amount of which is 0,040 g/m³, counting an average from the results of the total measurings. (End values: minimum=0,003 g/m³, maximum=0,15 g/m³; both at Tiszakeszi). This could result trophity of mesoeutrophic nature. On the basis of the chlorophyll a content, the actual trophity-degree ranges from atrophic nature (zero values were practically even measured in the Winter months) to eupolytrophic nature, but the oligomesotrophic nature is also characteristic. Nevertheless, it is typically of mesotrophic nature in its certain channel sections. The trophity-degree value of the Tisza — in an extreme case: for example in 1975 — was also found to be of eupolytrophic nature.

On the basis of the total algal count, the trophity-degree is generally higher than on the basis of the chlorophyll-a content; this can firstly be explained by the high number of the small-sized diatoms. The study on the longitudinal segments between the period of 07. 06. 1977—08. 06. 1977 is characteristic of the dominating diatoms.

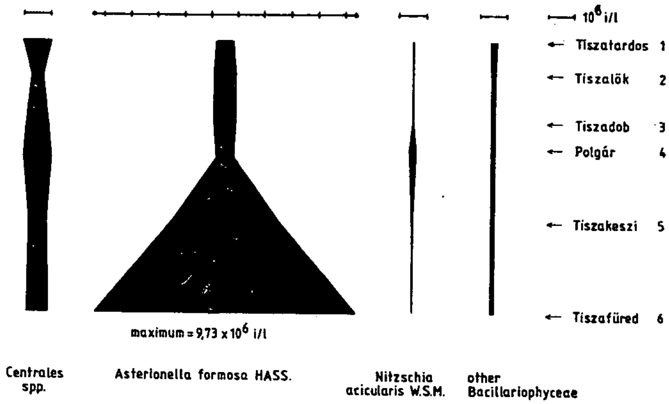

Fig. 10. The Bacillariophyceae composition and distribution of the Tisza in 06.:07-08. 1977.

It can well be seen from Figure 10 that besides the generally characteristic Centrales-taxa the *Asterionella formosa* HASS. Pennales-taxon showed an unexpected increase in the water of the Tisza, pressing out the rest of the algae. It is unfortunate that due to technical reasons, the chlorophyll a content could not be measured at the time of the subsiding of the characteristic populationmaximum.

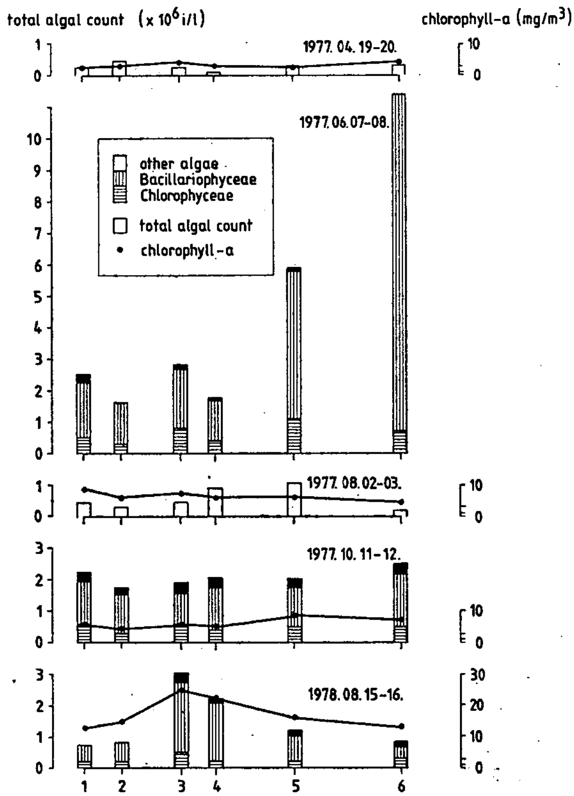

Fig. 11. Results of the characteristic longitudinal segmentstudies at the Tisza (1977—1978).

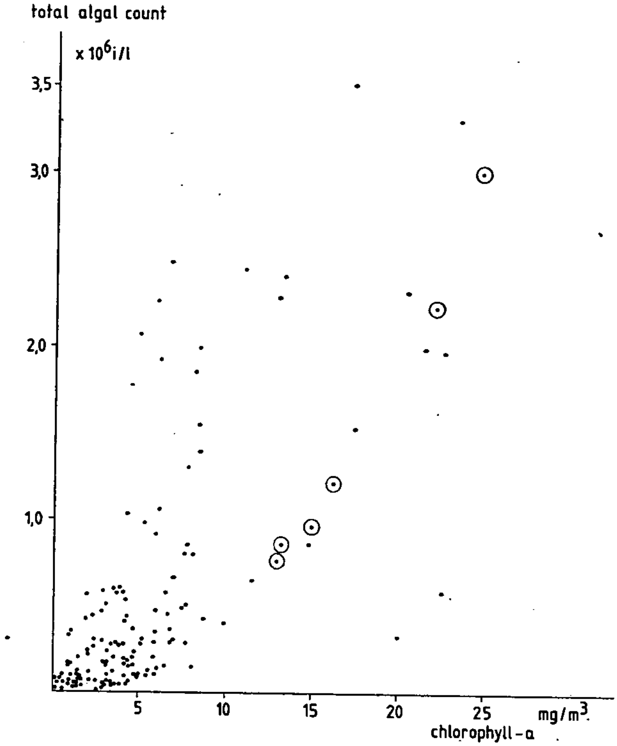

Fig. 12. Relationship between total algal count and chlorophyll-a content at the Tisza (1976—1978).

It is characteristic to the chlorophyll-a a and the total algal count relationship that in the longitudinal segment they generally change in conformity and the values are opportunely significantly decreasing. A few examples of this can be seen on Figure 11. Figure 12 also shows their relationship, which has not been complicated with the value pairs of the years 1979—1980 of similar tendency, for the sake of lucidity. It can be detected from the Figure that their connection is undistinctive in the case of small values, however, at the time of the subsiding of the algae population maximums, their relationship is unambiguous: in general, the maximums of the chlorophyll-a a and the total algal count belong together.

Practically, therefore, the trophity of the Tisza may show extreme changes, but even on the basis of those mentioned so far, the high trophity-degree in the section between Tokaj and Tiszafüred — referring to the river's eutrophizing condition — can also be regarded as characteristic. Nevertheless, it is thought-provoking that the chlorophyll-a determining method used in the water conservancy practice does not take into consideration the quantity of pheophytins being present in smaller-larger amounts — and being in relationship with the physiological state of the algae. As a consequence, on the basis of our measurement results so far, the actual trophity-— degree was overestimated in one part of the cases. To eliminate this in the future, pheophyte-measurements were started in 1982 with experimental nature, and these will be continued regularly in the forthcoming years. (The evaluation of the few results gained so far was naturally not taken into consideration in this paper.)

Returning to the nutriments, let's study their participation ratio compared to each other in the water of the Tisza. It had been determined on the basis of a large amount of measurements that for the algae that nutriment (=medium, here: the Tisza water) is the most favourable, in which the C:N:P ratio=106:16:1. Counting an average from the results of every measurement, this ratio in the bed-section of the Tisza between Tokaj and Tiszafüred was found to be 2000:120:1, rounded off. This means that compared to the participation ratio of the dissolved reactive phosphorus — which is the determinative factor for algal increase — the participation ratio of C is close to 20-folds and that of N is over 7-folds. Under such circumstances, it is natural that from the nutriments, the dissolved reactive phosphorus would become exhausted the soonest, followed by nitrogen, and carbon being the last. Between the two 5-year-periods, there are no basic differences in the C:N:P ratio, but comparing the certain years in the function of time, a slight increase can be observed in the participation ratio of N; at the same time, that of C is decreasing. The explanation to this may probably be in the increase of the NO_3^- content. This shift in ratio is also effective in the longitudinal segment: compared to Tiszatardos, the participation ratio of N manifests a significant increase in the Tiszakeszi segment.

Saprobity: on the basis of the standard values of the biologically accessible organic matter content (=COD_p) (causing saprobity), the biologically accessible organic matter quantity is not significant in the water of the Tisza. Contrary to this, the values of the saprobe-index (="S") — countable at the time of occurrence of the

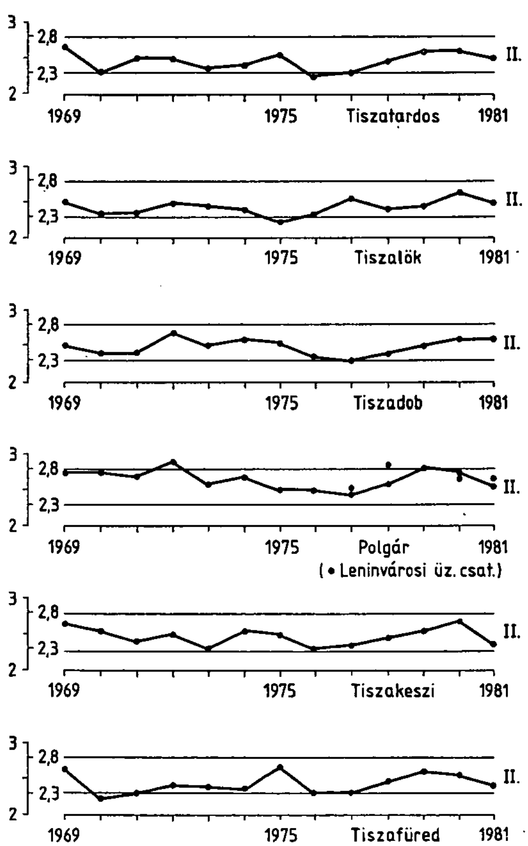

Fig. 13. Standard saprobe-index values of the TISZA between 1969—1981.

microscopic living organs — characterize more unfavou rable water quality in general; the standard saprobity was found to be of nature between betamesosaprobic — alpha-mesosaprobic, which is well illustrated on Figure 13. The changes are not unambiguous in time; in the longitudinal segment the saprobity-increase is noteworthy, experienced during the inflow of the Sajó. The dissolved oxygen content and accordingly, the oxygen saturation also characterize more unfavourable conditions. The maximum values of the dissolved oxygen content between 1969—1978 were found to be low, however, they showed noteworthy decrease in certain segments of the studied bed-section. This is also manifested in the case of the minimums, first of all in the recent years. In longitudinal segment the most characteristic change was the decrease in oxygen content, experienced in general during the inflow of the Sajó.

Nevertheless, it is found to be characteristic by the author that between the two segments selected for the comparison — Tiszatardos and Tiszakeszi — there are no great characteristic differences; the variations are not unambiguous.

Toxicity: on the basis of our studies so far — disregarding a few outstanding cases: extreme water pollution or flood periods — the water of the Tisza is not of toxic quality. Factors determining the water quality of the Tisza.

On the basis of the study results evaluated at the time of the compiling of the essay, the most important factor determining water quality is regarded to be the water output. The tables and diagrams unambiguously prove that the increase in quantity of the evaluated water quality characteristics is in tight relationship with the increase in water output. At the same time, the changes in concentration — with a few exceptions — do not show connection with the water output, although it would be expected — even considering the abrupt pollutions — that with the increase in water output there would be a decrease in the concentration of the contaminating material, too. (In case of the Tisza author finds the possibility unfeasible according to sense that the sources of contamination — mostly settling in the district waters — could regulate their contaminating activity in correlation with the water output). According to author's opinion the "loading"-increase is firstly originated from the washing ins. The connection of the TFM and water output, as well as the TFM and COD_k "loading" relationship prove that at the time of the increase in water output the Tisza washes in the soil layers rich in organic matters and nitrogen-containing fertilizers from the flood areas and the cultivated areas. This becomes evident when taking into consideration those reported in the foregoings: the NO_3^-, the COD_p and the COD show a tendency of significant increase; while the changes in NH_4^+, BOD_5 and TDM are of slighter degree or are not characteristic (Fig. 14). Nevertheless, in the case of the Tisza, it is favourable that even the dissolved oxygen content is dependent on the water output in a proportional ratio, which is well demonstrated on Figure 15.

From the other factors determining the water quality the most characteristic are the contaminants of the Leninváros area, and the Sajó:

Regarding the common effect of the contaminants in the Leninváros district, the followings are worthy of mentioning: the slightly increasing tendency of the discharged sewage amount (in 1970: 0,967 m^3/s; in 1980: 1,257 m^3/s) is followed by the increase in the amount of certain contaminating material (COD_k, TDM, NO^3); at the same time, the amount of other contaminating material (e. g. NH_4^+) shows a significant decrease. The fact should be regarded as a noteworthy result that compared to the period between 1971—1975, the joint amount of the mineral nitrogen forms (NH_4^+ — NO_2^- — NO_3^-) expressed in N decreased in the period between 1976—1980.

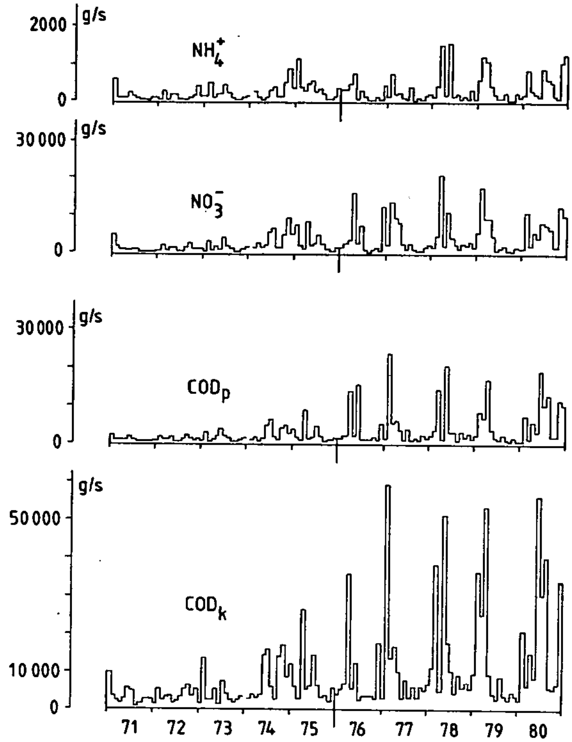

Fig. 14. Changes in the water quality characteristics of the TISZA in the function of water output at Tiszatardos.

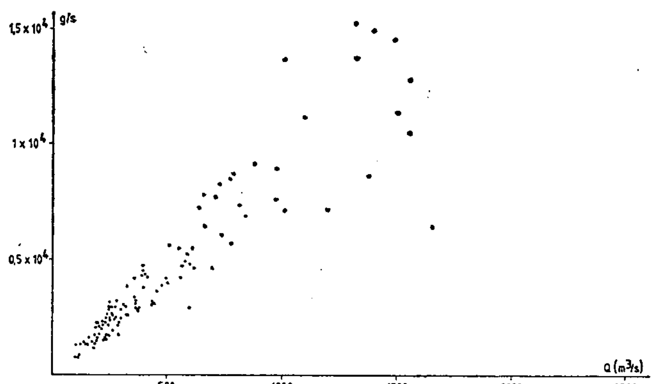

Fig. 15. Relationship between water output and O_2 amount at Tiszatardos between 1971—1980.

The degree of the decrease — expressed in nitrogen — is 25% meaning, that contrary to the 1083 t/year average values of the period between 1971—1975, the average reaching the Tisza between 1976—1980 was 802 t/year mineral nitrogen: that is, 281 t/year less amount of nitrogen loads the Tisza today.

The effect of the Sajó on the Tisza demands a separate essay, which is hoped to be prepared soon. Although it is not author's task to evaluate the Sajó, the most characteristic features should not be left unconsidered:

— on the basis of the studies between 1971—1980 the Sajó delivered an average of 5—10 g/m^3 mineral nitrogen into the Tisza, which appeared there in a well demonstrable form: comparing the values of Polgár and Tiszakeszi the surplus was averagely 0,5—1,0 g/m^3 N. Therefore, the Sajó significantly contributed to the increase in nitrogen-"loading" at the Tisza bed-section during the inflow;
— in the Sajó the C:N:P ratio gradually comes close to the ideal towards the mouth, but its average value even there can be characterized by the 5-folds "surplus" of C and N;
— its chlorophyll- a content shows extreme variety, its amount is determined by the Hernád chlorophyll- a content;
it is characteristic to the mineral nitrogen content that its concentration is low (under 10 g/m^3) in the water flowing in from the border, under the BVK, however, the maximum may even be above 50 g/m^3, and before the mouth it may even decrease to a value of 15 g/m^3 due to the dilution. Nevertheless, its amount (="loading") does not decrease from Sajószentpéter to Kesznyéten, moreover — first of all on the effect of the sewages from the city Miskolc — it can be characterized by values of increasing nature. This refers to the fact that in the Sajó, the certain nitrogen-forms may become transformed, nevertheless, they do not leave from there. The cause of this is unclear as yet.

* * *

1. The water quality of the Tisza at the section between Tokaj and Tiszafüred is acceptable in general, although there are also results characteristic of unfavourable conditions.
2. The water quality of the Tisza is fundamentally determined by the water output; simultaneously with its increase, the amount of the biologically available nutriments will also become higher. At the same time, it should not be disregarded that between the period 1971—1980, the utilization of chemical fertilizers containing N and P effective agents substantially increased, which has decisive influence on the development of the nutriment concentrations and their loading, respectively.
3. From the property-groups of the biological water quality, the halobity and toxicity are favourable and can practically be characterized by balanced values in the studied period. The trophity shows extreme changes in the function of seasons, it may even surpass the degree characteristic to the eutrophic state at the end of Summer — Autumn (occasionally in Spring). In contrast to the 106:16:1 ratio of carbon-nitrogen-phosphorus regarded as favourable for the algae, this value is 2000:12:1 in the Tisza. The saprobity shows relatively balanced changes, however, — especially the change in time of O_2 content — it rather indicates a shift towards unfavourable direction.
4. It is noteworthy that between the two 5-year-periods the increase in COD_k concentration at the Tiszatardos segment is essentially higher than at the Tiszakeszi segment. Its cause is thought to be in the sedimenting effect of the banked up bed-section above Tiszalök, which could only be proved by the measuring of the residuum originating from the alluvial deposit.
5. On the contrary, the NO_3^- content increased in higher degree in the segment of Tiszakeszi compared to Tiszatardos. The cause of this is firstly seen in the fact that the washing ins originating from the areas belonging to the bed-section between the two segments are added to the amount brought from above, nevertheless, the casual effect of the Sajó cannot be neglected either.

On the basis of the afore-mentioned, the followings are thought to be expedient:

Table 1. *Annual changns in thn water quality indexes (g/m^3) in the two profiles.*

Table 1	COD_P		COD_K		BOD_5		TDM		O_2		NH_4^+		NO_3^-	
	U	L	F	A	F	A	F		F	A	F	A	F	A
1971 min.	2,8	2,9	6,7	8,4	1,1	2,0	205	190	7.1	6,2	0,35	0,20	2,0	3,0
max.	5,2	5,9	17,0	21,6	8,8	7,7	290	360	11,5	13,3	0,75	2,10	6,5	7,0
average	3,8	4,3	12,3	15,5	3,3	4,3	239	274	8,9	9,4	0,49	0,98	3,8	4,9
1972 min.	2,8	4,4	7,6	15,5	2,1	3,0	174	190	6,7	7,1	0,20	0,36	2.8	3,2
max.	5,0	8,0	17,6	28,4	3,9	7,8	253	352	12,4	12,1	1,58	1,70	6,0	6,5
average	3,8	5,7	12,7	19,4	3,0	4,5	218	255	8,9	9,4	0,48	0,77	4,1	4,8
1973 min.	2,9	4,2	6,1	13,9	2,1	2,0	171	184	6,6	6,7	0,20	0,15	2,2	3,2
max.	5,8	15,0	20,8	33,3	3,4	3,9	306	360	11,8	12,1	1,14	2,20	7,0	7,5
average	4,2	7,1	13,9	21,7	2,6	3,2	232	271	9,3	9,4	0,54	0,94	4,6	5,6
1974 min.	2,4	3,5	9,3	12,8	2,0	1,9	149	174	6,1	5,6	0,20	0,40	3,8	4,8
max.	5,7	14,9	18,8	39,8	3,6	4,1	272	309	12,6	11,7	1,47	1,55	8,0	8,5
average	3,9	6,7	12,2	20,9	2,7	2,9	209	232	9,3	9,0	0,51	0,82	6,0	6,9
1975 min.	2,1	3,0	9,0	11,0	2,0	2,4	152	157	4,9	6,3	0.10	0,49	3,6	2,8
max.	8,0	11,8	24,0	34,0	4,3	4,8	351	395	12,9	12,3	1,40	2,55	8,0	10,0
average	4,0	6,2	14,6	20,1	3,0	3,1	272	296	9,1	8,8	0,73	1,10	5,4	6,5
1976 min.	3,1	4,8	9,4	11,6	1,4	1,9	141	138	7,8	5,2	0,10	0,35	2,8	4,0
max.	15,7	14,1	20,0	42,0	3,2	4,0	280	322	11,4	11,2	1,25	1,65	14,0	12,0
average	5,5	6,7	13,9	21,7	2.7	2,8	224	254	9,4	9,0	0,47	1,01	6,0	6,9
1977 min.	3,6	4,2	10,9	11,1	1,2	2,5	166	178	7,0	6,6	0,15	0,25	3,0	4,6
max.	14,0	13,0	35,0	34,0	3,6	5,2	263	304	11,8	11,5	0,65	1,35	8,0	10,5
average	5,5	5,9	16,5	18,0	2,8	3,3	215	249	9,4	9,2	0,38	0,70	5,5	7,0
1978 min.	3,2	4,2	11,0	14,6	1,7	1,7	175	201	6,6	6,4	0,20	0,45	4,2	4,8
max.	14,5	13,4	34,2	29,1	3,8	5,8	313	343	11,3	11,7	1,05	1,80	8,4	12,5
average	5,8	6,9	19,1	21,7	3,0	3,3	247	272	9,1	9,2	0,49	1,05	5,6	7,7
1979 min.	2,9	4,1	9,9	13,0	1,7	2,4	185	193	6,7	5,9	0,15	0,30	3,2	5,0
max.	9,8	7,5	30,8	24,5	4,8	5,8	324	366	11,8	11,2	0,80	1,20	8,5	16,0
average	5,0	5,9	17,5	19,9	3,4	3,7	244	274	9,4	8,9	0,48	0,74	5,5	7,6
1980 min.	4,2	4,6	13,2	14,8	1,9	2,5	202	187	3,9	4,7	0,25	0,20	4,0	4,4
max.	16,3	10,4	46,9	56,7	6,3	6,5	326	318	11,8	11,3	1,30	2,20	14,0	15,0
average	7,5	7,3	24,3	26,1	3,9	4,5	247	256	8,9	8,6	0,67	0,90	7,0	8,1

Table 2. *Total annual changes of the water qualty indexes and comparison of the results of the two five year's periods in the area of Tiszatardos*

Table 2	ΣQ	COD_p		COD_k		BOD_5		TDM		O_2		NH_4^+		NO_3^-	
	[m³/s]	ΣC [g/m³]	Σ(C·Q) [g/s]	ΣC [g/m₃]	Σ(C·Q) [g/s]	ΣC [g/m³]	Σ(C·Q) [g/s]	ΣC [g/m³]	Σ(C·Q) [g/s]	ΣC [g/m³]	Σ(C·Q) [g/s]	ΣC [g/m³]	Σ(C·Q) [g/s]	ΣC [g/m³]	Σ(C·Q) [g/s]
1971	3 271	45,0	11 628	147,6	34 358	40,0	10 029	2 863	745 188	106,2	30 318	5,91	1 762	45,5	13 894
1972	3 697	45,6	13 883	152,1	45 577	35,7	10 921	2 612	786 435	107,3	32 885	5,72	1 763	48,7	15 079
1973	4 221	50,8	17 742	166,7	48 814	31,1	10 564	2 786	896 653	111,4	39 417	6,49	2 259	54,8	19 711
1974	7 730	46,5	31 186	146,7	95 182	32,4	20 122	2 514	1 546 670	112,0	69 483	6,16	3 474	71,7	44 964
1975	6 464	48,6	28 762	174,7	94 694	36,0	19 497	3 265	1 538 980	109,7	59 027	8,77	4 342	64,6	36 296
T 1971—75	25 383	236,5	103 201	787,8	318 625	175,2	71 133	14 040	5 513 926	546,6	231 130	33,05	13 600	285,3	129 944
1976	7 361	66,5	47 293	167,2	104 108	32,0	18 839	2 692	1 431 056	112,7	70 376	5,65	3 059	72,3	51 476
1977	7 167	66,2	50 393	198,2	137 106	33,2	20 375	2 579	1 469 040	112,6	68 542	4,60	2 614	66,2	45 241
1978	8 621	69,5	58 361	229,8	171 591	36,6	26 644	2 959	1 945 962	108,9	77 792	5,90	5 019	67,2	56 278
1979	8 612	60,0	45 214	210,1	164 187	40,4	28 009	2 930	1 979 299	112,7	87 307	5,75	4 366	65,4	54 731
1980	10 200	89,8	86 801	291,3	230 909	46,6	40 717	2 963	2 361 917	106,3	83 017	8,07	6 336	84,4	70 901
T 1976—80	41 961	352,0	288 062	1096,6	807 901	188,8	134 584	14 123	9 187 274	553,2	387 034	29,97	21 394	355,5	278 627
A 1971—75	423	3,9	1 720	13,1	5 310	2,9	1 185	234	91 899	9,1	3 852	0,55	227	4,7	2 166
A 1976—80	699	5,9	4 801	18,3	13 465	3,1	2 243	235	153 121	9,2	6 450	0,50	357	5,9	4 644
±%	+65	+51	+179	+40	+153	+7	+89	+0,5	+67	+1	+67	−9	+57	+25	+114

a) studies should be carried out on the pollutions originating from the washing ins at the periods of floods; b) including studies at the longitudinal segments, which should be carried out regularly at various water levels — at least in certain characteristic channel sections —; c) furthermore, studies should be performed at least seasonally on the constituents of the oxygen-circulation, applying uniform methods. At the same time author finds it inevitable to carry out studies regularly on the organic nitrogen and the pheophytins at the most significant segments of the Tisza's whole Hungarian channel section.

Used abbreviations:

NO_3^-	nitrate-ion
COD_p	chemical oxygen demand (with $KMnO_4$)
COD_k	chemical oxygen demand (with $K_2Cr_2O_7$)
NH_4^+	ammonium-ion
BOD_5	"biochemical oxygen demand" (of 5 days)
TDM	total dissolved matter
TFM	total floating matter
O_2	dissolved oxygen
Ca^{++}	calcium-ion
HCO_3^-	hydrogen/carbonate-ion
CO_2	carbon dioxide
U	Tiszatardos (upper segment)
L	Tiszakeszi (lower segment)
1	1971—1975 (first 5-year-period)
2	1976—1980 (second 5-year-period)

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A Tisza biológiai vízminősége Tokaj—Tiszafüred között 1971—1980. évi vizsgálatok alapján

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Kivonat

Tanulmányomban a Tisza két jellemző szelvényében (Tiszatardos és Tiszakeszi) 1971—1980 között végzett vízminőségvizsgálatok eredményeit hasonlítottam össze. Az értékelt tízéves időszak alapvetően eltérő vízmennyiségekkel jellemezhető ötéves időszakra tagolható: 1971—1975 között többnyire 500 m³/s alatti; 1976—1980 között 500 m³/s feletti, számos alkalommal 1000 m³/s-ot is lényegesen meghaladó értékekkel jellemezhető.

A két ötéves időszak összehasonlító értékelése egyértelműen arra utal, hogy a Tisza vízminőségét alapvetően a vízhozam határozza meg, amelynek növekedésével egy időben nagyobb lesz a biológiailag hozzáférhető tápanyagok mennyisége is!

Az értékelt vízminőségi jellemzők alapján megállapítható, hogy mindkét szelvényben jelentékeny romlás következett be, amely Tiszakeszi szelvényében kifejezettebb, mint Tiszatardos szelvényében. Oka elsősorban a két szelvény közötti mederszakaszhoz tartozó területekről származó bemosódásban lehet.

Биологическое качество воды Тисы на участке между Токай — Тисафюред на основе проведенных в 1971—1980 гг. исследований

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Резюме

Автор работы сравнивает результаты анализа качества воды двух характерных отрезков Тисы (Тисатардош и Тисакеси), проведенного в 1971—1980 гг. Анализируемый десятилетний период по различной массе воды может быть разделён на два периода: 1971—1975 гг., когда масса воды была чаще всего ниже 500 м³/сек., и 1976—1980 гг., когда масса воды была выше 500 м³/сек, а нередко и превышала 1000 м³/сек.

Сравнительная оценка двух пятилетних периодов ясно показывает, что качество воды Тисы определяется в основном притоком воды, с увеличением которого одновременно увеличивается и количество биологически доступных питательных веществ.

На основе анализируемых показателей качества воды можно установить, что на обоих отрезках наблюдается значительное худшение качества воды, особенно на отрезке Тисакеси. Причину этого следует искать, вероятно, в первую очередь, в смыве с территорий, находящихся между отрезками русел двух участков.

Kvalitet vode Tise na deonici Tokaj—Tiszafüred u periodu 1971—1980.

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Abstrakt

U saopštenju su poredjeni rezultati ispitivanja kvaliteta vode za period 1971—1980. godine sa dve deonice Tise (Tiszatardos i Tiszakeszi). Istraživano 10-to godišnje razdoblje, u odnosu na vodenu masu, odlikuje se sa dva petogodišnja perioda: 1971—1975. ispod 500 m³/s i 1976—1980. iznad 500 m³/s, povremeno čak sa vrednostima iznad 1000 m³/s.

Uporedna analiza ova dva petogodišnja perioda jednosmisleno ukazuje na činjenicu da je kvalitet vode Tise us osnovi odredjen vodenom masom, čijim se povećanjem istrovremeno povecavaju i biološki dostupne hranljive materije.

Na osnovu analiziranih parametara utvrdjeno je da je na obe deonice došlo do značajnog pogoršanja kvaliteta vode, što je na deonici Tiszakeszi izraženije nego na deonici Tiszatardos.