PART 2

SK98K0054

Surface Water Quality

In 1996 the surface water quality measurements were performed, according to the Agreement, at 8 profiles on the Hungarian territory and at 15 profiles on the Slovak territory - Fig. 2-1. At these profiles the influence of the measures described in the Agreement on the surface water quality was monitored (backwater effect upstream the underwater weir, increased discharges in the Danube downstream the Čunovo weir and in the Mosoni branch of the Danube, water supply to the right side river arm system).

The sampling and analytical methods used are mainly based on methods agreed by the Sub-commission for Water Quality Protection of the Slovak-Hungarian Trans-boundary Water Commission.

The Annexes of the Slovak and Hungarian National Reports on the Environment Monitoring in 1996 contain the observed data in 1996 and the data for long term period (October, 1992 - October, 1996) for the selected profiles.. A long-term evaluation of surface water quality development at four selected profiles both on Hungarian and Slovak sides were done and which are documented by graphical presentation of measured data. The annexed table of agreed limit values (agreed on LV. Session of the Slovak Hungarian Trans-boundary Water Commission) were used for the evaluation. The Water Quality Protection Sub-commission of the Slovak Hungarian Trans-boundary Water Commission in 1996 elaborated a report entitled "Tendency and dynamics of water quality changes of the Danube river and its tributaries (1989-1995)". This report is comparing the surface water quality in pre-dam conditions (1989-1992) with conditions after putting the Gabčíkovo scheme into operation (1993-1995). The results of this report were used in the evaluation of surface water quality too.

2.1. Basic physical and chemical parameters

Water temperature

The water temperature in the Danube and in the right-side river arm system in 1996 follows in principle the water temperature course in the Danube at Bratislava (109). The water temperature in the seepage canal differs in minimal and maximal values by 3-4 °C (in the winter warmer, in the summer colder), which is typical for seepage canals supported by ground water. Water temperature values at Bratislava (109) in 1996 fluctuated in the range of long term values (0-25 °C). The water in the Ásványráró river branch was warmer in the summer period before introducing the water supply, because of insufficient water inflow accompanied by slower water flow. The water temperature courses in the period 1992-1996 is documented for the Danube profiles at Bratislava (109) and Rajka (1848) and for the right side river arm system at Ásványráró river branch (0023) - Fig. 2-2. The water supply to the river branch system lowers the water temperature to values similar to the Danube's water temperature.

pH

The pH values representing the alkalinity of water are higher in the growing season period in the river arm system, which refers to the assimilation activity of phytoplankton. The pH values in the Danube at Rajka profile (1848) follow the pH values fluctuation at Bratislava (109). The range of pH values varies from 7.6 to 8.5. The highest pH values sometimes over 9.0 were observed in the river branch system. The pH values in the winter period are lower than in summer period as a result of decreased assimilation activity.

Conductivity

The conductivity of the surface water refers to the dissolved solids content. The conductivity in the Danube and in the right-side river arm system in 1996 in principle follows the conductivity course at Bratislava profile (109). The conductivity values mainly fluctuate in the range from 30 to 50 mS/m. In 1996 a shift of maximal values towards the spring is observed at both Bratislava and Rajka profiles. Comparing the long-term measurements a slight increase of electric conductivity is observed in the seepage canal at lock No II. Increasing electric conductivity, confirming increasing high dissolved solids content in the Mosoni Danube in 1996 is connected with its tributaries of relatively high dissolved solids content.

Suspended solids

Suspended solids content is closely related to the discharge. In 1996 the suspended solids content in the Danube and in the right-side river arm system is mainly fluctuating up to 50 mg/l. Only during high discharges the suspended solids content increases in the Danube water over 50 mg/l (profile 109), maximally up to 100 mg/l. Values over 100 mg/l during the period 1992-1996 at Bratislava profile (109) are considered as extremes occurring during higher floods.

The extreme value of 1077 mg/l measured at Rajka profile in November 1992 is, according to the opinion of the Slovak side, connected with erosion of extremely large amount of gravel and soils downstream of inundation weir caused by flood (two or three millions m^3, which was confirmed also by the report elaborated by Working Group of Monitoring and Water Management experts for the Gabčíkovo System of Locks in November 1993[3]). According to Hungarian experts the reason of this high content of suspended solids, beside the flood is the construction work of the Danube diversion.

Basic physical and chemical parameters - summary

The concentrations of basic physical and chemical parameters in the Danube have a seasonal character and are in principle related to the discharge in the Danube at Bratislava. Comparing the long-term data no significant changes were observed. The electric conductivity has slightly increased in 1996. The water temperature in the right-side river branch system, due to continuous water supply since 1995, in principle has followed the water temperature in the Danube water.

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3 "Data Report, Assessment of Impacts of Gabčíkovo Project and Recommendations for Strengthening of Monitoring System", written by Working Group of Monitoring and Water Management experts for the Gabčíkovo System of Locks, Commission of European Communities, Republic of Hungary, Slovak Republic, Budapest, November 1993

2.2. Cations and Anions

The content of basic cations and anions in the period of 1992-1996 has a fluctuating seasonal character related also to the discharge in the Danube. Comparing to the long-term measurements the values of basic cations mostly have not changed significantly. However, slight changes were observed in sodium, increasing in 1996 at both Bratislava (109) and Medveďov (112) profiles, probably as a result of chemical protection of roads during the previous very cold winter. At Bratislava (109) increase of potassium and magnesium values were observed in 1996 as well. Slight increase of sulphate and chlorine anion concentrations were recorded in 1996. Changes in cation and anion concentrations are not significant in relation to the water quality.

2.3. Nutrients

Nitrates

Nitrates concentrations at all measured profiles in the Danube water as well as in the right-side river arms system have a similar course in 1996. The values mainly fluctuate in the range from 5 to 20 mg/l. The fluctuation of nitrate concentrations in the Ásványi river branch, due to the continuous water supply, in principle follows the fluctuation in the Danube water at Bratislava (109) and Rajka (1848) - Fig. 2-3. Based on long-term measurements a seasonal fluctuation of nitrates content can be observed, with minimum values in the summer period and with maximum values in the winter or early spring period. Based on long term measurements during 1992-1996 nitrates concentrations at Rajka profile fluctuate up to 15 mg/l, with some isolated higher values (mainly up to 20 mg/l) - Fig. 2-3. The values in the seepage canal during 1992-1996 mostly equally fluctuate in the range from 2 to 10 mg/l.

Ammonium ion

The contents of ammonium ion at all measured profiles in the Danube and in the right-side river branch system are similar in 1996, while at Bratislava profile (109) the values are slightly higher. Based on long term data the decreasing tendency of ammonium ion values can be observed. Due to the slower nitrification processes higher ammonium ion concentrations occur in periods with lower water temperature.

Nitrites

In 1996 in the Danube and in the right-side river arms system the course of the nitrite concentrations has a similar character at all measured profiles. Based on the long-term data the concentration of nitrites, a temporary product of nitrification and denitrification processes, has a fluctuating seasonal character. The values in long run fluctuates in the range from 0.05 to 0.2 mg/l. Higher nitrites values refer to higher intensity of self purification processes ongoing in the Danube water - Fig. 2-4. This occurs in spring and summer period.

Total nitrogen

In the long run most of the measured total nitrogen values in the Danube fluctuate mostly over the value of 2.5 mg/l. In the right-side river branch system in 1996 the total nitrogen values have similar course to the Danube water.

Phosphates

Based on long-measurements no significant changes in phosphate concentrations were observed with a slight seasonal fluctuation in the respective years. A slight increase of phosphate values can be observed at Bratislava (109) and other profiles in 1996, starting in November 1995.

Total phosphorus

The total phosphorus concentration in the Danube is fluctuating mostly in the range from 0.01 to 0.3 mg/l. Long term data of dissolved phosphorus content do not reflect a significant changes and the seasonal fluctuation in the respective years is slight.

Nutrients - summary

From the point of view of nutrient content the Danube water allows creation of an eutrophication processes under suitable other conditions. For comparison the nutrient content in the Danube is lower than in other European river. The content of nutrients in the Danube is not a limiting factor of eutrophication.

At Bratislava (109) and Medveďov (112) profiles an increasing trend of concentrations of nitrogen containing anions (Fig. 2-3) and phosphorus were observed from 1995 or casually from 1996.

Since introducing the water supply of river arm system the nutrients content in the right-side river branch system in principle has followed the fluctuation of nutrients in the Danube water.

2.4. Oxygen and organic carbon regime parameters

Oxygen

The oxygen content in the oxygen-saturated water, in the direct contact with atmospheric air depending on water temperature, is about 8.26 mg/l at 25 °C and 12.8 mg/l at 5 °C. Besides this the oxygen content fluctuates in connection with the assimilation activity of phytoplankton and organic carbon oxidation processes.

Comparing the long term concentrations of dissolved oxygen at profiles on the Slovak side at Bratislava (109) and Medveďov (112) the course has a similar character, while at Medveďov profile (112) higher values occur of the dissolved oxygen concentration than at Bratislava profile - Fig. 2-5.

The long term courses of the dissolved oxygen concentration at Hungarian profiles at Rajka (1848) and Medve (1806) are similar - Fig. 2-6.

Comparing the Slovak and Hungarian data both at Medveďov and Medve profiles - Fig. 2-7, it can be seen that the dissolved oxygen values are different. The same can be identified comparing the measured values of oxygen at Bratislava, measured by the Slovak side, and values at Rajka measured by the Hungarian side - Fig. 2-8. The Parties will examine these differences.

In the right-side river branch system, due to the continuous water supply in the 1996 hydrological year, the extremely high oxygen content fluctuation got closer to the course of dissolved oxygen values in the Danube river - Fig. 2-8.

The oxygen regime parameters at Vének are influenced by the local pollution (pollution originating from city Győr) together with the hydrological conditions at confluence with the Danube. In connection to this unfavourable low values were measured here also in 1996.

COD_{Mn} and BOD_5

COD and BOD parameters represent the chemically and biologically degradable organic matter content. Increasing pollution by organic matter in the Danube can be mostly observed during the periods with higher discharges in the Danube. In 1996 the values of COD a BOD fluctuated in the range from 2 to 6 mg/l for COD and in the range mainly from 1 to 4 mg/l for BOD.

The Ásványi river branch, due to the continuous water supply from 1995, follows the character of COD and BOD values in the Danube more regularly.

The values of COD a BOD in the long run fluctuates in a range from 2 to 6 mg/l for COD, except the extreme values during high discharge in the Danube (e.g. Rajka in November 24, 1992) and in a range from 1 to 5 mg/l for BOD.

In the Mosoni Danube at Vének because of the aforementioned reasons the COD and BOD values are higher by 70-100%.

TOC

Long-term TOC values at Slovak representative profiles at Bratislava (109) and Medved'ov (112) values fluctuate in a range from 1 to 5 mg/l - Fig. 2-9.

Long term TOC values at Hungarian profiles Rajka (1848) and Medve (1806) fluctuate in the range from 4 to 12 mg/l - Fig. 2-9.

The Parties will examine these differences.

Oxygen and organic carbon regime - summary

The oxygen and organic carbon related parameters in the Danube reflect the assimilation activity of the phytoplankton and organic carbon oxidation processes. Since 1992 increase of organic matter content, expressed by TOC values, can be observed at Bratislava (109) and Medved'ov (112).

2.5. Metals

Iron

The iron in the surface water is associated with the suspended solids. The mutual coherence of the iron concentrations and suspended solids content in the surface water is documented by the highest concentrations of iron measured at the time of highest suspended solids content. During periods with common discharges the iron concentration fluctuates mainly up to 0.5 mg/l. At Rajka and Ásványráró profiles the values of iron content are lower than at Bratislava profile (109).

Manganese

Manganese, similarly to iron occurs in surface water mainly in solid phase. During the flood periods the manganese concentration reaches maximally 0.65 mg/l. During periods with common discharges the manganese concentration fluctuates mainly up to 0.1 mg/l.

Heavy metals

Except copper the heavy metal concentrations in 1996 fluctuated in the range of the limits corresponding to the I. class of surface water quality. The copper solely reached values up to 40 μg/l at Rajka profile, which corresponds to the I. and II. class of surface water quality. Concentrations of respective heavy metals at profiles measured by Hungarian side have substantially greater fluctuation. The maximal values of the mercury content doubled in the Danube water at Bratislava from 0.4 pre-dam period to 0.8 μg/l after damming period. The same pattern can be seen at Medveďov from 0.3 to 0.6 μg/l for the same period. This is expressed by the data in the report of the Water Quality Protection Sub-commission of the Slovak Hungarian Trans-boundary Water Commission.

Metals - summary

Based on long term data no significant changes in iron and manganese concentrations have been observed. Based on long-term data the concentrations of heavy metals, except the mercury, fluctuate in the range of limits corresponding to the I-II. class of surface water quality.

2.6. Biological and microbiological parameters

Coliform bacteria

The surface water bacteriological pollution can be well determined according to the number of Coliform bacteria. In 1996 the number of Coliform bacteria at Bratislava profile (109) fluctuated in the range from 10 to approximately 750 NrC/ml. At Rajka profile the values of Coliform bacteria fluctuated up to 250 NrC/ml. Based on long term data the water quality at Bratislava and at Rajka can be qualified by IV-V. surface water quality class. At Rajka, downstream the Čunovo weir a long-term continual slight decrease of bacteriological pollution is observed. The bacteriological pollution in 1996 downstream the Danube, and along the river arm system leaving the water supply inflow at Helena profile decreases. The course of the number of Coliform bacteria in the Danube and the right side river arm system is shown on the Fig. 2-10.

Chlorophyll-a

The relatives increase of chlorophyll-a concentrations between two compared profiles represents the growth of algae on the respective section based on long-term measurements. Chlorophyll-a concentrations along the Danube flow-path continuously increase from Bratislava to Medveďov. The chlorophyll-a concentrations in the Danube document spring maximum values at the end of April and beginning of May, summer maximum is reached in July (during the maximum of the temperature curve) and the autumn culmination at the end of September. Low concentrations between the culmination waves occur in the period of high discharges and in the period of snow melting in Alps. Measured chlorophyll-a values do not reach at Bratislava profile 50 mg/m^3 and 100 mg/m^3 at Rajka profile even in culmination. Comparing the long-term data from 1992 to 1996 no increase of chlorophyll-a concentrations was observed - Fig. 2-11.

Saprobity index

The saprobity index values represents the self-purification ability of the water, the ability of degradation of organic matter. The saprobity index in relation to the stretch of river represents also the water quality in the river. Saprobity index of surface water in the influenced area is fluctuating in the range from 2 to 2.5. This degree of saprobity corresponds to beta-mezosaprobity. The self-purification processes at this saprobity index run mainly on the level of oxidising processes. The saprobity index in the Mosoni Danube at Vének profile due to the pollution by sewerage water fluctuates from beta to alpha-mezosaprobity.

Other biological parameters

The observation of the number of algae, the number of zooplankton and the macrozoobenthos is according to the Agreement performed four times a year. In 1996 the changes in the number of algae at 8 observation points reflected seasonal changes. In the spring period, during the spring algae growth, the highest density of algae were observed, maximum of which were reached at Ásványi river branch. The water in the seepage canal at Lock No. II. was poor in algae content during the whole year because seepage water has small content of nutrient. In species composition of zooplankton population in the water bodies the dominance of Rotatoria was characteristic.

Based on macrozoobenthos monitoring it can be stated that a slow spreading of Danube taxons were observed in the river branch system in the direction of water supply.

2.7. Quality of sediments

In the international practice as a standard for the evaluation of the bed-load pollution level the so-called "Canadian list" is considered, published by National Oceanic and Atmospheric Administration in 1990. This standard distinguishes three levels of pollution: level without pollution, the lowest pollution level and the serious pollution level.

In 1996 at one sampling on the Hungarian side of the joint monitoring area bed-load sediment samples were taken at 8 sampling points of the water bodies. Organic and inorganic micropollutants analysis were performed on the sampled bed-load sediments. Seven heavy metal components were analysed from the inorganic micropollutants.

Sampling points, examined heavy metals components, and results of the measured concentrations related to the amount of analysed dried sample is given in the Hungarian National Annual Report.

Based on the investigation results it can be stated that serious pollution level was not detected on any of the sampled points. There are places where the concentrations of four of the seven examined heavy metals were higher than the respective limit values for the lowest pollution level. Regarding this the influenced area is mostly polluted by toxic cadmium, because the measured concentrations on five from eight investigated points were several times higher than 0.6 mg/kg, representing the lowest pollution level. In the report of the Water Quality Protection Working Group of the Trans-boundary Water Commission it is stated that the pollution levels of suspended solids and bottom sediments were measured at the Danube profiles. Measured data indicate that higher concentrations of micropollutants occur in the suspended solids than in the bottom sediment.

From the organic micropollutants PCBs have been analysed. Besides the total PCBs concentration, eight isomeric analyses were performed. Based on the measured concentrations of PCBs it can be stated that the PCBs pollution of the area is low. Even the maximum measured values are lower than the lowest pollution level values of the "Canadian list".

2.8. Conclusions

Because of the short time of the surface water quality investigation the impact of the measures according to the Agreement can not be evaluated comprehensively. Increasing values of some parameters, nitrogen and phosphorus anions. some of cations (sodium, potassium and manganese), TOC, and metals (nickel, arsenic and mercury) are observed already in the Danube at Bratislava profile (109) which is situated upstream of water works and effect the surface water quality in-flowing to the territory influenced by temporary measure according to the Agreement.

The water quality in the Danube at Rajka, influenced by backwater, and below the confluence of the Danube and the tailrace canal at Medve, slightly differs. At Rajka profile during the growing season the chlorophyll-a concentration raised, and the content of organic matter and nutrients decreased. The bacteriologic pollution decreased between the two profiles. The water quality at Locks I. and II. on the seepage canal was not influenced by the backwater upstream the underwater weir because of the location of the seepage canal.

Fluctuation of individual parameters characterising the surface water quality in the right-side river branch system, due to the continuous water supply since 1995, was in most cases modified, and follows the fluctuation in the Danube water. Based on surface water quality data in the frame of the joint monitoring in 1996 it can be stated that the quality of water discharged to the water supply system in the inundation area became more balanced along the water supply path because of the shorter retardation time regarding the previous period.

The water quality in the Mosoni Danube is influenced besides the water supply by its tributaries and local pollution of settlements. Before its confluence to the Danube the water quality state is labile, which is proved by unfavourable oxygen regime parameters.

The Danube water quality was evaluated also by the Water Quality Protection Working Group of the Trans-boundary Water Commission in the report "Tendency and dynamics of water quality changes of the Danube river and its tributaries (1989-1995)", December 1996, based on measurements from 1989 to 1995.