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Changes of Ecological Status of the Keres River

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Abstract. The aim of the paper is to present the long-lasting problem of pollution of the small river Keres, which has its source in Hungary and in its lower course flows into the Tisa River in Vojvodina. The results of analyses conducted on a monthly basis from 2003 have shown that the water of the Keres is highly polluted, i.e. it falls in the category of sewage water. High COD values, significantly above the maximal allowed concentration for the Serbian 4th class evaluation (40 mg/l) were recorded since the end of 2004, even up to 164 mg/l. Along the entire watercourse the Keres is loaded with As, Cr and Cu above the allowed MAC. The accumulation of As, Ba, Cu and Sr in plants *Plantago major*, *Sas carex* and *Phragmites australis* at locations 100 m upstream from the Ludos Lake and at Adorjan village is particularly significant.

Keywords: River Keres, pollution, heavy metals, COD

1 Introduction

The small river Keres flows from Hungary to Serbia, where after a short course flows into Ludos lake, and further towards the Tisa. The water quality of the Keres river is in category II, according to current regulations [1]. The flow of water in our country, upstream from Ludos lake, depends mostly on the amount of water discharged in Hungary.

The sewage waters from Subotica flow through the roundabout channel around Palic lake into the Keres, and further into the Tisa river. The repairing of sewage waters purifier from Subotica, which started in 2004, resulted in severe aggravation of the Keres water quality, and its low capacity water current has the characteristics of sewage waters.

2 Material and Methods

Quality investigations of the Keres River in Serbia, as well as the sampling, were performed according to literature references [2]

HPK was determined by Kubel method, with acidic KMnO_4 .

The concentration of nitrites was determined with α -naphthylamine, after diamination.

The chemical parameters were analyzed according to literature reference [3],[4]

The spectrophotometric measurements were performed at 543 nm. The Spectrophotometer KONTRON, type Uvikon 930 S/N 27-1872, was used in experimental analyses.

The concentration of heavy metals in the Keres river water was determined at different locations: A – 1,000 m upstream from Ludos lake, B – at the dam below Ludos lake, C- at the border of SO Kanjiza, D– 200 m after the fishpond in Kapetanski rit, E– at Adorjan.

The concentration of heavy metals and metalloides in water was determined by the Atomic absorption spectroscopy method, with graphitic cuvette, according to Hungarian standard [5]

The concentration of heavy metals and other elements in plants *Plantago major*, *Sas carex*, *Phragmites australa* was determined at the localities 1,000 m upstream from Ludos lake and at Adorjan, where Keres enters Tisa.

The determination of content of chemical elements in the plants was performed by the Atomic absorption spectroscopy with graphitic cuvettes, according to Hungarian standard [6] (GFAAS-Varian Spectra AA800).

The analyses of chemical elements in water and plants were performed at the Corvinus University in Budapest.

3 Results and Discussion

The pollution detected in the Keres Kiver can be the organic load and the load with heavy metals.

The organic load detected in the Keres starts at Ludos Lake. The highest HPK values were ranging from 120 to 160 mg/l. The change of HPK values from 2003 (before the Keres degradation) till August 2007 is presented in Fig. 1. The latest results show that the Keres River is, and was in previous years, in the category of sewage water.

The pollution detected since autumn 2004 reflected on the increase of nitrite and nitrate ions in water.

The concentrations of nitrite ions during 2003, 2005, 2006 and 2007 are presented in Fig. 2.

During 2003, the values for nitrite ions were in the range prescribed for quality classes 1 and 2. In the following two years the values increased about 10 times, on the average. The highest nitrite concentration, 0.81 mg/l, was measured at the end of August, 2005. In 2006 and 2007 the concentration of nitrites in the Keres water was beyond the limits of normatives for class 4.

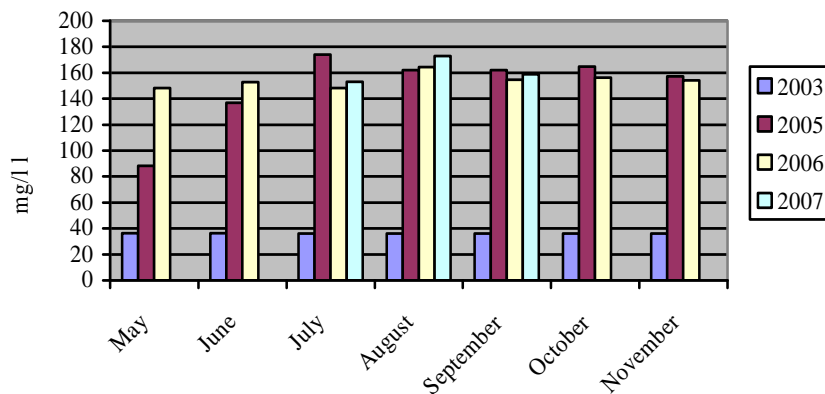


Fig 1. COD values in Keres River in 2003, 2005, 2006 and 2007

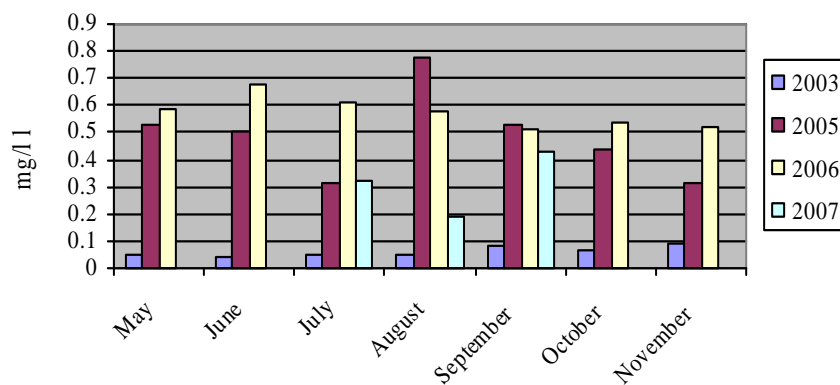


Fig 2. Concentration of nitrites in Keres River in 2003, 2005, 2006 and 2007

The values for nitrate ions in 2003, 2005, 2006 and 2007 are presented in Fig. 3. In 2005, 2006 and 2007 the nitrates concentration is in the range for 3 and 4 quality class, whereas the values are several times higher compared to 2003, the year which can be considered as the referent one.

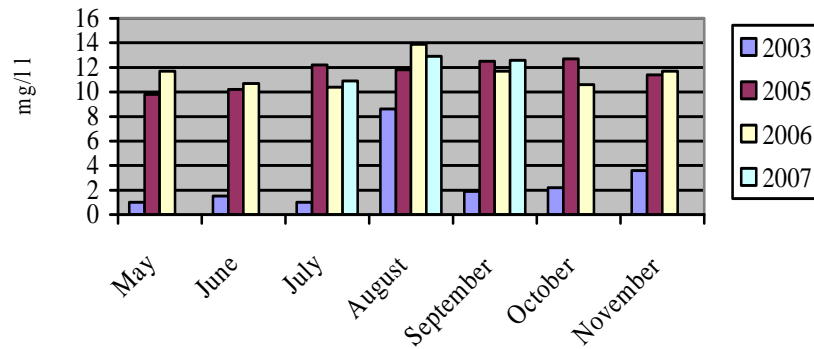


Fig 3. Concentration of nitrates in Keres River in 2003, 2005, 2006 and 2007

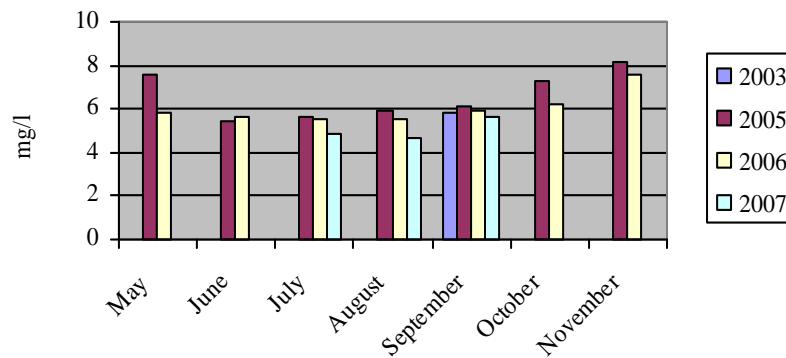


Fig 4. Concentration of dissolved O₂ in Keres River in 2003, 2005, 2006 and 2007

During the whole period of investigation, the concentrations of dissolved O₂ were from 4.7 to 9.1 mg/l. These values are within the range of usual seasonal deviation of this parameter in the function of water temperature change.

In the entire investigated period pH value of Keres river was in the range 6 – 9. The neutral, i.e. salt-basic medium remained, apart from the presence of high organic load. Figure 5 presents pH values in the Keres River.

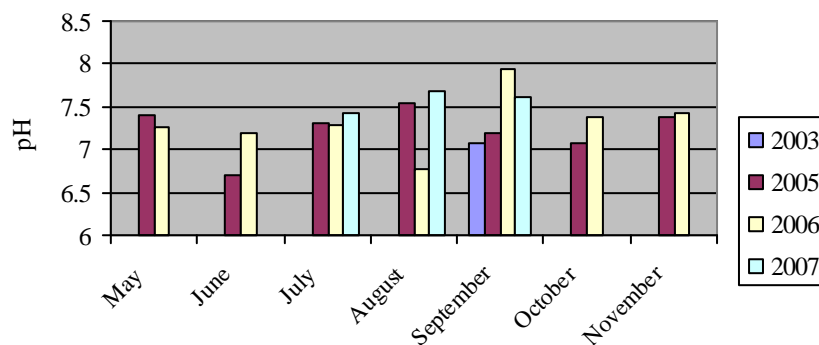


Fig 5. pH values of River Keres

The concentration of heavy metals in the Keres River water was determined at different locations : A- 1,000 m upstream from Ludos lake, B- at the dam below Ludos lake, C- at the border of SO Kanjiza, D- 200 m after the fishpond in Kapetanski rit, E- at Adorjan. The obtained results are presented in Fig. 6.

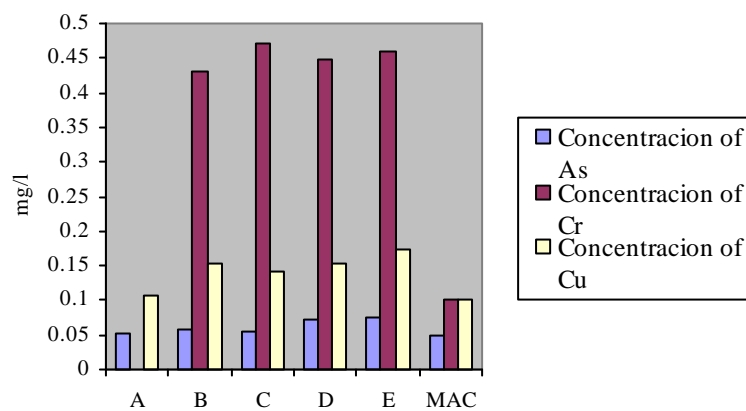


Fig 6. Concentration of As, Cr and Cu in Keres River, MAC - maximum accepted concentrations

Along the entire watercourse the Keres is loaded with As, Cr and Cu above the allowed MDK. The piling-up of As, Ba, Cu and Sr in plants *Plantago major*, *Sas carex* and *Phragmites australis* at locations 1,000 m upstream from Ludos lake and at Adorjan is particularly significant. In addition, at Adorjan, Cr was also detected in

plants. The results stating the piling of heavy metals in water plants are presented in Table 1.

Table 1. Concentration of metals, metalloides and nonmetals in water plants (in µg/g)

Metals	Plants					
	Plantago major		Sas carex		Phragmites australis	
	A	B	A	B	A	B
Al	92.23	260.2	140.7	41.4	90.29	107.16
As	3.74	3.91	2.70	4.89	3.30	3.4
B	16.7	19.5	6.04	12.61	9.15	10.25
Ba	31.37	30.59	23.44	20.97	30.26	22.05
Ca	17,180	23,778	4,532	5,163	3,170	3,861
Cd	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Co	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cr	< 0.5	1.12	< 0.5	1.48	< 0.5	0.96
Cu	11.66	10.97	9.6	6.7	6.6	6
Fe	346.1	416.8	152.2	635.5	71.64	73.83
Ga	0.91	0.97	1.71	2.27	1.77	2.36
K	41,802	38,745	20,507	14,699	20,415	19,997
Li	0.79	0.81	0.42	0.83	0.31	0.31
Mg	4,374	4,873	2,021	2,410	1,548	1,851
Mn	27.92	33.92	121.5	193.8	91.11	99.25
Mo	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Na	1,401	870	1,744	1,328	1,110	747.6
Ni	0.77	1.12	0.57	0.76	0.928	1.73
P	2,795	2,808	1,550	1,408	1,800	1,403
Pb	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Se	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Si	384	329.4	693.2	324.6	720.5	413.5
Sr	74.43	105.8	17.4	25.59	41.52	49.53
Ti	1.03	5.597	2.261	10.79	0.8933	1.7019
V	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Yn	25.41	30.41	15.04	26.25	13.35	14.35

According to the first (non-reported) results, lymphocytoses was found in several kinds of small art of carp fish, pointing to stress in fish from Kapetanski rit. due to organic pollution. The planctone composition of the Keres favors the fact that water quality is in category IV i.e. in the class of sewage waters

4 Conclusions

Contrary to official categorization, during the investigation period, from 2004 to 2007, the quality of the Keres River was found to be in the category of sewage waters since the reconstruction of city sewage water purifier in Subotica started [7],[8],[9].

Sewage waters from Subotica affected directly quality of the Keres, degrading it to the level of collector of pollutants. The problem is that the water of Keres River was used during draft periods for irrigation of this distinct agricultural region in Serbia. For this reason, the monitoring of Keres, as the tributary of Tisa River, in the scope of the project "Continuous investigation of Tisa river from Martonos to Senta" is of great importance for the local population of this region.

The pollution, which can be of public and industrial type, appears mainly as an organic load – presented through very high HPK values. The latest results, obtained in September 2007, show HPK was 160 mg/l in the Keres. This value being four times higher compared to the situation before the repair of the sewage water purifier in the city of Subotica. [10]

The pollution with some heavy metals and metalloides (As) over the limit values for the 4th class (according to JUS categorization) was also registered at almost all monitored locations in the Keres. Besides, the toxic elements are already piling in water macrophytes [11]. The origin of these pollutants corresponds to pollutants of industrial waste waters of Subotica, except As. There is no reliable proof, however. It seems that this pollutant comes from Hungary.

During 2006 and 2007, mud was removed and the Keres riverbed was revitalized. In this period, activities were performed on 7 km and 15 km long sections, respectively. A total of 75.000 m³ of earth was removed from the Keres riverbed. The mud from the Keres is located in the form of embankment on agricultural land. Having in mind that the leveling of the embankment is planned, the incorporation of mud into the cultivable soil and the contamination with heavy metals is a reasonable danger.

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