Chemical characteristics of the water and sediment of the Criş/Körös[1] river system

József Hamar, Katalin Zsuga, Alpár Fodor & Michaela Ponta

Abstracts

The rivers of the Criş/Körös river system rise in the Transylvanian Mountains in Romania. After their junction the Hármas-Körös river meets the Tisza river in the Hungarian Great Plain. Environs of the headwaters are clean but the human impact along the river is important (such as mines, dams, and communal waste). Retaining the water output by dams and the process of eutrophication caused some difficulties for the regional water management.

Keywords: river, water, sediment, chemical composition.

Introduction

The Criş/Körös Rivers system consists of the following four main rivers: Barcău/ Berettyó, Crişul Repede/Sebes-Körös, Crişul Negru/Fekete-Körös and the Crişul-Alb/ Fehér-Körös. After the junction of the Fekete-Körös and Fehér-Körös the river is named Kettős-Körös and after it meets with the Sebes-Körös, the river is named Hármas-Körös. The Körös Rivers represent one of the most developed river systems to tribute to the Tisza River (cf. Fig. 1.).

Most examinations of longitudinal sections in the Carpathian Basin were made on the Tisza (Bodrogközy (Reg.) 1981). A detailed study of the sediment was performed (Györy, Végvári 1981, László, Berta 1981). The toxic metal contents of the water and the sediment were examined (Waijandt, Bancsi, 1989, Waijandt et al. 1990) The physical and chemical study of the Mureş/Maros river was the first joined expedition by Romanian and Hungarian experts. (Waijandt, 1995).

The monitoring of chemical composition of the Criş/Körös river system is continuously done by the authorities of both countries.

1 The first name is Romanian, and the second Hungarian.

Material and methods

The samples were taken during expeditions in 1994 and 1995 (see Tables).

The chemical parameters of the water and sediment samples of rivers were analysed according to the Hungarian standard methods by Environmental Laboratory of the Körös District Authority. Besides on some general parameters (pH, conductivity, macroions etc.), the components of the oxygen and nutrient budget of the river were studied. The concentrations of heavy metals were measured by AAS. This project was a part of co-operation between the authorities and the Babeş-Bolyai University.

Results and discussion (Tab. 1-5.)

The Crişul Alb/Fehér Körös River

Based on the inorganic ion contents, the water is a Ca-HCO_3-SO_4 type. The total dissolved solid content in the headwater is not too high but the effect of Brad town is drastic. The sulphate content increased more than tenfold and other ions also increased considerable.

Oxygen content was high, excluding Brad (3,21) because of the organic wastes (Fig. 2.).

The contents of nitrogen and phosphor were low in the headwater. After Brad the ammonium and ortho-phosphate concentrations were higher. The valuable organic pollution purification processes along longitudinal section of the river were satisfactory.

The chlorophyll-a content was very low, indicating a lower activity of phytoplankton. We think that the relatively high oxygen concentration (excluding Brad sampling site) was caused by the turbulence of the river.

The heavy metal content of the water were low, with the exception of Brad where the total Zn concentration increased suddenly.

No significant Cd, Ni, Pb, Cr or Cu concentrations were measured in the sediments along the river, but the Zn accumulation at Brad was considerable.

Crişul Negru/Fekete-Körös River

Based on the inorganic ion contents, the water is the Ca-HCO_3- type. Dissolved inorganic ion content was low in the headwater, but uniformly higher later. These values

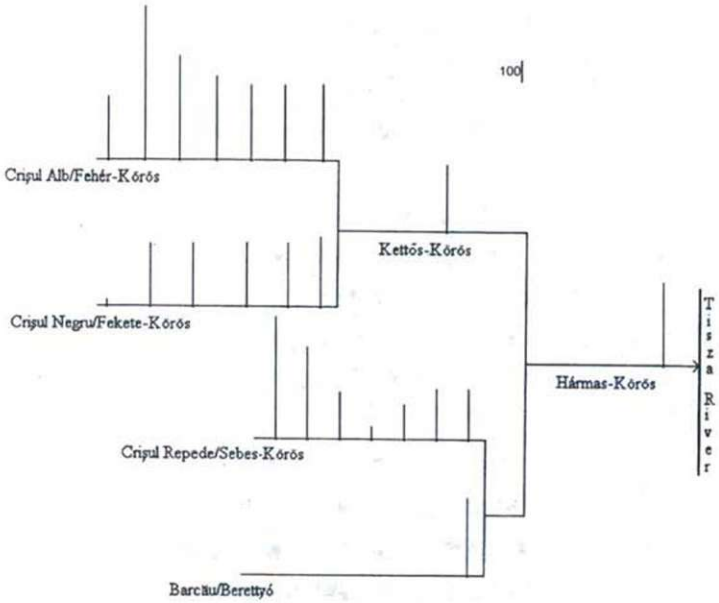

Fig. 1. Dinamism of the conductivity (μS/cm)

(334-210 mg/l) suggest a moderate salt content. The dynamics of the conductivity were similar and quite balanced (Fig. 1.).

The pH was low (6,5-7,0) and free CO2 was found along the river.

The oxygen content was high and saturation was nearly 100%. Chemical Oxygen Demand (COD-Cr) increased along the river, but the values were relatively moderate. The contents of the nitrogen and phosphorus forms were low in the longitudinal section of the river. We think that the higher concentration of nitrate near the spring has a geological background.

The chlorophyll-a content was low and increased along the river.

Heavy metal contents of the water and the sediment where low. The relatively higher Mn and Zn contents of the sediment have a geological background.

Crişul Repede/Sebes Körös River

The ionic type of this river is Ca-HCO_3. Environs of the upper section (Şaula-Ciucea) were characterized by higher chemical values, caused by the geological background and

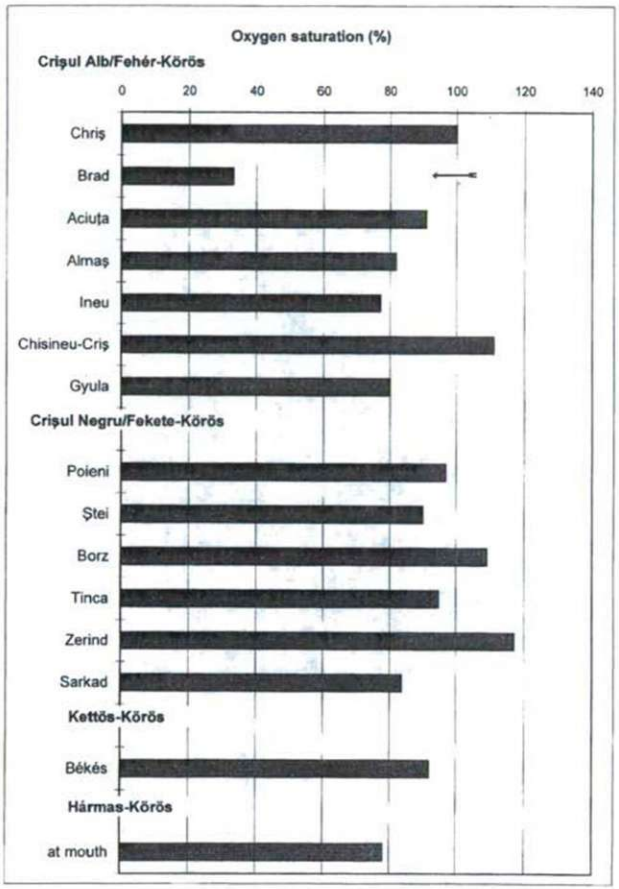

Fig. 2.

agriculture activity. The inorganic ion contents, the total hardness and conductivity were relatively higher. In the Criş Strait, between Vadu Crişului and Fughiu, many streams diluted the water (Fig. 3.).

The oxygen content was high with the exception of two sampling sites (1,55-1,97 mg/l). We expect this to be caused by the common waste of the town of Oradea

Ortho-phosphate contents where higher at upper region and the mouth, but it was diluted by streams along the Strait.

Heavy metal contents of the water and sediment were low but accumulated at the mouth.

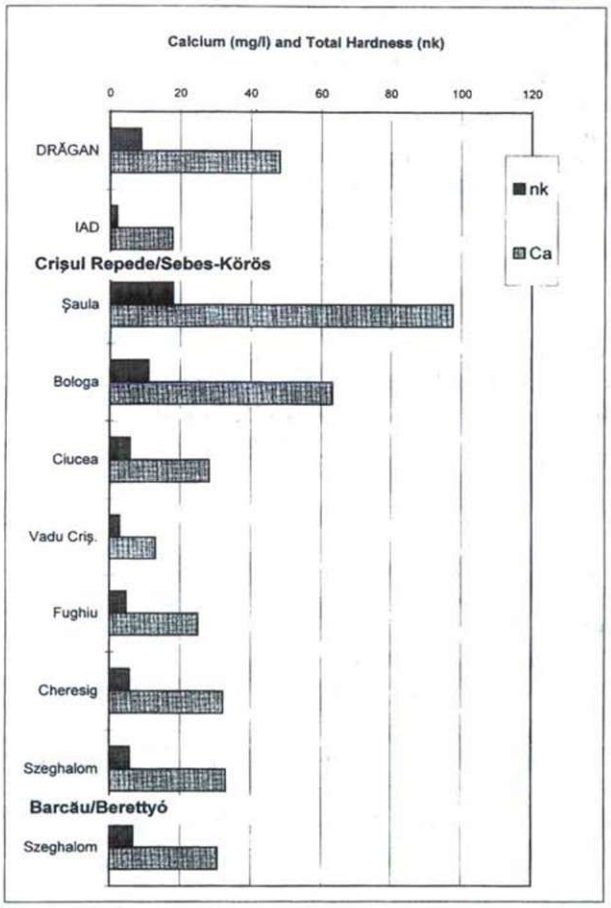

Fig. 3.

The Drăgan/Dregán and Iad/Jád Streams

Both streams are tributaries of Crişul Repede river. They are Ca-HCO_3 types with low inorganic ion contents. The dissolved oxygen concentration and the inorganic N and P concentrations were high. A low heavy metal concentration was found.

Barcău/Berettyó River

The river was only sampled at its mouth.

Based on the inorganic ions we determined the water as a Na-HCO_3 type. All measured inorganic ion concentrations were moderately low. The COD-Cr was higher because of the organic material. Low heavy metal content was detected.

Kettős-Körös River

The river starts at the confluence of the Crişul Negru and Crişul Alb and is located in the Hungarian Great Plain (see Fig. 1.).

The ionic type of this river was Ca-HCO_3. The conductivity and the total dissolved solid content indicated a moderately low salt concentration. The pH was neutral and the oxygen saturation near 100%. Inorganic N content and Chlorophyll-a were low.

Excluding Mn and the Zn, No metal accumulation in the sediment were found.

Hármas-Körös River

This river collects the waters of the Criş/Körös catchment area (see Fig. 1.).

The inorganic ion content was moderately low and the dominancy of some ions like Ca, Na, chloride, sulphate and hydrogen-carbonate can be traced back to the water composition of the tributaries.

The oxygen content, the inorganic N and P concentration and the Chlorophyll-a value show a moderately eutrophicated condition of the water.

There was no important metal accumulation in the sediment.

Conclusion

Environs of the headwaters are clean but the human impact along the river is important (such as mines, dams, and communal waste). Retaining the water output by dams and the process of eutrophication caused some difficulties for the regional water management.

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Tab. 1. Chemical composition of the water (16-17. 08. 1994)

Sampling sites	Crişul Alb/Fehér -Körös						
	Chriş	Brad	Aciuţa	Almaş	Ineu	Chişineu-Criş	Gyulavári
Water temperature , °C	14,0	16,0	17,0	19,0	20,0	21,0	23,5
pH (on-the-spot)	6,50	6,80	6,90	6,90	7,00	7,00	7,00
Conductivity (µS/cm)	296	733	502	406	359	377	387
Free Co_2 (mg/l)	6,6	15,4	6,6	4,4	5,5	2,2	6,6
Dissolved O_2 (mg/l)	10,21	3,21	8,78	7,57	6,96	9,80	6,75
Oxigen Saturation (%)	100	33	91	82	77	111	80
COD-Cr (mg/l)	0,0	11,9	11,2	8,2	8,4	10,0	12,8
Calcium (mg/l)	61,0	122,00	76,00	67,00	51,00	53,00	55,00
Magnesium (mg/l)	3,90	21,10	13,00	12,20	11,70	11,90	12,10
Sodium (mg/l)	3,9	30,4	16,4	14,8	11,6	15,7	16,3
Potassium (mg/l)	1,0	6,0	3,9	4,0	3,7	4,0	4,2
Chloride (mg/l)	1,37	23,80	12,59	11,12	9,17	11,61	11,90
Sulphate (mg/l)	18,54	239,03	139,03	116,59	71,22	67,32	78,05
HCO_3 (mg/l)	213,50	262,30	173,85	117,95	173,85	186,05	186,05
CO_3 (mg/l)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total dissolved solid (mg/l)	216	572	420	374	280	306	316
Total Fe (mg/l)	0,04	0,59	0,18	0,22	0,57	0,30	0,08
Total Mn (mg/l)	0,02	1,59	0,13	0,16	0,25	0,15	0,07
NH_4 (mg/l)	0,006	2,813	0,042	0,263	0,099	0,077	0,056
NO_2 (mg/l)	0,010	0,090	0,007	0,023	0,010	0,040	0,030
NO_3 (mg/l)	0,496	0,332	0,044	0,460	0,093	1,351	1,696
PO_4 (mg/l)	0,012	0,809	0,052	0,031	0,018	0,156	0,166
Total P (mg/l)	0,051	0,460	0,069	0,101	0,087	0,105	0,096
ANA detergents (mg/l)	0,022	0,112	0,025	0,030	0,018	0,001	0,000
Chlorophyll-a (mg/l)	1,6	2,4	2,45	2,8	6,8	7,4	7,6
Total Cd (µ/l)	0,0	0,1	0,0	0,0	0,0	0,0	0,0
Total Ni (µ/l)	0,0	2,5	0,0	2,8	0,0	0,0	0,0
Total Zn (µ/l)	14,5	100,0	<10,0	<10,0	<10,0	<10,0	<10,0
Total Pb (µ/l)	0,0	0,0	0,0	0,0	0,0	0,0	3,0
Total Cr (µ/l)	5,3	1,1	0,6	1,7	1,0	0,6	2,0
Total Cu (µ/l)	2,9	15,3	5,6	2,5	2,0	2,1	2,0

Tab. 2. Chemical composition of the water (16-17. 08. 1994)

Sampling sites	Crişul Negru/Fekete-Körös						Kettős-K.	Hármas-K
	Poiana	Ştei	Borz	Tinca	Zerind	Sarkad	Békés	mouth
Water temperature , °C	14,5	16,5	19,5	21,0	23,5	23,0	22,0	22,0
pH (on-the-spot)	6,50	6,75	6,75	6,75	7,00	7,00	7,00	7,00
Conductivity (µS/cm)	77	310	309	296	296	316	316	424
Free Co_2 (mg/l)	3,3	6,6	4,4	5,5	1,1	3,3	5,5	3,30
Dissolved O_2 (mg/l)	9,87	8,77	9,93	8,36	9,84	7,17	7,99	6,73
Oxigen Saturation (%)	97	90	109	95	117	84	92	78
COD-Cr (mg/l)	0,0	5,6	5,1	5,6	7,7	16,3	11,7	10,7
Calcium (mg/l)	14,00	54,00	51,00	44,00	41,00	48,00	46,00	43,00
Magnesium (mg/l)	1,90	8,20	14,00	9,90	8,80	9,50	9,00	9,90
Sodium (mg/l)	7,3	7,6	7,2	9,2	9,7	10,4	10,6	39,9
Potassium (mg/l)	0,9	2,6	3,0	2,9	3,0	3,6	3,3	4,2
Chloride (mg/l)	2,83	5,27	6,73	6,73	8,20	10,63	9,66	40,88
Sulphate (mg/l)	17,56	26,83	22,93	25,37	25,85	27,81	37,56	50,25
HCO_3 (mg/l)	61,00	204,35	213,50	192,15	189,10	195,20	186,05	201,30
CO_3 (mg/l)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total dissolved solid (mg/l)	96	272	238	238	344	224	210	272
Total Fe (mg/l)	0,04	0,13	0,41	0,33	0,21	0,34	0,19	0,13
Total Mn (mg/l)	0,01	0,07	0,14	0,04	0,06	0,10	0,40	0,05
NH_4 (mg/l)	0,000	0,587	0,096	0,062	0,013	0,088	0,079	0,140
NO_2 (mg/l)	0,007	0,423	0,100	0,023	0,007	0,027	0,013	0,023
NO_3 (mg/l)	2,037	3,225	2,649	1,173	0,053	0,283	0,168	0,890
PO_4 (mg/l)	0,028	0,291	0,156	0,058	0,169	0,113	0,111	0,601
Total P (mg/l)	0,055	0,134	0,156	0,062	0,101	0,058	0,108	0,200
ANA detergents (mg/l)	0,015	0,030	0,025	0,000	0,024	0,000	0,000	0,000
Chlorophyll-a (mg/l)	2,1	1,8	2,2	3,8	4,2	6,4	8,2	16,8
Total Cd (µ/l)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total Ni (µ/l)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total Zn (µ/l)	3,2	<10,0	11,7	<10,0	<10,0	<10,0	<10,0	<10,0
Total Pb (µ/l)	0,0	0,0	1,2	0,0	0,0	9,5	0,0	0,0
Total Cr (µ/l)	0,3	1,0	2,6	0,9	0,4	3,8	0,2	0,4
Total Cu (µ/l)	1,1	1,2	4,1	1,3	1,4	10,9	1,6	1,6

Tab. 3. Chemical composition of the water (27-28. 07. 1995)

Sampling sites	Drăgan/Dregán Creek	Iad/Jád Creek	Crişul Repede/Sebes-Körös							Barcău/Berettyó
			Şaula	Bologa	Ciucea	Vadu Criş	Fughiu	Cheresig	Szeghalom	Szeghalom
Water temperature °C	16,8	9,2	13,2	16,2	16,2	12	18,5	25,8	24,5	24,2
pH	8,25	8,36	7,75	8,14	8,3	8,18	8,04	7,96	7,92	7,9
Conductivity (µS/cm)	334	67	591	437	215	95	165	238	238	385
Dissolved Oxigen (mg/l)	7,7	11,54	9,99	8,7	10,33	11,53	1,55	1,97	10,9	14,85
COD-Cr (mg/l)	6,4	0,5	4,5	10,9	3,4	0,6	4,8	10,4	5	24,8
Total Hardness (Germ.)	9	2,8	17,9	11,7	5,3	2,3	4,3	5,6	5,7	6,3
Calcium (mg/l)	48,2	17,7	97,5	63,1	28,3	13,1	25,1	32,2	33	30,6
Magnesium (mg/l)	9,6	1,5	18,6	12,5	5,8	1,9	3,6	4,7	4,8	8,8
Sodium mg/l)	11	3,8	13,9	13,1	8,8	4,6	5,9	10,5	10,4	38,8
Potassium (mg/l)	3,9	0,8	4,5	5,1	3	1	1,9	3,3	3,3	4,7
Chloride (mg/l)	9,1	0	11,5	13	5	0,1	0,5	4,8	7,6	40
Sulphate (mg/l)	28,9	5,6	52	43,8	21,4	13,5	4,9	3,3	44,3	52
HCO3 (mg/l)	195	45	390	254	126	62	104	125	126	146
Total Fe (mg/l)	0,21	0,08	0,35	0,39	0,14	0,15	0,27	0,29	0,18	0,92
Total Mn (mg/l)	0,04	0,03	0,07	0,05	0,26	0,03	0,07	0,07	1,25	0,19
NH4 (mg/l)	0,013	0,01	0,019	0,029	0,026	0,019	0,04	0,229	0,099	0,265
NO2 (mg/l)	0,07	0,027	0,094	0,097	0,028	0,006	0,08	0,399	0,152	0,024
NO3 (mg/l)	2,9	3	7	4,8	1,7	2,6	2	3,6	2,8	1,4
PO4 (mg/l)	0,221	0,089	0,276	0,484	0,043	0,043	0,077	0,353	0,322	0,11
ANA-detergents (mg/l)	0,014	0,006	0,18	0,019	0,011	0	0	0,006	0	0,007
Total Cd (µ/l)	0,2	0,1	0,2	0,1	0	0 5	0,1	0,2	0,1	0,2
Total Ni (µ/l)	0,3	0	1,3	5,4	0	0,2	0,2	0,8	1,3	1,2
Total Zn (µ/l)	--	--	10	33	--	--	--	23	71	20
Total Pb (µ/l)	0,3	0,1	0,6	0,6	0	0,3	0,2	0,7	1,3	1,2
Total Cr (µ/l)	0,2	0	1,3	--	0,1	0,3	0	1	1,6	0,6
Total Cu (µ/l)	1,9	9	4,1	11,2	1,9	1,2	1,2	1,4	7,1	10,6

Tab. 4. Chemical composition of the sediment (16-17. 08. 1994)

Sampling sites		Crişul Alb/Fehér-Körös					
		Criş	Brad	Aciuţa	Almaş	Ineu	Ch-Criş
	unit/dry weight						
Total Fe	g/kg	23;53	36,37	27,29	9,69	19,61	8,44
Total Mn	mg/kg	439,05	1995,40	1768,50	224,60	678,20	337,10
Kjeldahl-N	g/kg	2,720	2,850	2,690	0,130	3,550	0,290
Total P	g/kg	0,480	1,050	0,720	0,300	0,600	0,190
Total Cd	mg/kg	0,0	7,4	2,4	0,0	4,8	0,7
Total Ni	mg/kg	44,9	52,8	28,8	10,3	24,9	8,4
Total Zn	mg/kg	89,3	1139,2	307,0	42,4	328,1	59,5
Total Pb	mg/kg	25,3	79,9	63,0	13,5	116,1	28,0
Total Cr	mg/kg	17,3	38,2	22,9	4,5	13,5	7,2
Total Cu	mg/kg	41,1	377,9	126,2	6,0	117,2	23,4

Rivers		Crişul Negru/Fekete -Körös						Kettős-K	Hármas-K
Sampling	sites	Poiana	Ştei	Borz	Tinca	Zerind	Sarkad	Békés	mouth
	unit/dry weight								
Total Fe	g/kg	12,65	9,60	8,94	24,65	17,02	18,92	24,74	19,20
Total Mn	mg/kg	411,40	285,20	236,20	519,10	675,30	616,10	802,80	617,10
Kjeldahl-N	g/kg	1,700	0,710	0,210	0,630	0,540	1,250	1,570	0,990
Total P	g/kg	0,360	0,210	0,300	0,390	0,360	0,480	0,650	0,630
Total Cd	mg/kg	0,5	0,4	0,0	1,6	0,7	0,5	0,9	0,5
Total Ni	mg/kg	15,2	10,6	10,4	29,6	20,5	19,3	30,0	24,8
Total Zn	mg/kg	69,8	37,8	23,4	242,6	107,2	75,8	137,0	116,4
Total Pb	mg/kg	35,0	21,0	8,8	58,7	35,6	98,2	43,0	29,8
Total Cr	mg/kg	11,5	6,9	5,5	16,8	12,7	13,7	24,5	23,5
Total Cu	mg/kg	27,0	12,5	5,3	50,3	26,0	24,6	50,9	27,9

Tab. 5. Chemical composition of the sediment (27-28. 07. 1995)

Sampling sites		Drăgan/Dregán Creek	Iad/Jád Creek	Crişul Repede/Sebes Körös							Barcău/Berettyó
				Şaula	Bologa	Ciucea	Vadu Criş.	Fughiu	Cheresig	Szeghalom	Szeghalom
	unit/dry weight										
Total Fe	g/kg	15,1	21,6	17,1	16,8	25	19,7	19,6	17,6	26,9	29,2
Total Mn	mg/kg	397	587	566	541	540	506	831	466	1020	1180
Total Ni	mg/kg	7,2	15,9	28	11,7	20,2	14,1	17,2	15,1	32,1	36,8
Total Zn	mg/kg	41	86	68	46	120	72	60	81	177	141
Total Pb	mg/kg	6,9	12,5	13,3	7,8	16,2	14,7	11,1	21,9	62,6	22,9
Total Cr	mg/kg	5,6	10,1	13,6	8,2	9,7	8,7	9,9	24	55	21
Total Cu	mg/kg	8,1	15,2	16,3	10,2	19,5	13,3	16,3	17,8	31	37