Table ESM.1. Limit values of two categories of ecological status (very good and good) for basic physico-chemical parameters of the water for very large lowland rivers (type HR-R_5B, includes lower reach of the Mura River) according to Croatian Regulation on Water Quality Standards [29].

	Category of ecological status	**Limit values Lowland large rivers**	**Limit values Lowland small streams**
pH	*Very good*	7.4–8.5	7.4–8.5
	Good	7.0–7.4 & 8.5–9.0	7.0–7.4 & 8.5–9.0
Ammonia / mg L^{-1}	*Very good*	0.02	0.1
	Good	0.2	0.3
Nitrates / mg L^{-1}	*Very good*	0.8	1
	Good	1.8	2
Total nitrogen / mg L^{-1}	*Very good*	1.2	1.4
	Good	2.5	2.6
Total phosphorus / mg L^{-1}	*Very good*	0.05	0.13
	Good	0.2	0.3
Chlorophyll a* / μg L^{-1}	*Very good*	5.9-20.0	-
	Good	10.0-40.0	
Chemical oxygen demand / mg O_2 L^{-1}	*Very good*	2.5	2.5
	Good	5.5	5.5

*limit values for chlorophyll a refer to category of euthropication status – defined for rivers

Table ESM.2. Limits of detection (LOD) for dissolved metals/metalloids in water, metal/metalloids in sediment and coals, and in coal water eluates. Moreover, the recoveries for analysed elements in certified control samples (CCS) and materials (CRM) (listed in Material and methods section) are provided.

	Water		**Sediment/coal**		**Coal water eluates**	
	LOD μg L^{-1}	**CCS recovery (%)**	**LOD μg g^{-1}**	**CRM recovery (%)**	**LOD μg L^{-1}**	**CCS recovery (%)**
Major elements						
Na	5.20	101±7	5.00	87.7±0.7	0.500	92.9±4.2
K	41.1	94.7±3.4	5.00	90.8±0.8	5.00	95.1±5.8
Mg	14.8	95.1±2.4	5.00	84.1±1.6	0.500	92.4±3.1
Ca	221	94.3±3.2	100	101±12	10.0	82.7±0.6
Trace elements						
Ag	0.002	96.8±2.3	0.005	-	0.005	82.7±5.7
Al	0.331	102±9	5.00	87.8±4.0	0.500	107±9
As	0.004	99.0±0.4	0.050	101±12	0.020	105±3
Ba	0.042	97.9±3.2	0.500	94.9±2.7	0.500	105±2
Bi	0.001	101±3	0.005	111±1	0.005	-
Cd	0.001	97.6±7.1	0.005	98.3	0.005	104±4
Co	0.003	97.9±2.3	0.005	91.1±0.5	0.005	107±3
Cr	0.028	101±2	0.200	112±1	0.020	106±2
Cs	0.001	-	0.050	89.6±2.4	0.020	-
Cu	0.040	95.4±2.6	0.200	112±3	0.020	105±2
Fe	0.028	97.0±4.0	5.00	89.2±0.4	0.500	103±2
Li	0.008	92.5±6.3	0.050	88.7±4.9	0.050	103±8
Mn	0.013	106±5	5.00	91.2±0.1	0.500	103±3
Mo	0.001	102±1	0.200	115±9	0.020	99.2±2.7
Ni	0.007	98.1±3.7	0.200	108±2	0.020	105±2
P	-	-	10.0	83.2	5.00	-
Pb	0.019	98.7±3.3	0.200	99.6±2.1	0.020	105±4
Rb	0.003	-	0.200	95.4±2.1	0.020	-
S	-	-	10.0	-	100	-
Sb	0.001	97.9±3.2	0.050	105	0.020	98.3±3.1
Se	0.060	98.9±2.1	0.050	-	0.020	-
Sn	0.008	-	0.050	104±4	0.020	99.8±2.9
Sr	0.021	112±4	5.00	95.6±2.9	0.500	109±5

Table ESM.2. – continued.

	Water		Sediment/coal		Coal water eluates	
	LOD $\mu g\ L^{-1}$	**CCS recovery (%)**	**LOD $\mu g\ g^{-1}$**	**CRM recovery (%)**	**LOD $\mu g\ L^{-1}$**	**CCS recovery (%)**
Th	-	-	0.050	108±9	0.005	-
Ti	0.044	96.5±3.2	0.050	86.8±1.7	0.020	91.5±8.4
Tl	0.001	103±2	0.050	103	0.005	-
U	0.004	-	0.050	99.1±1.7	0.020	-
V	0.001	102±2	0.050	87.9±2.5	0.020	103±4
W	0.001	-	-	-	-	-
Zn	0.819	104±9	5.00	105±1	0.500	-
Lanthanides						
La	0.001	90.3±2.4	0.050	94.0±3.4	0.005	-
Ce	0.001	101±2	0.050	97.5±2.2	0.005	-
Pr	0.001	100±5	0.050	90.1±0.4	0.005	-
Nd	0.001	93.6±1.3	0.050	98.9±1.9	0.005	-
Sm	0.001	88.8±1.8	0.050	97.1±1.1	0.005	-
Eu	0.001	-	0.050	98.3±7.0	0.005	-
Gd	0.001	-	0.050	90.1±5.7	0.005	-
Dy	0.001	96.5±2.5	0.050	87.9±3.8	0.005	-
Ho	0.001	90.9±0.1	0.050	87.8±0.1	0.005	-
Er	0.001	114±3	0.050	88.5±2.3	0.005	-
Tm	0.001	105±1	0.050	93.8±0.1	0.005	-
Yb	0.001	102±3	0.050	90.5±2.1	0.005	-
Lu	0.001	108±1	0.050	84.4±4.4	0.005	-

Table ESM.3. Dissolved major and trace elements concentrations in the river-water at the nine sites of the Mura River (MI – the initial, most upstream location in Croatia; MB – location near bridge, in the municipality of Sveti Martin na Muri; HL – Hlapičina; MS – Mursko Središće; KR – Križovec; PT – Podturen; DK – Dekanovec; GR – Goričan; KT – Kotoriba), covering its entire section within Croatia, in two sampling campaigns (June 2023, rainy period; October 2023, dry period), expressed as mean ± standard deviation (n=3). The concentrations of the same elements are also provided for the Gradiščak Stream (SG), flowing in the area between the two upstream riverine sites (MI, MB). Asterisks (*) refer to statistically significant differences between two samplings at the same site (p<0.05). Grey cells with bolded text refer to statistically significantly higher values for all Mura sites together in that sampling campaign (p<0.05).

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Major elements (mg L^{-1})										
Na_{Jun}	*7.51±0.38	*8.58±0.02	*7.68±0.64	*7.61±0.24	*7.48±0.12	*7.74±0.49	*7.78±0.10	*7.97±0.17	*8.01±0.86	*78.9±1.7
Na_{Oct}	14.9±0.3	17.2±2.4	14.8±0.2	14.8±0.4	15.1±0.3	15.3±0.4	16.3±0.8	15.2±0.7	15.0±0.2	1154±89
K_{Jun}	*1.73±0.10	*1.80±0.01	*1.89±0.22	*1.99±0.13	*1.82±0.03	*1.91±0.13	*1.81±0.02	*1.82±0.04	*1.89±0.25	*3.27±0.08
K_{Oct}	2.73±0.07	2.88±0.35	2.73±0.15	2.71±0.12	2.76±0.06	2.88±0.11	2.91±0.16	2.72±0.15	2.70±0.03	33.0±2.7
Mg_{Jun}	*6.67±0.31	*6.90±0.01	*7.24±0.61	*7.23±0.24	*7.10±0.09	*7.31±0.42	*7.03±0.08	*7.20±0.14	*7.57±0.79	*26.0±0.6
Mg_{Oct}	9.66±0.18	10.3±1.0	9.56±0.11	9.62±0.32	9.65±0.21	10.0±0.2	10.3±0.5	9.86±0.47	9.76±0.11	19.2±1.5
Ca_{Jun}	*32.1±1.9	*32.7±0.6	*34.3±2.2	*34.7±1.1	*33.7±0.5	*35.1±1.9	*33.7±1.2	*33.7±0.7	*34.6±4.3	*94.8±0.6
Ca_{Oct}	46.6±1.2	48.8±5.4	46.0±0.3	46.4±1.9	46.1±1.0	47.6±1.7	49.6±3.2	46.0±2.1	47.0±0.5	79.6±6.5
Trace elements (μg L^{-1})										
Ag_{Jun}	0.002±0.000	0.002±0.000	0.002±0.000	*0.220±0.006	*0.221±0.017	*0.201±0.010	0.002±0.000	0.002±0.000	*0.002±0.000	0.002±0.000
Ag_{Oct}	0.003±0.002	0.007±0.009	0.009±0.009	0.004±0.003	0.043±0.069	0.029±0.045	0.002±0.000	0.067±0.056	0.034±0.019	0.003±0.001
Al_{Jun}	*14.0±0.5	*16.9±1.1	*13.4±0.4	*15.0±2.3	*15.9±1.6	*14.8±1.0	*13.4±1.8	*12.6±0.5	*12.6±0.5	18.8±3.3
Al_{Oct}	6.98±2.66	6.07±0.12	6.36±0.25	6.35±0.12	6.59±0.61	6.43±0.48	5.30±0.21	6.59±0.60	5.66±0.27	20.8±1.7
As_{Jun}	*0.914±0.037	*0.944±0.022	*0.989±0.014	*0.987±0.011	*0.973±0.021	*1.06±0.03	*1.01±0.04	*1.05±0.01	*1.11±0.02	*1.49±0.04
As_{Oct}	1.19±0.04	1.22±0.01	1.22±0.01	1.21±0.01	1.24±0.03	1.35±0.03	1.17±0.03	1.28±0.03	1.22±0.02	4.25±0.03
Ba_{Jun}	*17.8±0.5	*20.3±0.3	*19.0±0.2	*19.2±0.5	*18.8±0.3	*18.5±0.5	*18.5±0.5	*19.5±0.2	*20.2±0.2	*433±3
Ba_{Oct}	28.0±0.8	29.4±1.1	28.1±0.1	27.8±0.2	28.5±0.7	30.1±0.7	29.5±0.6	29.2±0.1	28.4±0.1	4796±43
Bi_{Jun}	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD
Bi_{Oct}	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD
Cd_{Jun}	0.005±0.002	*0.005±0.001	*0.005±0.001	0.006±0.003	0.006±0.002	0.005±0.001	*0.005±0.001	*0.006±0.000	0.006±0.003	0.003±0.001
Cd_{Oct}	0.008±0.000	0.009±0.001	0.009±0.001	0.010±0.004	0.008±0.001	0.012±0.005	0.009±0.001	0.009±0.001	0.008±0.001	0.002±0.000
Co_{Jun}	*0.063±0.002	*0.063±0.006	*0.061±0.008	0.076±0.032	*0.056±0.005	*0.079±0.004	*0.052±0.001	*0.062±0.002	*0.062±0.001	*0.137±0.003
Co_{Oct}	0.088±0.004	0.087±0.004	0.085±0.001	0.084±0.003	0.087±0.002	0.139±0.018	0.078±0.002	0.092±0.001	0.088±0.001	0.200±0.002
Cr_{Jun}	0.129±0.008	*0.199±0.022	0.148±0.012	*0.323±0.047	*0.298±0.044	*0.309±0.037	*0.136±0.005	*0.135±0.003	0.133±0.009	*0.226±0.005
Cr_{Oct}	0.131±0.008	0.145±0.023	0.135±0.010	0.138±0.006	0.140±0.004	0.187±0.016	0.263±0.032	0.167±0.019	0.152±0.010	0.182±0.001

Table ESM.3. – continued.

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Trace elements (µg L^{-1}) – continued										
Cs$_{Jun}$	*0.015±0.001	*0.013±0.001	*0.017±0.001	*0.018±0.001	*0.017±0.002	*0.014±0.001	*0.015±0.001	*0.013±0.001	*0.011±0.001	*0.599±0.007
Cs$_{Oct}$	0.053±0.004	0.052±0.001	0.057±0.000	0.055±0.000	0.060±0.004	0.057±0.002	0.056±0.005	0.045±0.001	0.042±0.000	8.71±0.04
Cu$_{Jun}$	0.788±0.352	0.650±0.066	0.611±0.079	0.621±0.118	0.586±0.027	*0.603±0.015	*0.589±0.006	0.628±0.068	0.622±0.050	*1.38±0.01
Cu$_{Oct}$	0.668±0.050	0.620±0.007	0.656±0.038	0.659±0.006	0.664±0.067	0.757±0.037	0.728±0.056	0.626±0.014	0.569±0.005	1.11±0.03
Fe$_{Jun}$	*11.9±0.8	*15.0±0.5	*14.5±2.8	*17.1±5.8	*14.4±1.3	*15.0±1.6	*13.2±1.8	*12.0±0.4	*10.9±1.2	*50.6±3.0
Fe$_{Oct}$	31.5±9.1	29.7±1.6	26.6±0.8	27.5±1.1	28.4±2.3	40.3±4.5	17.8±0.6	24.4±0.8	22.7±1.3	227±13
Li$_{Jun}$	*1.59±0.02	1.92±0.04	*1.53±0.03	*1.50±0.03	*1.44±0.03	*1.41±0.02	*1.42±0.01	*1.40±0.06	*1.38±0.01	*34.2±1.2
Li$_{Oct}$	2.51±0.06	2.83±0.58	2.47±0.05	2.65±0.44	2.59±0.03	2.39±0.22	2.77±0.27	2.68±0.05	2.60±0.11	862±46
Mn$_{Jun}$	*15.0±1.1	*16.7±0.6	*16.0±0.5	13.8±0.3	*11.7±0.2	*35.1±1.7	*11.7±0.1	*16.4±0.03	*17.6±0.2	*73.7±0.6
Mn$_{Oct}$	12.2±0.8	22.4±2.6	17.6±0.05	13.9±0.3	13.6±0.1	133±2	14.7±0.4	28.0±2.8	12.0±0.2	227±2
Mo$_{Jun}$	*0.604±0.009	*0.595±0.008	*0.710±0.010	*0.723±0.013	*0.726±0.008	*0.707±0.026	*0.744±0.005	*0.753±0.006	*0.754±0.003	*0.463±0.006
Mo$_{Oct}$	1.46±0.05	1.42±0.01	1.44±0.03	1.45±0.02	1.46±0.04	1.46±0.02	1.35±0.01	1.32±0.02	1.37±0.02	0.798±0.008
Ni$_{Jun}$	*0.451±0.017	*0.461±0.030	0.471±0.044	0.472±0.041	*0.452±0.015	*0.473±0.023	*0.435±0.009	*0.479±0.015	*0.489±0.006	0.750±0.015
Ni$_{Oct}$	0.543±0.032	0.532±0.005	0.520±0.005	0.514±0.016	0.544±0.024	0.681±0.127	0.529±0.008	0.531±0.011	0.521±0.010	0.764±0.004
Pb$_{Jun}$	0.054±0.037	*0.043±0.003	*0.043±0.006	0.099±0.049	0.129±0.038	0.114±0.012	*0.044±0.008	0.039±0.006	0.097±0.055	0.048±0.016
Pb$_{Oct}$	0.093±0.024	0.088±0.013	0.083±0.002	0.087±0.006	0.087±0.009	0.099±0.009	0.063±0.004	0.120±0.087	0.064±0.008	0.092±0.043
Rb$_{Jun}$	*1.79±0.02	*1.92±0.02	*1.93±0.05	*1.93±0.10	*1.88±0.06	*1.88±0.04	*1.85±0.04	*1.91±0.01	*1.93±0.03	*8.63±0.05
Rb$_{Oct}$	2.51±0.04	2.60±0.06	2.57±0.03	2.58±0.03	2.65±0.04	2.70±0.04	2.86±0.07	2.78±0.01	2.58±0.06	131±1
Sb$_{Jun}$	*0.142±0.004	*0.140±0.006	*0.143±0.003	*0.148±0.007	*0.142±0.007	*0.144±0.008	*0.152±0.007	*0.151±0.005	*0.155±0.002	*0.124±0.000
Sb$_{Oct}$	0.195±0.005	0.194±0.002	0.193±0.007	0.193±0.005	0.197±0.007	0.206±0.009	0.187±0.002	0.194±0.002	0.191±0.000	0.314±0.002
Se$_{Jun}$	0.105±0.037	0.117±0.035	0.115±0.004	0.119±0.044	0.101±0.029	*0.085±0.029	0.096±0.015	0.148±0.002	0.135±0.038	0.251±0.010
Se$_{Oct}$	0.093±0.035	0.117±0.005	0.116±0.039	0.134±0.019	0.134±0.031	0.139±0.014	0.111±0.035	0.136±0.021	0.102±0.041	0.222±0.042
Sn$_{Jun}$	0.013±0.009	0.014±0.006	0.061±0.077	0.020±0.010	0.019±0.015	0.027±0.010	0.020±0.011	0.018±0.011	0.012±0.007	*0.029±0.012
Sn$_{Oct}$	0.012±0.007	0.009±0.002	0.008±0.000	0.058±0.086	0.009±0.002	0.080±0.125	0.008±0.000	0.008±0.000	0.013±0.008	0.149±0.036
Sr$_{Jun}$	*105±2	*107±2	*112±2	*111±3	*110±1	*109±4	*110±1	*113±0.5	*116±1	*389±3
Sr$_{Oct}$	169±3	171±2	172±1	172±2	174±4	177±5	179±3	179±0.1	173±1	1280±23
Ti$_{Jun}$	0.073±0.014	*0.086±0.006	0.080±0.032	0.111±0.076	0.057±0.014	0.058±0.023	0.071±0.041	0.054±0.018	*0.044±0.000	*0.158±0.026
Ti$_{Oct}$	0.152±0.128	0.123±0.020	0.076±0.010	0.058±0.019	0.079±0.011	0.111±0.027	0.074±0.031	0.072±0.012	0.091±0.029	1.46±0.19

Table ESM.3. – continued.

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Trace elements (μg L^{-1}) – continued										
Tl_{Jun}	*0.007±0.000	*0.007±0.000	*0.007±0.000	*0.007±0.000	*0.007±0.001	*0.007±0.000	*0.008±0.000	*0.008±0.001	*0.008±0.000	0.003±0.000
Tl_{Oct}	0.010±0.000	0.010±0.001	0.010±0.001	0.010±0.000	0.010±0.000	0.011±0.000	0.011±0.001	0.009±0.001	0.010±0.000	0.002±0.000
U_{Jun}	*0.543±0.009	*0.508±0.017	*0.562±0.060	*0.557±0.013	*0.522±0.019	*0.561±0.040	*0.507±0.011	*0.544±0.055	*0.543±0.018	1.97±0.16
U_{Oct}	0.751±0.083	0.687±0.016	0.689±0.004	0.720±0.054	0.708±0.010	0.757±0.054	0.669±0.035	0.687±0.008	0.730±0.049	1.58±0.15
V_{Jun}	*0.411±0.038	*0.396±0.011	*0.429±0.011	*0.410±0.015	*0.416±0.008	*0.454±0.021	*0.426±0.016	*0.480±0.023	*0.516±0.014	*0.641±0.004
V_{Oct}	0.644±0.033	0.643±0.013	0.632±0.002	0.632±0.019	0.653±0.027	0.620±0.017	0.524±0.016	0.595±0.011	0.588±0.001	1.16±0.02
W_{Jun}	*0.364±0.018	*0.379±0.007	0.745±0.015	*0.627±0.010	*0.629±0.012	*0.693±0.027	*0.492±0.004	*0.477±0.005	*0.489±0.004	*0.008±0.001
W_{Oct}	0.742±0.020	0.725±0.010	0.732±0.011	0.731±0.012	0.773±0.019	0.801±0.013	0.715±0.008	0.715±0.004	0.712±0.005	0.028±0.002
Zn_{Jun}	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	*≤ LOD	≤ LOD	≤ LOD	≤ LOD	*≤ LOD
Zn_{Oct}	≤ LOD	0.922±0.111	≤ LOD	0.933±0.197	1.19±0.64	1.82±0.23	0.833±0.024	≤ LOD	≤ LOD	3.38±0.40

LODs – presented in Table ESM.2

Table ESM.4. Dissolved rare earth elements (lanthanides) in the river-water at the nine sites of the Mura River (MI – the initial, most upstream location in Croatia; MB – location near bridge, in the municipality of Sveti Martin na Muri; HL – Hlapičina; MS – Mursko Središće; KR – Križovec; PT – Podturen; DK – Dekanovec; GR – Goričan; KT – Kotoriba), covering its entire section within Croatia, in two sampling campaigns (June 2023, rainy period; October 2023, dry period), expressed as mean ± standard deviation (n=3). The concentrations of the same elements are also provided for the Gradiščak Stream (SG), flowing in the area between the two upstream riverine sites (MI, MB). Asterisks (*) refer to statistically significant differences between two samplings at the same site ($p<0.05$). Grey cells with bolded text refer to statistically significantly higher values for all Mura sites together in that sampling campaign ($p<0.05$).

	MI	**MB**	**HL**	**MS**	**KR**	**PT**	**DK**	**GR**	**KT**	**SG**
Lanthanides (µg L^{-1})										
La$_{Jun}$	0.020±0.001	*0.022±0.001	0.022±0.004	*0.018±0.000	0.018±0.001	0.018±0.002	*0.017±0.002	*0.017±0.001	0.016±0.001	*0.018±0.001
La$_{Oct}$	0.025±0.007	0.020±0.000	0.021±0.001	0.020±0.001	0.021±0.002	0.022±0.002	0.013±0.001	0.014±0.001	0.019±0.004	0.050±0.003
Ce$_{Jun}$	0.029±0.000	0.030±0.001	0.033±0.004	0.028±0.003	0.026±0.001	0.027±0.003	*0.026±0.002	*0.025±0.001	0.025±0.002	*0.026±0.003
Ce$_{Oct}$	0.039±0.015	0.030±0.000	0.030±0.001	0.030±0.000	0.030±0.004	0.034±0.004	0.016±0.000	0.021±0.001	0.025±0.007	0.069±0.008
Pr$_{Jun}$	0.005±0.000	0.005±0.000	0.005±0.001	0.004±0.000	*0.004±0.000	0.004±0.001	0.004±0.001	*0.004±0.000	0.004±0.000	*0.004±0.000
Pr$_{Oct}$	0.007±0.002	0.005±0.000	0.005±0.001	0.005±0.000	0.005±0.001	0.005±0.000	0.003±0.000	0.003±0.000	0.004±0.000	0.009±0.001
Nd$_{Jun}$	0.020±0.001	0.021±0.000	0.022±0.006	0.020±0.000	0.020±0.002	0.019±0.003	*0.019±0.001	*0.017±0.001	0.017±0.002	*0.020±0.002
Nd$_{Oct}$	0.028±0.011	0.021±0.001	0.022±0.000	0.022±0.002	0.021±0.001	0.021±0.001	0.013±0.002	0.015±0.000	0.020±0.004	0.037±0.002
Sm$_{Jun}$	0.005±0.002	0.004±0.001	0.004±0.001	0.003±0.001	*0.004±0.001	0.004±0.001	0.004±0.001	0.004±0.001	0.004±0.001	*0.006±0.001
Sm$_{Oct}$	0.007±0.003	0.005±0.001	0.004±0.002	0.004±0.001	0.005±0.001	0.005±0.001	0.003±0.000	0.004±0.001	0.004±0.001	0.016±0.001
Eu$_{Jun}$	0.002±0.001	0.003±0.001	0.002±0.000	0.002±0.000	0.003±0.003	0.002±0.001	0.002±0.000	0.002±0.001	0.002±0.001	*0.021±0.001
Eu$_{Oct}$	0.003±0.001	0.003±0.000	0.002±0.001	0.002±0.000	0.003±0.000	0.002±0.000	0.002±0.000	0.002±0.000	0.002±0.001	0.227±0.003
Gd$_{Jun}$	*0.008±0.000	*0.009±0.000	*0.012±0.001	*0.011±0.001	*0.010±0.001	*0.010±0.001	*0.013±0.002	*0.014±0.001	*0.010±0.003	*0.007±0.002
Gd$_{Oct}$	0.023±0.007	0.020±0.001	0.021±0.001	0.020±0.001	0.020±0.001	0.024±0.003	0.020±0.001	0.022±0.001	0.020±0.001	0.020±0.004
Dy$_{Jun}$	0.004±0.001	0.005±0.001	0.004±0.001	0.004±0.001	0.004±0.001	*0.003±0.001	0.004±0.000	0.004±0.000	0.004±0.001	*0.005±0.001
Dy$_{Oct}$	0.007±0.003	0.005±0.001	0.005±0.001	0.005±0.001	0.005±0.001	0.006±0.001	0.004±0.000	0.005±0.001	0.005±0.001	0.011±0.001
Ho$_{Jun}$	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	*≤ LOD
Ho$_{Oct}$	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	0.003±0.001
Er$_{Jun}$	0.003±0.001	0.004±0.001	0.003±0.001	*0.003±0.001	*0.003±0.001	*0.003±0.000	0.003±0.000	0.003±0.001	*0.003±0.001	*0.004±0.001
Er$_{Oct}$	0.005±0.001	0.004±0.000	0.004±0.001	0.005±0.001	0.005±0.001	0.004±0.001	0.004±0.000	0.005±0.001	0.005±0.000	0.008±0.001
Tm$_{Jun}$	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD
Tm$_{Oct}$	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD
Yb$_{Jun}$	0.004±0.001	*0.004±0.000	*0.003±0.000	*0.003±0.001	*0.003±0.001	0.003±0.001	0.003±0.001	0.003±0.000	0.003±0.001	*0.004±0.000
Yb$_{Oct}$	0.005±0.001	0.005±0.001	0.005±0.001	0.005±0.001	0.005±0.000	0.005±0.001	0.004±0.001	0.005±0.000	0.005±0.001	0.008±0.001
Lu$_{Jun}$	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD
Lu$_{Oct}$	≤ LOD	≤ LOD	0.002±0.001	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	≤ LOD	0.002±0.001

LODs – presented in Table ESM.2

Table ESM.5. Major and trace element concentrations in sediments at the nine sites of the Mura River (MI – the initial, most upstream location in Croatia; MB – location near bridge, in the municipality of Sveti Martin na Muri; HL – Hlapičina; MS – Mursko Središće; KR – Križovec; PT – Podturen; DK – Dekanovec; GR – Goričan; KT – Kotoriba), covering its entire section within Croatia, in two sampling campaigns (June 2023, rainy period; October 2023, dry period), expressed as mean ± standard deviation (n=3). The concentrations of the same elements are also provided for the Gradiščak Stream (SG), flowing in the area between the two upstream riverine sites (MI, MB). Asterisks (*) refer to statistically significant differences between two samplings at the same site (p<0.05). Grey cells with bolded text refer to statistically significantly higher values for all Mura sites together in that sampling campaign (p<0.05).

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Elements in mg g⁻¹										
Na_{Jun}	*13.2±0.03	*13.3±0.4	*13.4±0.8	*12.8±0.8	11.8±0.5	10.9±1.5	10.7±0.5	11.0±0.9	*14.5±0.2	10.4±1.4
Na_{Oct}	8.80±0.69	9.81±0.14	9.04±0.72	10.0±0.6	10.7±0.9	9.29±0.32	8.46±1.37	10.2±0.5	10.4±0.2	10.4±0.5
K_{Jun}	*11.2±0.4	*14.8±1.4	*11.0±1.7	16.2±2.1	11.2±1.3	*19.0±0.7	7.28±0.69	*14.2±1.4	*16.2±3.7	*9.78±0.72
K_{Oct}	8.06±0.36	7.60±0.28	7.73±0.77	15.3±1.3	9.44±0.71	15.1±1.0	6.36±1.25	9.59±2.17	8.10±0.85	12.6±1.5
Mg_{Jun}	*13.0±1.2	*13.7±1.4	10.8±3.4	10.4±1.8	9.51±1.20	*10.5±1.2	*3.39±0.98	10.5±0.8	*14.4±2.6	*4.51±0.82
Mg_{Oct}	8.36±0.86	8.24±0.68	10.1±0.7	13.0±0.9	10.8±0.6	13.7±1.1	7.15±0.86	8.64±1.68	7.89±0.74	7.54±0.63
Ca_{Jun}	*22.7±2.3	*21.0±1.7	18.6±3.3	18.0±2.9	22.5±1.2	*13.9±3.2	*8.71±1.6	20.7±6.1	*19.4±0.5	16.1±1.8
Ca_{Oct}	15.8±1.2	16.9±1.2	19.6±1.7	20.5±1.3	25.1±8.3	21.6±2.4	13.9±2.3	15.1±1.9	14.1±1.1	17.9±1.7
Al_{Jun}	*52.1±3.4	*61.4±4.6	49.9±10.7	49.4±7.6	44.8±4.7	49.9±5.0	27.6±5.1	*62.7±5.5	*69.6±13.4	*34.6±2.3
Al_{Oct}	32.4±1.9	33.6±0.9	37.9±1.6	53.9±3.4	38.3±1.5	53.0±4.1	33.3±2.8	39.8±6.7	36.0±1.8	45.5±4.5
Fe_{Jun}	*34.8±5.8	*33.1±2.5	36.0±4.2	34.2±3.0	24.8±3.2	*38.8±1.4	38.9±2.4	*39.8±2.6	*36.5±6.4	20.4±2.2
Fe_{Oct}	19.9±2.0	25.2±2.2	35.8±8.6	29.7±1.9	22.4±0.4	29.6±1.1	30.7±11.3	26.5±2.8	23.7±1.3	23.5±2.2
Mn_{Jun}	1.29±0.18	*1.06±0.04	1.46±0.30	0.925±0.099	*0.884±0.058	0.897±0.024	1.86±0.09	1.16±0.06	1.21±0.038	0.515±0.093
Mn_{Oct}	1.37±0.08	1.55±0.22	2.03±0.55	0.936±0.040	1.09±0.04	0.982±0.054	1.79±0.64	1.08±0.03	1.05±0.06	0.446±0.040
Ti_{Jun}	*4.31±0.97	*4.37±0.62	3.89±0.14	4.63±0.38	2.97±0.57	*5.04±0.21	3.48±0.56	*4.22±0.26	*4.76±0.44	3.01±0.55
Ti_{Oct}	1.98±0.29	2.45±0.22	3.43±0.40	4.07±0.18	2.87±0.06	3.98±0.14	2.73±0.74	3.06±0.59	2.83±0.13	4.09±0.58
Elements in μg g⁻¹										
Ag_{Jun}	0.072±0.017	0.067±0.022	0.054±0.013	*0.078±0.001	-	0.112±0.010	0.054±0.011	-	0.099±0.051	*0.067±0.012
Ag_{Oct}	0.074±0.016	0.109±0.097	0.056±0.004	0.108±0.019	0.047±0.013	0.132±0.023	0.061±0.028	0.068±0.022	0.048±0.011	0.134±0.031
As_{Jun}	9.23±6.78	*7.55±0.81	4.85±0.71	9.46±2.77	4.88±0.96	14.0±2.1	3.21±0.48	*20.2±3.3	11.7±8.4	6.04±2.05
As_{Oct}	4.24±0.97	3.24±0.35	4.38±0.71	9.71±0.85	4.50±0.67	10.6±1.0	3.05±0.81	5.64±1.75	5.56±1.41	5.90±0.31
Ba_{Jun}	298±11	*377±41	274±56	376±50	325±27	420±16	174±21	*469±34	421±115	*515±129
Ba_{Oct}	271±23	274±19	257±25	467±45	303±17	458±31	206±41	319±58	270±38	925±103
Bi_{Jun}	*0.252±0.017	*0.272±0.024	0.220±0.022	0.411±0.164	0.159±0.036	0.468±0.016	0.139±0.001	0.424±0.043	0.340±0.152	*0.195±0.030
Bi_{Oct}	0.154±0.031	0.144±0.018	0.197±0.027	0.462±0.020	0.179±0.012	0.523±0.240	0.142±0.040	0.326±0.195	0.164±0.032	0.370±0.074

Table ESM.5. – continued.

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Elements in $\mu g\ g^{-1}$ – continued										
Cd$_{Jun}$	0.246±0.141	*0.190±0.019	0.137±0.037	0.241±0.052	0.122±0.038	0.277±0.017	0.215±0.073	0.231±0.062	0.209±0.055	*0.128±0.010
Cd$_{Oct}$	0.124±0.026	0.139±0.025	0.186±0.045	0.292±0.067	0.160±0.058	0.254±0.038	0.182±0.061	0.164±0.058	0.150±0.012	0.221±0.026
Co$_{Jun}$	*10.2±1.4	*11.3±1.3	9.71±0.28	13.6±2.5	8.55±1.00	*16.5±0.7	7.86±0.53	*14.7±1.5	13.1±3.7	8.36±1.60
Co$_{Oct}$	7.21±1.08	6.94±0.42	9.55±0.83	14.0±1.2	8.84±0.66	13.7±0.7	6.76±1.22	9.72±2.49	7.98±0.68	9.95±0.56
Cr$_{Jun}$	*68.8±10.8	*74.1±8.0	66.0±10.0	83.4±12.3	57.1±6.3	*100±5	62.5±10.0	*86.5±5.2	79.8±17.8	*49.2±8.2
Cr$_{Oct}$	37.6±3.5	42.2±3.4	70.6±14.3	81.5±5.0	61.8±11.0	79.0±5.1	42.4±10.5	60.9±14.3	50.7±5.5	68.5±4.1
Cs$_{Jun}$	2.50±0.23	*3.77±0.48	2.26±0.76	*3.55±0.67	2.76±0.42	4.67±0.45	0.971±0.280	*5.73±0.72	4.65±1.99	*3.20±0.49
Cs$_{Oct}$	2.18±0.19	1.88±0.20	2.12±0.13	5.52±0.43	2.57±0.20	5.48±0.49	1.53±0.33	3.05±1.01	2.38±0.40	8.45±1.46
Cu$_{Jun}$	*14.7±1.5	*18.5±2.0	*13.5±0.7	25.7±6.3	*27.3±7.1	*35.0±2.1	7.7±1.8	*42.9±3.4	23.7±12.4	*17.1±3.5
Cu$_{Oct}$	9.27±1.09	7.96±0.62	9.86±1.28	26.8±2.3	12.0±1.4	28.4±2.7	6.96±0.87	13.9±4.5	9.21±1.9	73.7±17.7
Li$_{Jun}$	*26.3±1.6	*31.5±4.1	22.6±1.6	36.5±7.8	25.8±3.1	43.0±4.7	16.6±2.8	*40.2±5.8	35.4±9.4	*19.9±2.4
Li$_{Oct}$	19.9±2.0	18.8±1.5	24.0±0.9	40.4±6.0	22.2±0.6	41.9±4.4	18.1±5.0	24.1±7.2	21.2±1.1	39.9±9.9
Mo$_{Jun}$	*0.774±0.214	0.787±0.107	1.04±0.60	0.945±0.192	0.770±0.151	*1.31±0.08	0.515±0.270	1.01±0.10	0.791±0.274	0.598±0.127
Mo$_{Oct}$	0.349±0.062	0.734±0.265	1.18±0.81	1.40±0.66	0.896±0.433	1.02±0.15	0.261±0.071	0.947±0.340	0.522±0.155	0.776±0.064
Ni$_{Jun}$	*27.0±4.6	*32.5±3.4	26.2±5.2	39.2±8.2	27.0±2.5	*49.0±2.4	19.5±5.9	*43.0±5.1	36.6±10.8	*20.6±2.6
Ni$_{Oct}$	17.2±1.5	16.9±2.6	23.0±1.3	39.3±2.9	26.2±0.7	39.3±2.1	13.3±1.7	27.4±7.1	22.6±2.5	30.9±1.6
P$_{Jun}$	*718±164	*829±97	*659±28	985±121	*392±52	*1146±98	*476±51	572±94	*867±77	*682±133
P$_{Oct}$	371±80	349±15	499±13	809±31	524±29	803±57	348±49	544±134	503±7	1198±198
Pb$_{Jun}$	17.3±1.4	20.7±2.0	21.7±9.3	26.1±3.4	18.6±2.0	30.1±0.8	12.0±1.5	*46.4±7.6	32.8±20.0	18.0±4.6
Pb$_{Oct}$	14.0±1.7	18.4±6.6	16.2±1.9	29.7±1.7	18.6±0.8	33.9±3.8	12.6±2.4	19.5±4.1	16.7±2.3	20.0±1.4
Rb$_{Jun}$	*50.0±3.2	*69.3±7.0	43.7±15.8	*32.7±8.1	55.2±5.9	*32.7±1.5	*19.6±3.1	84.0±13.0	77.7±22.8	*33.2±0.6
Rb$_{Oct}$	43.1±1.5	40.5±1.9	41.4±5.0	88.4±8.2	50.0±3.1	85.4±5.4	31.9±5.9	54.0±14.3	44.2±5.0	78.3±8.8
S$_{Jun}$	426±58	*599±48	367±53	*729±108	424±120	783±42	272±46	331±64	387±116	*795±252
S$_{Oct}$	353±12	378±28	457±45	969±55	414±46	941±111	262±26	458±146	289±56	3084±244
Sb$_{Jun}$	0.833±0.131	1.01±0.16	0.869±0.075	1.22±0.22	0.697±0.147	1.62±0.10	0.585±0.062	*1.57±0.06	1.33±0.61	*0.841±0.118
Sb$_{Oct}$	0.752±0.143	0.813±0.317	0.786±0.074	1.29±0.05	0.885±0.097	1.52±0.30	0.553±0.051	0.893±0.299	0.708±0.103	1.38±0.17
Se$_{Jun}$	0.144±0.046	0.118±0.029	0.122±0.137	0.346±0.119	0.348±0.105	0.357±0.085	0.079±0.051	*0.343±0.310	0.183±0.054	0.195±0.033
Se$_{Oct}$	0.223±0.219	0.079±0.051	0.092±0.160	0.275±0.024	0.055±0.095	0.353±0.214	0.073±0.041	0.081±0.053	0.125±0.130	0.610±0.412
Sn$_{Jun}$	*2.97±0.71	*3.14±0.53	*2.41±0.03	3.45±0.61	3.59±1.60	4.39±0.30	2.27±1.14	*4.52±0.56	3.73±1.37	*2.86±0.61
Sn$_{Oct}$	1.56±0.23	1.81±0.38	1.99±0.17	3.59±0.32	2.39±0.53	4.67±1.55	1.45±0.14	2.38±0.61	5.26±4.46	4.66±0.65

Table ESM.5. – continued.

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Elements in μg g⁻¹ – continued										
Sr_{Jun}	*142±7	142±12	123±20	*124±10	129±10	*107±14	*79.2±6.1	132±11	*148±7	*117±11
Sr_{Oct}	115±10	126±2	127±8	148±8	145±2	148±6	101±7	135±14	125±6	145±4
Th_{Jun}	*6.57±0.89	*6.76±1.17	4.55±1.72	*5.16±0.98	6.19±1.24	*6.10±0.54	*1.95±0.78	*10.9±1.0	*7.90±2.81	*3.78±0.25
Th_{Oct}	4.41±0.85	4.99±0.57	5.19±0.02	8.53±0.74	5.89±0.30	8.58±0.59	4.41±0.81	6.36±1.43	5.17±0.76	8.48±1.04
Tl_{Jun}	0.309±0.016	*0.401±0.049	0.302±0.041	0.502±0.114	*0.473±0.023	0.673±0.058	0.226±0.050	*0.747±0.024	0.491±0.180	*0.323±0.031
Tl_{Oct}	0.333±0.019	0.303±0.025	0.331±0.030	0.599±0.027	0.370±0.017	0.591±0.052	0.256±0.037	0.396±0.119	0.344±0.048	0.523±0.055
U_{Jun}	1.82±0.40	1.87±0.12	1.50±0.11	1.97±0.22	1.50±0.14	2.29±0.08	1.18±0.23	*2.38±0.13	1.91±0.43	*1.24±0.12
U_{Oct}	1.17±0.32	1.45±0.28	1.76±0.38	2.17±0.06	1.44±0.05	2.11±0.15	1.34±0.30	1.57±0.33	1.23±0.09	1.91±0.12
V_{Jun}	*69.9±7.8	*81.4±10.3	*66.2±2.7	96.7±16.3	60.1±8.4	*117±7	53.9±3.6	*98.6±10.5	*93.1±23.4	*45.2±2.6
V_{Oct}	44.6±5.9	48.2±1.6	58.7±3.4	93.2±7.3	57.0±2.4	92.7±5.8	43.6±6.0	61.6±14.6	53.2±4.4	71.4±8.1
W_{Jun}	*2.72±0.53	*2.77±0.36	3.06±0.89	*3.77±0.74	2.46±0.34	4.17±0.48	1.12±0.20	2.64±0.56	2.75±0.75	*1.25±0.13
W_{Oct}	1.55±0.32	1.59±0.24	2.62±0.50	6.50±1.41	2.39±0.96	4.09±0.48	1.10±0.21	2.86±0.71	1.56±0.30	1.77±0.20
Zn_{Jun}	*89.8±17.3	*102.6±9.1	*99.1±19.0	120±7	76.1±4.4	*139±5	*74.2±8.5	*118±18	*136±27	*82.8±10.7
Zn_{Oct}	53.6±6.5	52.4±4.9	63.1±4.5	114±7	65.8±6.1	111±7	48.2±4.5	72.9±19.1	56.7±7.2	158±24

Table ESM.6. Rare earth element (lanthanide) concentrations in sediments at the nine sites of the Mura River (MI – the initial, most upstream location in Croatia; MB – location near bridge, in the municipality of Sveti Martin na Muri; HL – Hlapičina; MS – Mursko Središće; KR – Križovec; PT – Podturen; DK – Dekanovec; GR – Goričan; KT – Kotoriba), covering its entire section within Croatia, in two sampling campaigns (June 2023, rainy period; October 2023, dry period), expressed as mean ± standard deviation (n=3). The concentrations of the same elements are also provided for the Gradiščak Stream (SG), flowing in the area between the two upstream riverine sites (MI, MB). Asterisks (*) refer to statistically significant differences between two samplings at the same site (p<0.05). Grey cells with bolded text refer to statistically significantly higher values for all Mura sites together in that sampling campaign (p<0.05).

	MI	**MB**	**HL**	**MS**	**KR**	**PT**	**DK**	**GR**	**KT**	**SG**
Lanthanides (μg g^{-1})										
La_{Jun}	*25.5±2.1	25.3±5.0	16.0±6.6	*14.6±1.4	21.6±4.0	*14.0±1.8	*6.8±3.8	*34.3±2.0	27.5±8.6	*12.3±1.0
La_{Oct}	14.8±2.7	18.7±2.7	18.3±2.4	29.3±4.1	20.5±1.0	28.2±1.2	16.4±3.3	24.7±3.7	18.4±1.9	28.8±2.8
Ce_{Jun}	*48.3±7.7	49.0±8.6	31.2±12.2	*28.9±3.9	42.4±7.4	*28.6±3.3	*13.8±7.1	*67.8±4.3	53.8±16.4	*26.4±4.5
Ce_{Oct}	29.6±5.3	36.1±4.7	36.7±5.5	58.0±8.7	40.2±2.0	56.1±2.3	33.0±6.0	48.7±8.1	36.5±3.7	57.6±5.9
Pr_{Jun}	*5.85±0.83	6.03±1.07	3.89±1.46	*3.85±0.56	5.08±0.96	*3.82±0.41	*1.76±0.85	*7.97±0.48	6.56±1.99	*3.03±0.24
Pr_{Oct}	3.56±0.65	4.37±0.58	4.47±0.68	7.00±1.09	4.81±0.30	6.71±0.22	4.01±0.62	5.76±1.01	4.40±0.41	6.79±0.72
Nd_{Jun}	*22.7±4.0	23.6±4.3	15.7±5.8	*15.8±2.6	19.6±3.6	*15.6±1.6	*7.1±3.5	*31.7±2.1	26.3±7.9	*12.4±0.9
Nd_{Oct}	14.4±2.5	17.3±2.7	18.1±3.0	27.6±4.0	18.6±1.2	26.6±1.2	16.3±2.0	22.9±4.0	17.2±1.6	26.6±3.0
Sm_{Jun}	4.47±1.09	4.71±0.67	3.20±1.07	*3.36±0.65	3.93±0.75	*3.35±0.24	*1.52±0.65	*6.37±0.33	5.35±1.58	*2.61±0.25
Sm_{Oct}	3.04±0.68	3.59±0.49	3.76±0.44	5.44±0.59	3.74±0.21	5.23±0.18	3.30±0.32	4.49±1.02	3.54±0.10	5.40±0.61
Eu_{Jun}	1.07±0.19	1.09±0.15	0.827±0.256	*0.854±0.113	0.882±0.135	*0.812±0.072	*0.406±0.148	*1.41±0.08	1.27±0.28	*0.679±0.035
Eu_{Oct}	0.724±0.140	0.894±0.066	0.877±0.108	1.18±0.10	0.861±0.010	1.22±0.07	0.770±0.067	0.953±0.141	0.848±0.061	1.12±0.07
Gd_{Jun}	3.84±0.81	3.93±0.52	3.06±0.99	*2.88±0.41	3.41±0.48	*2.82±0.32	*1.39±0.50	*5.48±0.34	4.46±1.06	*2.21±0.16
Gd_{Oct}	2.76±0.57	3.25±0.44	3.74±0.59	4.52±0.49	3.12±0.11	4.50±0.22	3.32±0.56	3.91±0.58	3.10±0.25	4.09±0.42
Dy_{Jun}	4.21±0.89	3.94±0.36	3.64±1.10	*2.85±0.19	3.24±0.40	*2.71±0.44	*2.04±0.58	5.03±0.42	4.32±0.65	*2.12±0.15
Dy_{Oct}	3.32±0.56	4.13±0.51	5.37±1.32	4.06±0.22	3.25±0.17	4.02±0.23	5.22±1.83	4.30±0.44	3.69±0.39	3.51±0.29
Ho_{Jun}	0.867±0.176	0.794±0.042	0.773±0.231	*0.593±0.065	0.668±0.079	*0.548±0.076	*0.438±0.110	0.978±0.072	0.880±0.109	*0.424±0.030
Ho_{Oct}	0.702±0.098	0.891±0.089	1.16±0.35	0.793±0.027	0.688±0.040	0.781±0.020	1.17±0.44	0.886±0.063	0.787±0.069	0.653±0.069
Er_{Jun}	2.62±0.55	2.29±0.14	2.41±0.78	*1.68±0.10	1.92±0.22	*1.54±0.20	1.38±0.39	2.84±0.11	2.56±0.32	*1.25±0.07
Er_{Oct}	2.03±0.39	2.62±0.26	3.56±1.04	2.23±0.06	1.98±0.23	2.20±0.11	3.57±1.45	2.60±0.13	2.35±0.34	1.82±0.20
Tm_{Jun}	0.375±0.076	*0.314±0.018	0.351±0.115	*0.234±0.004	0.270±0.027	*0.211±0.024	*0.195±0.050	0.386±0.019	0.351±0.045	*0.168±0.010
Tm_{Oct}	0.295±0.070	0.384±0.034	0.528±0.167	0.308±0.006	0.292±0.053	0.307±0.007	0.535±0.239	0.385±0.010	0.345±0.045	0.254±0.037
Yb_{Jun}	2.53±0.48	*2.15±0.15	2.49±0.97	*1.52±0.12	1.81±0.14	*1.43±0.25	*1.41±0.39	2.64±0.15	2.37±0.22	*1.14±0.11
Yb_{Oct}	2.06±0.45	2.58±0.22	3.75±1.28	2.01±0.04	2.00±0.23	1.99±0.05	3.73±1.71	2.72±0.12	2.37±0.34	1.64±0.16
Lu_{Jun}	0.354±0.073	0.314±0.004	0.359±0.147	*0.215±0.003	0.245±0.027	*0.192±0.024	*0.202±0.059	0.368±0.019	0.335±0.039	*0.162±0.002
Lu_{Oct}	0.291±0.070	0.369±0.041	0.528±0.167	0.291±0.021	0.265±0.042	0.281±0.016	0.531±0.241	0.394±0.041	0.332±0.048	0.228±0.030

Table ESM.7. Enrichment factors (EF) for elements in sediments, calculated using Al as a reference element, with background concentrations based on upper category values for the studied area from the Geochemical Atlas of Europe [26]. The EFs are presented for nine sites of the Mura River (MI – the initial, most upstream location in Croatia; MB – location near bridge, in the municipality of Sveti Martin na Muri; HL – Hlapičina; MS – Mursko Središće; KR – Križovec; PT – Podturen; DK – Dekanovec; GR – Goričan; KT – Kotoriba), covering its entire section within Croatia, in two sampling campaigns (June 2023, rainy period; October 2023, dry period), expressed as mean ± standard deviation (n=3). EFs are also provided for the Gradiščak Stream (SG), flowing in the area between the two upstream riverine sites (MI, MB). Legend – light grey: >1 to < 2; dark grey: 2 to < 3; blue: 3 to < 4; red: ≥ 4.

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Na_{Jun}	1.8±0.1	1.5±0.1	1.9±0.3	1.8±0.2	1.9±0.1	1.5±0.2	2.8±0.4	1.2±0.2	1.5±0.3	2.1±0.2
Na_{Oct}	1.9±0.1	2.1±0.1	1.7±0.2	1.3±0.1	2.0±0.1	1.2±0.1	1.8±0.3	1.8±0.2	2.0±0.1	1.6±0.1
K_{Jun}	0.9±0.1	1.0±0.0	0.9±0.1	1.3±0.1	1.0±0.0	1.5±0.1	1.1±0.2	0.9±0.0	0.9±0.1	1.2±0.1
K_{Oct}	1.0±0.1	0.9±0.0	0.8±0.1	1.2±0.0	1.0±0.0	1.2±0.0	0.8±0.2	1.0±0.1	0.9±0.1	1.1±0.0
Mg_{Jun}	1.6±0.1	1.5±0.0	1.4±0.2	1.4±0.0	1.4±0.0	1.4±0.0	0.8±0.1	1.1±0.2	1.4±0.0	0.9±0.1
Mg_{Oct}	1.7±0.1	1.6±0.1	1.8±0.1	1.6±0.0	1.9±0.0	1.7±0.1	1.4±0.1	1.4±0.0	1.4±0.1	1.1±0.0
Ca_{Jun}	1.8±0.1	1.4±0.0	1.5±0.1	1.5±0.0	2.0±0.1	1.1±0.2	1.3±0.1	1.4±0.5	1.2±0.2	1.9±0.3
Ca_{Oct}	2.0±0.1	2.0±0.1	2.1±0.1	1.6±0.1	2.7±0.9	1.7±0.1	1.7±0.2	1.5±0.1	1.6±0.0	1.6±0.2
As_{Jun}	1.1±0.7	0.8±0.0	0.6±0.0	1.2±0.3	0.7±0.1	1.7±0.3	0.7±0.1	2.0±0.4	1.0±0.5	1.1±0.4
As_{Oct}	0.8±0.2	0.6±0.1	0.7±0.1	1.1±0.1	0.7±0.1	1.2±0.0	0.6±0.2	0.9±0.1	0.9±0.2	0.8±0.0
Ba_{Jun}	0.8±0.0	0.9±0.0	0.8±0.0	1.1±0.0	1.1±0.0	1.2±0.1	0.9±0.1	1.1±0.0	0.9±0.1	2.2±0.7
Ba_{Oct}	1.2±0.2	1.2±0.1	1.0±0.1	1.3±0.0	1.2±0.0	1.3±0.0	0.9±0.2	1.2±0.0	1.1±0.1	3.0±0.2
Cd_{Jun}	1.1±0.6	0.7±0.0	0.7±0.4	1.1±0.2	0.6±0.2	1.3±0.2	1.8±0.3	0.9±0.3	0.7±0.0	0.9±0.1
Cd_{Oct}	0.9±0.2	1.0±0.2	1.1±0.2	1.3±0.2	1.0±0.4	1.1±0.1	1.3±0.3	0.9±0.2	1.0±0.0	1.1±0.1
Co_{Jun}	1.2±0.1	1.1±0.0	1.2±0.3	1.7±0.2	1.2±0.0	2.0±0.2	1.8±0.3	1.4±0.0	1.1±0.1	1.5±0.4
Co_{Oct}	1.4±0.2	1.3±0.1	1.6±0.1	1.6±0.0	1.4±0.0	1.6±0.0	1.2±0.1	1.5±0.1	1.4±0.1	1.3±0.1
Cr_{Jun}	1.2±0.1	1.1±0.0	1.3±0.5	1.5±0.2	1.1±0.0	1.8±0.1	2.0±0.4	1.2±0.0	1.0±0.1	1.3±0.2
Cr_{Oct}	1.0±0.1	1.1±0.1	1.7±0.3	1.3±0.0	1.4±0.3	1.3±0.0	1.1±0.2	1.4±0.1	1.3±0.1	1.3±0.1
Cs_{Jun}	0.7±0.1	0.8±0.1	0.6±0.1	1.0±0.1	0.8±0.0	1.3±0.1	0.5±0.1	1.2±0.1	0.9±0.2	1.3±0.2
Cs_{Oct}	0.9±0.0	0.8±0.1	0.8±0.1	1.4±0.0	0.9±0.1	1.4±0.0	0.6±0.1	1.0±0.2	0.9±0.1	2.5±0.2
Cu_{Jun}	0.9±0.1	0.9±0.0	0.9±0.2	1.6±0.3	1.9±0.7	2.2±0.2	0.9±0.2	2.1±0.2	1.0±0.3	1.5±0.4
Cu_{Oct}	0.9±0.1	0.7±0.0	0.8±0.1	1.5±0.1	1.0±0.1	1.6±0.1	0.6±0.1	1.1±0.2	0.8±0.1	4.9±0.7
Fe_{Jun}	1.2±0.1	1.0±0.0	1.4±0.5	1.3±0.2	1.0±0.0	1.5±0.1	2.7±0.3	1.2±0.0	1.0±0.0	1.1±0.2
Fe_{Oct}	1.2±0.1	1.4±0.1	1.8±0.4	1.0±0.0	1.1±0.0	1.1±0.1	1.7±0.5	1.3±0.1	1.2±0.1	1.0±0.0
Li_{Jun}	1.1±0.0	1.1±0.1	1.0±0.2	1.6±0.3	1.3±0.1	1.9±0.3	1.4±0.4	1.4±0.1	1.1±0.1	1.3±0.2
Li_{Oct}	1.4±0.1	1.2±0.1	1.4±0.1	1.7±0.1	1.3±0.1	1.8±0.1	1.2±0.3	1.3±0.2	1.3±0.1	1.9±0.3

Table ESM.7. – continued.

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
Mn_{Jun}	1.3±0.1	0.9±0.1	1.6±0.7	1.0±0.3	1.0±0.1	0.9±0.1	3.5±0.5	1.0±0.1	0.9±0.1	0.8±0.2
Mn_{Oct}	2.2±0.1	2.4±0.3	2.7±0.6	0.9±0.0	1.5±0.1	1.0±0.1	2.7±0.8	1.4±0.3	1.5±0.1	0.5±0.0
Mo_{Jun}	2.0±0.5	1.8±0.1	3.3±2.7	2.7±0.5	2.4±0.3	3.6±0.3	2.5±0.9	2.2±0.1	1.6±0.4	2.4±0.7
Mo_{Oct}	1.5±0.2	3.0±1.0	4.3±2.8	3.6±1.8	3.3±1.7	2.7±0.3	1.1±0.2	3.4±1.4	2.0±0.5	2.4±0.1
Ni_{Jun}	1.2±0.2	1.2±0.1	1.3±0.3	1.9±0.3	1.4±0.1	2.3±0.2	1.6±0.3	1.6±0.1	1.2±0.1	1.4±0.2
Ni_{Oct}	1.2±0.0	1.2±0.2	1.4±0.1	1.7±0.0	1.6±0.0	1.7±0.0	0.9±0.1	1.6±0.2	1.5±0.1	1.6±0.1
P_{Jun}	1.2±0.2	1.2±0.1	1.2±0.2	1.7±0.3	0.8±0.0	2.0±0.2	1.5±0.4	0.8±0.1	1.1±0.1	1.7±0.4
P_{Oct}	1.0±0.2	0.9±0.1	1.1±0.0	1.3±0.1	1.2±0.0	1.3±0.0	0.9±0.1	1.2±0.1	1.2±0.0	2.3±0.2
Pb_{Jun}	1.1±0.1	1.1±0.0	1.4±0.4	1.8±0.1	1.4±0.0	2.0±0.2	1.5±0.2	2.5±0.6	1.5±0.6	1.7±0.6
Pb_{Oct}	1.4±0.1	1.8±0.6	1.4±0.2	1.8±0.0	1.6±0.0	2.1±0.2	1.3±0.3	1.6±0.1	1.5±0.1	1.5±0.0
Rb_{Jun}	0.7±0.1	0.8±0.0	0.6±0.1	0.5±0.2	0.9±0.0	0.5±0.0	0.5±0.1	0.9±0.1	0.8±0.1	0.7±0.0
Rb_{Oct}	0.9±0.0	0.8±0.0	0.8±0.1	1.1±0.0	0.9±0.0	1.1±0.0	0.7±0.1	0.9±0.1	0.9±0.1	1.2±0.0
Sb_{Jun}	0.7±0.1	0.7±0.0	0.8±0.2	1.0±0.2	0.6±0.1	1.4±0.1	0.9±0.1	1.1±0.1	0.8±0.2	1.0±0.2
Sb_{Oct}	1.0±0.2	1.0±0.4	0.9±0.1	1.0±0.1	1.0±0.1	1.2±0.2	0.7±0.1	0.9±0.1	0.8±0.1	1.3±0.1
Sn_{Jun}	1.0±0.2	0.9±0.1	0.9±0.2	1.2±0.2	1.4±0.6	1.5±0.1	1.5±0.9	1.2±0.2	0.9±0.2	1.4±0.3
Sn_{Oct}	0.8±0.1	0.9±0.2	0.9±0.1	1.1±0.0	1.0±0.2	1.5±0.4	0.7±0.0	1.0±0.1	2.5±2.1	1.7±0.1
Sr_{Jun}	1.5±0.0	1.2±0.0	1.3±0.1	1.4±0.1	1.5±0.1	1.2±0.1	1.6±0.2	1.1±0.2	1.2±0.2	1.8±0.3
Sr_{Oct}	1.9±0.1	2.0±0.1	1.8±0.2	1.5±0.0	2.0±0.1	1.5±0.1	1.6±0.1	1.8±0.3	1.9±0.0	1.7±0.1
Th_{Jun}	0.7±0.1	0.6±0.1	0.5±0.1	0.6±0.1	0.8±0.1	0.7±0.0	0.4±0.1	1.0±0.0	0.6±0.1	0.6±0.1
Th_{Oct}	0.8±0.1	0.8±0.1	0.8±0.0	0.9±0.0	0.9±0.0	0.9±0.0	0.7±0.1	0.9±0.1	0.8±0.1	1.0±0.0
Ti_{Jun}	0.7±0.1	0.6±0.0	0.7±0.2	0.8±0.1	0.5±0.0	0.8±0.1	1.1±0.3	0.6±0.0	0.6±0.1	0.7±0.1
Ti_{Oct}	0.5±0.1	0.6±0.0	0.8±0.1	0.6±0.0	0.6±0.0	0.6±0.0	0.7±0.1	0.6±0.0	0.7±0.0	0.7±0.0
Tl_{Jun}	0.7±0.1	0.7±0.0	0.7±0.1	1.2±0.2	1.2±0.1	1.6±0.2	0.9±0.1	1.4±0.1	0.8±0.1	1.1±0.2
Tl_{Oct}	1.2±0.0	1.0±0.1	1.0±0.1	1.3±0.0	1.1±0.0	1.3±0.0	0.9±0.2	1.1±0.1	1.1±0.1	1.3±0.0
U_{Jun}	1.2±0.2	1.0±0.0	1.1±0.2	1.4±0.2	1.1±0.0	1.6±0.2	1.5±0.2	1.3±0.1	0.9±0.0	1.2±0.1
U_{Oct}	1.2±0.3	1.5±0.3	1.6±0.3	1.4±0.0	1.3±0.0	1.4±0.0	1.4±0.2	1.3±0.1	1.2±0.1	1.4±0.1
V_{Jun}	0.8±0.0	0.8±0.0	0.9±0.2	1.2±0.1	0.8±0.0	1.5±0.1	1.3±0.2	1.0±0.0	0.8±0.1	0.8±0.1
V_{Oct}	0.9±0.1	0.9±0.0	1.0±0.0	1.1±0.0	0.9±0.0	1.1±0.0	0.8±0.0	1.0±0.1	0.9±0.0	1.0±0.0
W_{Jun}	1.8±0.3	1.5±0.1	2.3±1.3	2.7±0.8	1.9±0.1	2.9±0.6	1.4±0.3	1.5±0.4	1.4±0.3	1.3±0.2
W_{Oct}	1.6±0.3	1.6±0.2	2.4±0.4	4.1±0.6	2.2±0.9	2.7±0.5	1.1±0.2	2.5±0.3	1.5±0.2	1.3±0.0
Zn_{Jun}	1.6±0.2	1.6±0.1	1.9±0.5	2.3±0.3	1.6±0.3	2.7±0.3	2.6±0.7	1.8±0.4	1.9±0.6	2.3±0.2
Zn_{Oct}	1.6±0.1	1.5±0.1	1.6±0.0	2.0±0.0	1.6±0.1	2.0±0.1	1.4±0.0	1.7±0.2	1.5±0.1	3.3±0.3

Table ESM.8. Enrichment factors (EF) for lanthanides in sediments, calculated using Al as a reference element, with background concentrations based on upper category values for the studied area from the Geochemical Atlas of Europe [26]. The EFs are presented for nine sites of the Mura River (MI – the initial, most upstream location in Croatia; MB – location near bridge, in the municipality of Sveti Martin na Muri; HL – Hlapičina; MS – Mursko Središće; KR – Križovec; PT – Podturen; DK – Dekanovec; GR – Goričan; KT – Kotoriba), covering its entire section within Croatia, in two sampling campaigns (June 2023, rainy period; October 2023, dry period), expressed as mean ± standard deviation (n=3). EFs are also provided for the Gradiščak Stream (SG), flowing in the area between the two upstream riverine sites (MI, MB). Legend – light grey: >1 to < 2; dark grey: 2 to < 3; blue: 3 to < 4; red: ≥ 4.

	MI	MB	HL	MS	KR	PT	DK	GR	KT	SG
La_{Jun}	0.9±0.0	0.7±0.1	0.6±0.1	0.5±0.0	0.9±0.1	0.5±0.0	0.4±0.2	1.0±0.0	0.7±0.1	0.6±0.1
La_{Oct}	0.8±0.1	1.0±0.1	0.9±0.1	1.0±0.1	1.0±0.1	1.0±0.0	0.9±0.1	1.1±0.1	0.9±0.1	1.1±0.0
Ce_{Jun}	0.8±0.1	0.7±0.1	0.5±0.1	0.5±0.0	0.8±0.1	0.5±0.0	0.4±0.1	0.9±0.0	0.7±0.1	0.7±0.2
Ce_{Oct}	0.8±0.1	0.9±0.1	0.8±0.1	0.9±0.1	0.9±0.1	0.9±0.0	0.8±0.1	1.1±0.1	0.9±0.1	1.1±0.0
Pr_{Jun}	0.8±0.1	0.7±0.1	0.5±0.1	0.5±0.1	0.8±0.1	0.5±0.0	0.4±0.1	0.9±0.0	0.6±0.1	0.6±0.1
Pr_{Oct}	0.7±0.1	0.9±0.1	0.8±0.1	0.9±0.1	0.8±0.0	0.9±0.0	0.8±0.1	1.0±0.0	0.8±0.1	1.0±0.0
Nd_{Jun}	0.7±0.1	0.7±0.1	0.5±0.1	0.6±0.1	0.8±0.1	0.5±0.0	0.4±0.1	0.9±0.0	0.6±0.1	0.6±0.1
Nd_{Oct}	0.8±0.1	0.9±0.1	0.8±0.1	0.9±0.1	0.8±0.0	0.9±0.0	0.8±0.0	1.0±0.0	0.8±0.1	1.0±0.0
Sm_{Jun}	0.8±0.1	0.7±0.0	0.6±0.1	0.6±0.1	0.8±0.1	0.6±0.0	0.5±0.1	0.9±0.0	0.7±0.1	0.7±0.1
Sm_{Oct}	0.8±0.1	1.0±0.1	0.9±0.1	0.9±0.0	0.9±0.0	0.9±0.1	0.9±0.0	1.0±0.1	0.9±0.1	1.1±0.1
Eu_{Jun}	1.0±0.1	0.9±0.1	0.8±0.1	0.8±0.1	1.0±0.0	0.8±0.0	0.7±0.1	1.1±0.1	0.9±0.0	1.0±0.1
Eu_{Oct}	1.1±0.2	1.3±0.1	1.1±0.1	1.1±0.0	1.1±0.0	1.1±0.0	1.1±0.0	1.2±0.1	1.2±0.1	1.2±0.0
Gd_{Jun}	0.7±0.1	0.6±0.0	0.6±0.1	0.6±0.0	0.7±0.0	0.5±0.0	0.5±0.1	0.8±0.0	0.6±0.1	0.6±0.1
Gd_{Oct}	0.8±0.1	0.9±0.1	0.9±0.1	0.8±0.0	0.8±0.0	0.8±0.0	0.9±0.1	0.9±0.0	0.8±0.1	0.9±0.0
Dy_{Jun}	0.9±0.1	0.7±0.0	0.8±0.1	0.6±0.1	0.8±0.0	0.6±0.1	0.8±0.1	0.9±0.0	0.7±0.1	0.7±0.1
Dy_{Oct}	1.1±0.1	1.4±0.1	1.6±0.3	0.8±0.0	0.9±0.0	0.8±0.0	1.7±0.5	1.2±0.1	1.1±0.2	0.9±0.0
Ho_{Jun}	0.9±0.1	0.7±0.0	0.9±0.1	0.7±0.0	0.8±0.0	0.6±0.0	0.9±0.1	0.9±0.0	0.7±0.1	0.7±0.1
Ho_{Oct}	1.2±0.1	1.5±0.1	1.7±0.5	0.8±0.0	1.0±0.0	0.8±0.1	1.9±0.6	1.2±0.1	1.2±0.1	0.8±0.0
Er_{Jun}	0.9±0.1	0.7±0.0	0.9±0.1	0.7±0.1	0.8±0.0	0.6±0.0	0.9±0.1	0.9±0.0	0.7±0.1	0.7±0.1
Er_{Oct}	1.2±0.2	1.5±0.1	1.8±0.5	0.8±0.0	1.0±0.1	0.8±0.0	2.0±0.7	1.3±0.1	1.2±0.2	0.8±0.0
Tm_{Jun}	0.9±0.1	0.7±0.0	0.9±0.2	0.6±0.1	0.8±0.0	0.5±0.0	0.9±0.1	0.8±0.1	0.7±0.1	0.6±0.1
Tm_{Oct}	1.2±0.2	1.5±0.1	1.8±0.5	0.7±0.1	1.0±0.2	0.7±0.0	2.0±0.8	1.3±0.2	1.2±0.2	0.7±0.0
Yb_{Jun}	0.9±0.1	0.7±0.0	0.9±0.2	0.6±0.1	0.8±0.0	0.5±0.0	1.0±0.1	0.8±0.0	0.7±0.1	0.6±0.1
Yb_{Oct}	1.2±0.2	1.5±0.1	1.9±0.6	0.7±0.0	1.0±0.1	0.7±0.1	2.1±0.8	1.3±0.2	1.3±0.2	0.7±0.0
Lu_{Jun}	0.8±0.1	0.6±0.0	0.9±0.2	0.5±0.1	0.7±0.0	0.5±0.0	0.9±0.1	0.7±0.1	0.6±0.1	0.6±0.0
Lu_{Oct}	1.1±0.2	1.3±0.1	1.7±0.5	0.7±0.1	0.9±0.1	0.7±0.1	1.9±0.7	1.2±0.3	1.1±0.2	0.6±0.0

Figure ESM.1. Shematic representation of the cross-section of the Mura riverbed, with marked sediment sampling points in the rainy period of high water discharge (June 13, water-level at Mursko Središće: 237 cm) and in the period of lower water-level (October 3, water-level at Mursko Središće: 154 cm).

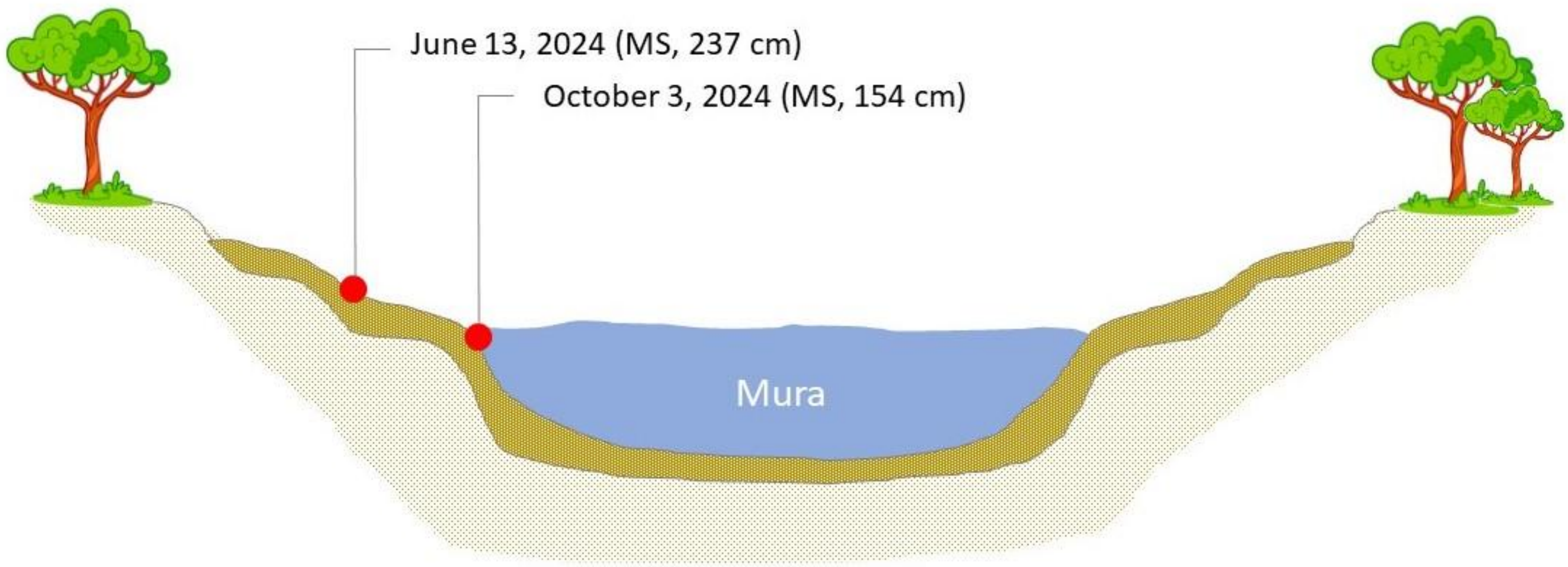


Figure ESM.2. Ternary diagram of grain size distribution of sediment samples collected at the Mura River sampling sites in June 2023 (created according to Shepard [27]).

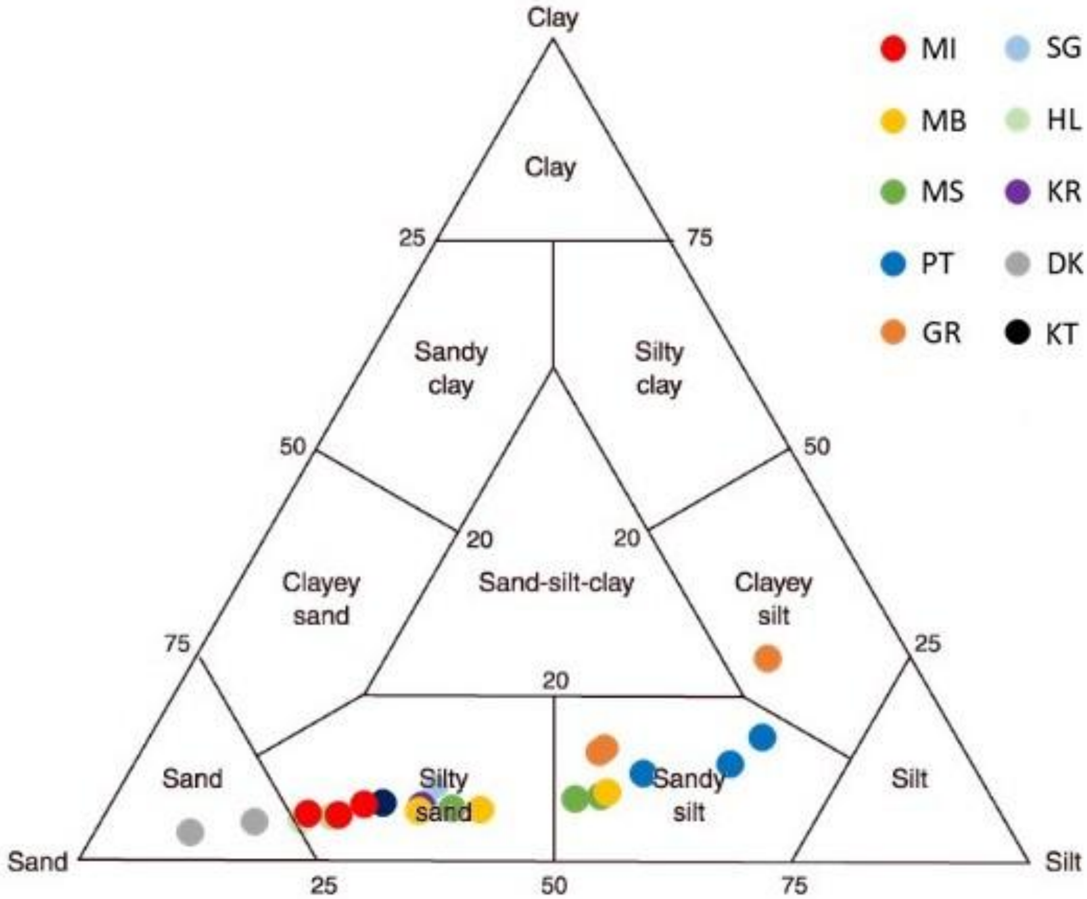


Figure ESM.3. Absolute concentrations of metal resistance genes (*cnr*A, *czc*D, and *pbr*T) and class 1 integron-integrase (*int*I1) in sediments from five Mura River locations (MI – the initial, most upstream location in Croatia; MS – Mursko Središće; KR – Križovec; PT – Podturen; KT - Kotoriba) and stream Gradiščak (SG). Each value represents the mean ± standard deviation of three replicates. Different letters indicate significant differences between locations ($p < 0.05$; comparison was made among five Mura River locations).

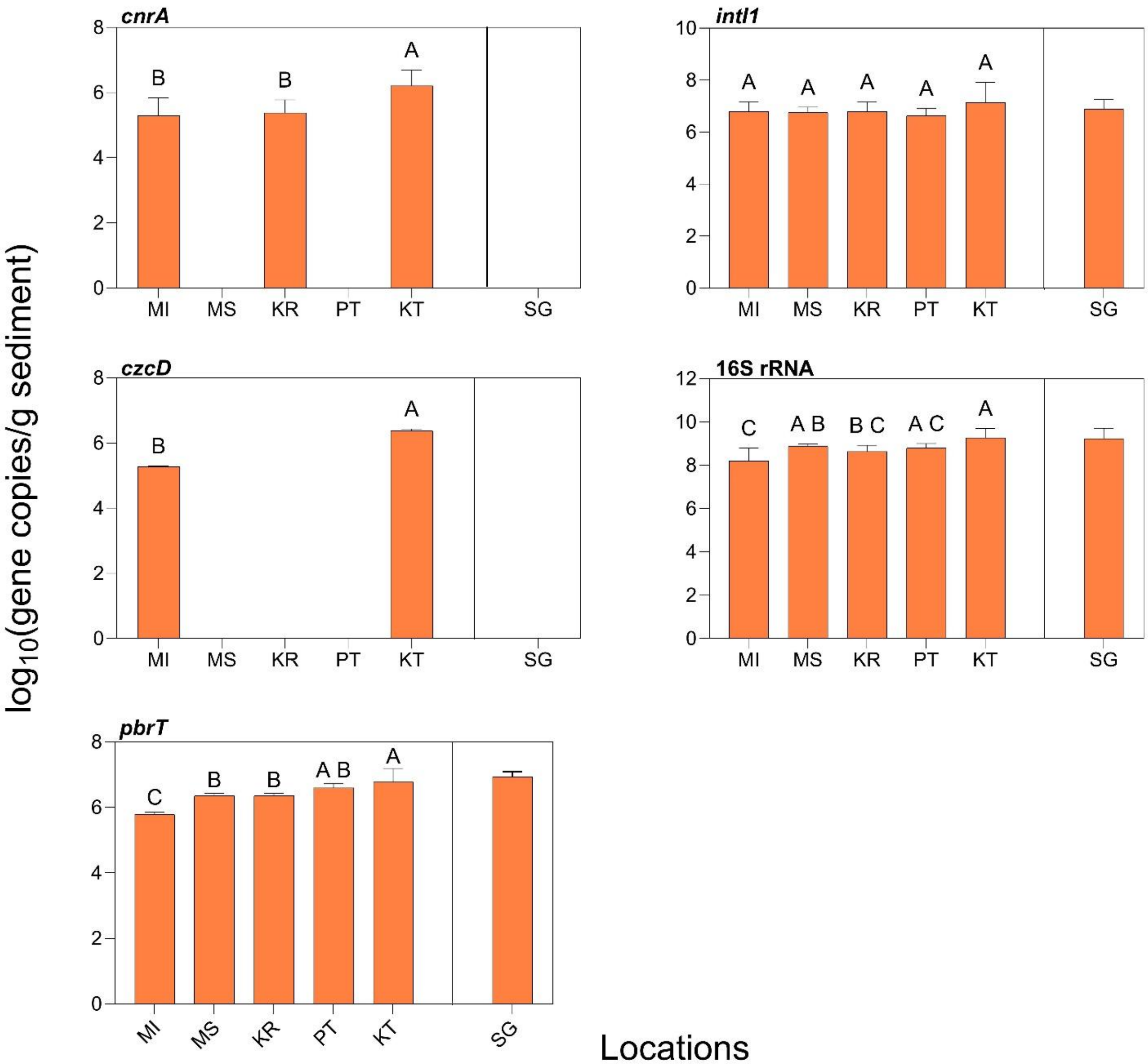


Figure ESM.4. Daily hydrological data for the Mursko Središće site at the Mura River: a) discharges; and b) water levels. The data refer to year 2023, and are provided by the Croatian Meteorological and Hydrological Service. The arrows in the graph indicate the initial times of water sampling in each sampling campaign.

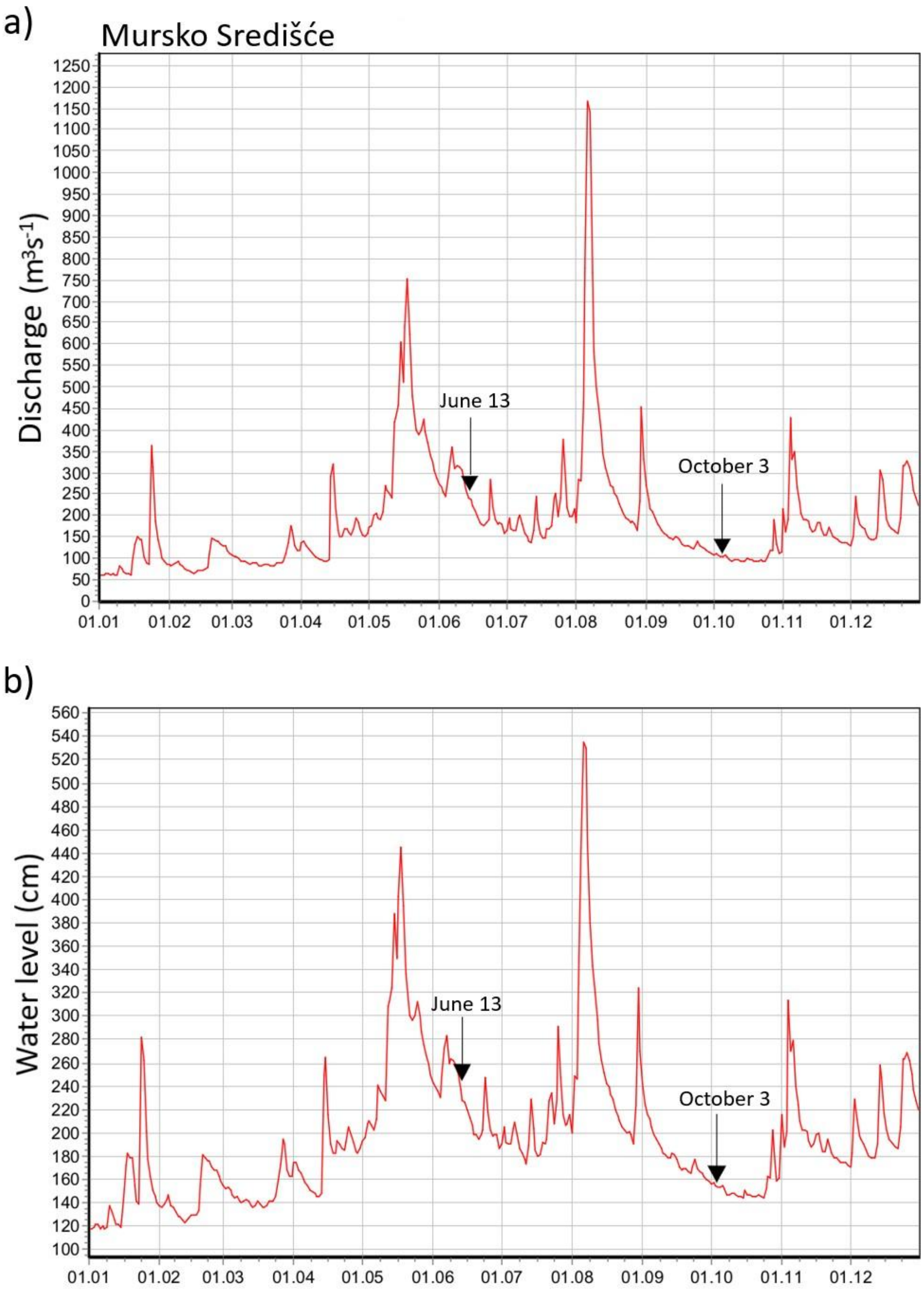
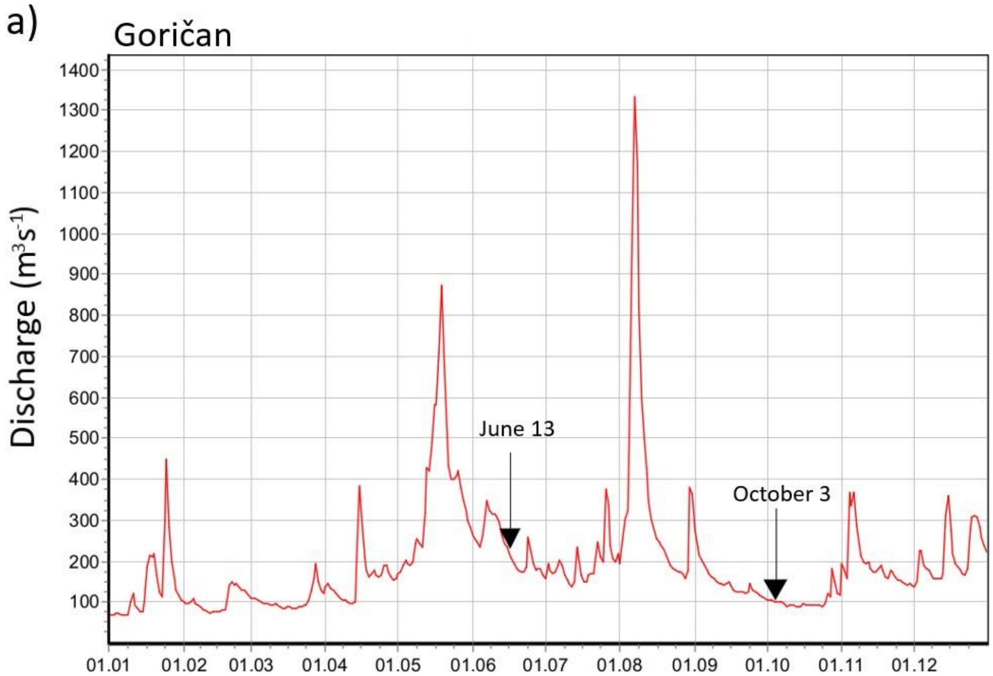


Figure ESM.5. Daily hydrological data for the Goričan site at the Mura River: a) discharges; and b) water levels. The data refer to year 2023, and are provided by the Croatian Meteorological and Hydrological Service. The arrows in the graph indicate the initial times of water sampling in each sampling campaign.



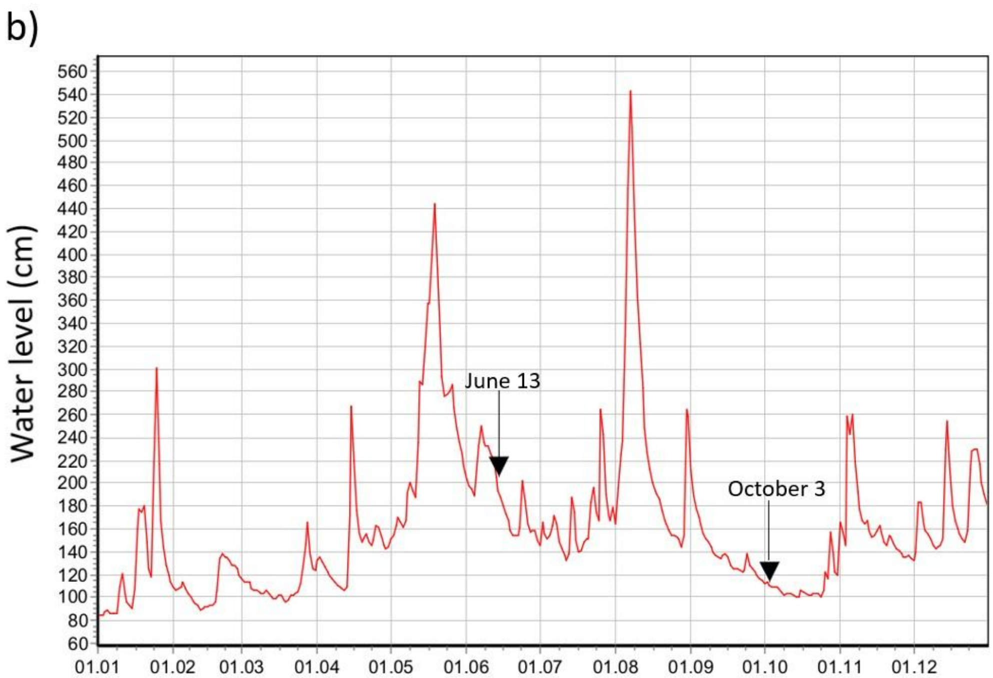


Figure ESM.6. Multidimensional preference analysis for selected elements measured in June (J, blue) and October (O, red) 2023 at nine sampling sites along the section of the Mura River flowing through Croatia (1 – the initial, most upstream location in Croatia; 2 – the municipality of Sveti Martin na Muri; 3 – Hlapičina; 4 – Mursko Središće; 5 – Križovec; 6 – Podturen; 7 – Dekanovec; 8 – Goričan; 9 – Kotoriba): a) elements dissolved in water; b) elements in sediment.