Supplementary material

A strontium and hydro-geochemical perspective on human impacted tributary of the Mekong River Basin: Sources identification, fluxes, and CO_2 consumption

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Figure S1. Land use and statistical data of agriculture/industry change in the MRB.

Table S1. The concentration of dissolved ions and strontium isotopes in the Mun River.

Table S2. Descriptive statistics of the detected physicochemical parameters in the MRB.

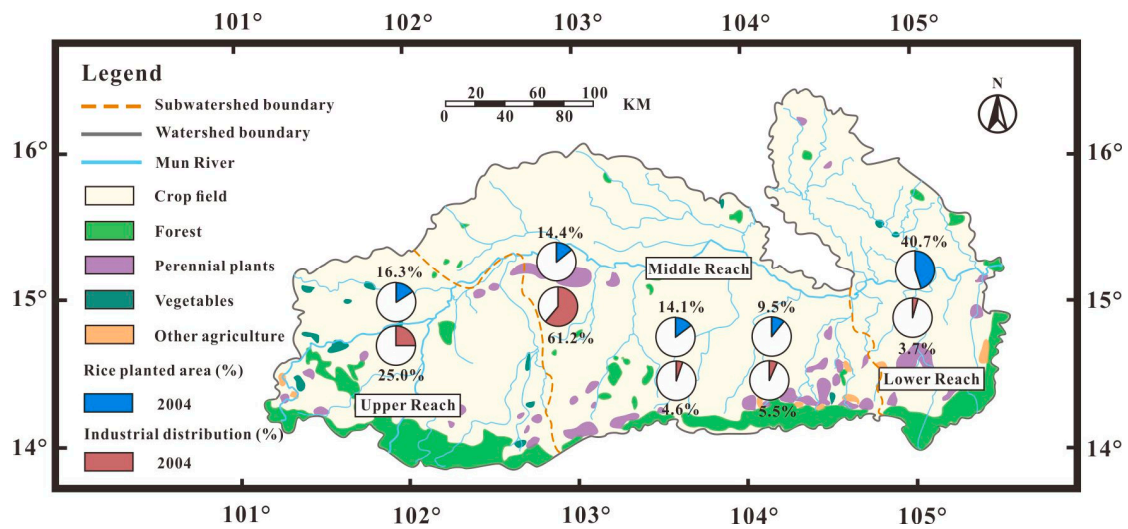**Table S3.** The results of One-way ANOVA analysis on detected chemical parameters in the MRB.

Figure S1. Land use and statistical data of agriculture/industry change in the MRB. The data of pie charts were derived from [1].

Table S1. The concentration of dissolved ions and strontium isotopes in the Mun River.

Num	T	pH	TDS	DO	Na$^+$	K$^+$	Mg^{2+}	Ca^{2+}	Cl$^-$	NO$_3^-$	SO$_4^{2-}$	HCO$_3^-$	SiO$_2$	Sr	^{87}Sr/^{86}Sr	2σ [1]
	°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	μg/L		
Upper Reach																
U1	28.3	7.09	62	6.8	4.6	2.3	2.0	9.3	2.8	0.03	2.3	47.6	14.4	48.3	0.7093	12
U2	26.7	7.87	397	7.2	14.1	2.6	9.6	103.5	19.2	0.83	9.8	362.3	19.0	338.4	0.7092	13
U3	28.8	8.51	209	11.8	18.1	4.9	7.1	38.0	19.2	0.56	9.0	158.3	3.6	231.3	0.7102	12
U4	26.0	8.15	222	7.4	17.7	5.0	7.1	42.4	18.2	0.39	8.5	173.9	4.5	236.6	0.7104	13
U5	26.2	7.44	325	7.0	38.8	7.7	8.1	46.9	45.6	0.09	15.6	200.4	7.8	261.6	0.7132	14
U6	26.7	7.79	325	7.2	41.1	7.1	8.3	48.3	48.8	0.33	17.5	201.3	8.3	264.3	0.7132	13
U7	27.6	7.33	397	5.6	84.0	12.7	8.7	22.5	126.7	0.10	16.1	115.3	12.2	176.8	0.7149	9
U8	28.4	7.66	598	7.4	134.8	14.1	11.6	30.0	215.7	0.02	18.3	146.4	8.0	187.5	0.7149	11
U9	30.5	7.65	748	6.9	169.3	9.7	11.4	38.7	256.0	0.03	7.9	159.2	14.2	165.9	0.7156	11
U10	28.2	7.92	384	7.6	81.5	5.1	6.7	22.7	126.2	0.03	22.6	96.1	11.7	152.7	0.7162	11
U11	29.8	7.82	1456	8.2	369.6	6.9	16.2	62.5	668.5	0.99	6.5	174.8	13.5	40.5	0.7111	12
U12	26.4	7.27	186	5.9	16.0	5.5	10.3	24.8	14.5	0.14	17.0	124.4	11.9	195.5	0.7085	13
U13	28.1	7.40	192	5.2	26.6	5.2	5.5	18.6	56.4	0.03	2.2	63.1	11.9	62.5	0.7118	12
U14	28.3	6.96	44	7.2	2.6	3.1	2.1	4.6	4.5	0.05	1.4	28.4	5.3	43.1	0.7131	9
U15	28.0	6.78	105	3.3	14.6	4.4	4.4	8.2	18.7	0.03	2.7	53.1	9.6	76.0	0.7194	12
U16	28.2	7.54	213	5.1	39.5	10.6	5.3	10.9	49.9	0.03	13.0	80.5	10.5	101.8	0.7168	9
U17	26.8	7.70	189	6.6	26.3	5.1	7.5	22.1	27.6	0.03	4.6	120.8	11.3	152.7	0.7109	10
U18	29.8	7.40	53	10.3	3.5	2.8	2.7	5.9	5.7	0.03	0.6	35.7	4.3	248.2	0.7128	12
Middle Reach																
M1	28.3	7.63	579	6.5	141.2	6.1	7.9	27.6	235.1	0.13	17.5	92.4	11.9	175.2	0.7168	13
M2	26.5	6.91	105	3.8	19.3	2.5	3.3	8.7	18.2	0.04	1.9	55.8	11.2	74.5	0.7219	13
M3	28.1	7.47	683	5.2	169.3	5.7	7.4	32.4	282.1	0.08	31.3	78.7	17.3	278.6	0.7196	11
M4	25.6	7.76	839	6.5	213.7	5.1	8.4	43.3	361.6	0.66	40.8	83.3	13.3	291.1	0.7154	10
M5	26.9	7.47	624	6.0	161.5	4.0	6.2	23.8	270.4	0.05	13.7	72.3	12.4	244.6	0.7223	11
M6	26.7	8.46	358	8.7	82.5	3.4	5.1	18.0	136.5	0.18	5.7	69.5	7.1	133.9	0.7214	10
M7	29.3	7.91	288	7.7	67.5	3.0	4.3	14.4	107.3	0.41	2.5	57.6	8.8	110.7	0.7191	10
M8	29.6	7.13	113	7.5	20.6	3.0	2.6	7.7	34.5	0.04	1.9	32.0	10.7	66.1	0.7085	10
M9	25.5	6.62	139	6.4	36.1	1.7	1.5	1.3	58.0	0.07	2.2	7.3	4.6	31.1	0.7096	11
M10	26.7	7.69	345	7.1	86.7	2.9	3.9	11.2	146.2	0.06	3.3	39.3	6.9	98.2	0.7192	9
M11	31.3	6.88	170	5.7	31.8	4.8	1.9	14.8	16.8	0.24	52.5	39.3	21.3	93.8	0.7281	11
M12	29.9	6.11	53	3.9	9.1	2.0	1.2	5.6	8.9	0.04	1.2	28.4	6.7	34.6	0.7095	11
M13	26.2	7.23	174	6.3	21.5	2.6	3.2	25.6	68.0	0.18	3.2	22.9	4.9	344.6	0.7113	10
M14	31.2	6.68	46	7.7	6.7	1.5	0.8	3.1	10.9	0.07	1.1	16.5	7.8	31.3	0.7098	10
M15	24.0	7.86	748	8.2	187.9	5.1	8.4	30.2	330.7	0.03	17.2	86.0	10.7	217.9	0.7196	12
M16	26.8	7.55	384	4.7	92.6	3.3	5.0	17.0	159.0	0.13	2.9	58.6	9.5	124.1	0.7214	10
M17	31.2	6.30	38	7.0	4.3	2.2	1.2	2.2	8.8	0.69	0.4	13.7	7.3	23.9	0.7115	14
M18	30.1	6.98	172	7.6	37.1	3.5	2.2	8.3	54.4	0.03	5.6	33.9	7.3	63.1	0.7093	11
M19	28.4	7.22	114	4.1	8.4	6.8	3.2	9.9	18.3	0.07	3.5	56.7	12.6	95.5	0.7269	12
Lower Reach																
L1	30.4	7.42	299	6.3	64.4	3.8	5.1	19.2	108.7	0.05	4.4	66.8	8.5	152.7	0.7152	12
L2	28.9	7.72	150	6.4	22.7	3.4	3.6	17.3	28.2	0.22	5.7	68.6	8.4	91.1	0.7189	13
L3	29.3	7.79	152	6.3	22.9	3.4	3.6	17.1	29.7	0.10	5.6	71.4	8.2	92.0	0.7184	11
L4	29.9	7.62	157	6.1	24.2	3.6	3.8	18.3	30.1	0.03	6.5	72.3	8.3	94.6	0.7198	11
L5	29.7	6.47	28	6.2	3.7	1.6	0.7	3.5	2.7	0.27	1.1	16.5	5.7	24.3	0.7103	9
L6	30.4	7.64	164	7.1	26.2	3.7	3.9	19.1	32.5	0.04	6.8	74.1	8.4	99.1	0.7198	13

L7	30.4	7.34	152	6.7	24.5	3.5	3.6	17.3	30.4	0.05	6.3	69.0	7.7	93.8	0.7207	96
L8	30.1	6.30	14	7.8	1.3	1.2	0.5	1.1	1.7	0.38	0.8	7.9	4.4	8.7	0.7121	12
L9	27.7	7.59	163	7.6	9.0	2.5	8.8	26.9	16.0	0.52	17.8	96.6	10.0	137.5	0.7182	9
L10	30.6	7.10	208	7.1	50.7	1.5	3.0	8.5	73.4	0.28	5.4	37.5	12.7	50.5	0.7108	9
L11	28.8	7.24	146	6.8	22.2	3.4	3.6	17.4	27.3	0.31	5.8	70.5	8.3	90.2	0.7221	12
L12	31.0	7.18	332	7.2	88.6	1.7	2.5	8.9	136.8	0.03	12.7	31.1	13.3	63.5	0.7109	9
L13	28.7	7.67	128	6.5	31.6	1.3	2.2	3.8	48.7	0.34	1.9	19.2	7.5	35.0	0.7096	10
L14	33.0	7.90	122	7.9	16.3	2.3	2.7	15.6	23.5	0.26	3.0	58.2	7.9	130.4	0.7217	67
L15	29.8	7.90	234	7.8	45.4	3.3	4.5	21.1	63.3	0.29	10.3	74.1	9.9	86.3	0.7189	11
L16	29.2	7.52	152	7.2	24.1	3.3	3.6	17.0	30.9	0.03	5.5	67.3	7.5	92.0	0.7177	8
L17	29.3	7.57	150	6.2	21.9	3.5	3.7	17.5	27.5	0.29	6.0	73.2	8.5	92.9	0.7221	9
L18	29.4	6.92	69	4.0	6.3	6.3	1.8	7.9	9.9	0.24	1.2	39.3	7.9	60.9	0.7094	10
L19	30.6	7.59	155	8.0	24.8	3.5	3.7	17.5	31.5	0.15	5.9	69.0	7.6	92.9	0.7249	9

Note: [1] 2σ represents the double Standard Deviation (2SD). The hydrochemistry data were derived from [1].

Table S2. Descriptive statistics of the detected physicochemical parameters in the MRB.

Parameters	Units	Upper reach (n^1 = 18)				Middle reach (n = 19)				Lower reach (n = 19)			
		Min	Max	Mean	cv%²	Min	Max	Mean	cv%	Min	Max	Mean	cv%
pH		6.8	8.5	7.6	5.6	6.1	8.5	7.3	8.2	6.3	7.9	7.4	6.0
TDS	mg/L	44.2	1456	339.0	98.7	38.4	838.5	314.1	82.4	13.7	331.5	156.5	49.1
DO	mg/L	3.3	11.8	7.0	26.9	3.8	8.7	6.3	23.1	4.0	8.0	6.8	13.8
Na^+	mg/L	2.6	369.6	61.3	146.6	4.3	213.7	73.6	93.7	1.3	88.6	27.9	76.7
K^+	mg/L	2.3	14.1	6.4	53.5	1.5	6.8	3.6	41.9	1.2	6.3	3.0	40.5
Mg^{2+}	mg/L	2.0	16.2	7.5	48.5	0.8	8.4	4.1	62.1	0.5	8.8	3.4	51.7
Ca^{2+}	mg/L	4.6	103.5	31.1	78.7	1.3	43.3	16.1	72.4	1.1	26.9	14.5	47.2
Cl^-	mg/L	2.8	668.5	95.8	167.7	8.8	361.6	122.4	97.0	1.7	136.8	39.6	87.0
NO_3^-	mg/L	0.02	1.0	0.21	143.9	0.03	0.69	0.17	119.7	0.03	0.52	0.20	70.0
SO_4^{2-}	mg/L	0.6	22.6	9.7	70.2	0.4	52.5	11.0	136.3	0.8	17.8	5.9	69.7
HCO_3^-	mg/L	28.4	362.3	130.1	61.9	7.3	92.4	49.7	52.8	7.9	96.6	57.0	42.4
Sr	μg/L	40.5	338.4	165.8	53.6	23.9	344.6	133.3	73.4	8.7	152.7	83.6	43.9
$^{87}Sr/^{86}Sr$		0.709	0.719	0.713	0.42	0.708	0.728	0.717	0.87	0.709	0.725	0.717	0.69

Note: ^{1} *n* represents number of samples. ^{2} cv% represents the percent of the Coefficient of Variance.

Table S3. The results of One-way ANOVA analysis on detected chemical parameters in the MRB.

	Na^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	NO_3^-	SO_4^{2-}	HCO_3^-	Sr
Upper reach									
F	0.002	1.064	0.563	3.611	0.052	0.267	5.497	5.754	6.116
Sig.	0.965	0.318	0.464	0.076	0.822	0.613	0.032*	0.029*	0.025*
Middle reach									
F	4.471	1.226	6.944	4.237	3.866	0.301	0.720	9.629	2.299
Sig.	0.050*	0.284	0.017*	0.055	0.066	0.590	0.408	0.006*	0.148
Lower reach									
F	0.515	0.011	0.435	0.037	0.495	2.827	1.358	0.030	0.024
Sig.	0.483	0.917	0.518	0.850	0.491	0.111	0.260	0.865	0.880

Note: * means that there were significant differences between the concentrations of dissolved ions in the mainstream and those in tributaries. Sig. means the significance value of each ion. Statistical significance was at the level of $p < 0.05$.

References

1. Liu, J.; Han, G.; Liu, X.; Liu, M.; Song, C.; Yang, K.; Li, X.; Zhang, Q. Distributive characteristics of riverine nutrients in the Mun River, northeast Thailand: Implications for Anthropogenic Inputs. *Water* **2019**, *11*, 954.