Supplementary Materials

Occurrence, ecological impact, and exposure risk of emerging contaminant REE in a coastal river

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Table S1 The instrument detection limits for REE

Element	Detection Limit (ng/L)
La	<0.4
Ce	<0.06
Pr	<0.06
Nd	<0.3
Sm	<0.2
Eu	<0.2
Gd	<0.2
Tb	<0.09
Dy	<0.2
Ho	<0.06
Er	<0.2
Tm	<0.08
Yb	<0.3
Lu	<0.05
Y	<0.2

Table S2 Acute-toxicity of REE and the corresponding values of Predicted No Effect Concentration (PNEC) (μg/L)

Rare Earth Elements	Algae		Crustaceans		Fish species		Benthos	PNEC
	Skeletonema costatum	*Chlorella autotrophica*	*Daphnia magna*	*Hyalella azteca*	*Oncorhynchus mykiss*	*Danio rerio*	*Tubifex tubifex*	
	EC50	EC50	LC50	LC50	LC50	LC50	EC50	
Y	3885.01	n.a.	n.a.	549	80640.28	n.a.	7201.79	0.549[a]
La	4054.49	4051.71	24029.70	1665	68311.02	83812.26	10556.40	1.665[a]
Ce	4158.17	4030.68	21960.68	651	54330.78	n.a.	11936.52	0.651[a]
Pr	n.a.	n.a.	9003.51	441	n.a.	n.a.	10637.95	0.441[a]
Nd	4375.03	4158.73	1384.32	511	34752.20	n.a.	10382.40	0.511[a]
Sm	4313.47	4348.06	7580.16	846	67243.84	n.a.	10362.56	0.846[a]
Eu	4432.32	n.a.	n.a.	717	n.a.	n.a.	11156.80	0.717[a]
Gd	4685.97	4556.98	6716.71	599	36619.44	64901.98	11577.28	0.599[a]
Tb	4533.42	4754.29	n.a.	693	n.a.	n.a.	13442.94	0.693[a]
Dy	4593.88	4719.00	9165.00	897	n.a.	n.a.	13585.00	0.897[a]
Ho	4829.92	4945.35	n.a.	755	n.a.	n.a.	11773.86	0.755[a]
Er	4794.82	4759.69	n.a.	929	81809.70	n.a.	13835.71	0.929[a]
Tm	4866.01	4938.64	n.a.	739	n.a.	n.a.	13934.25	0.739[a]
Yb	4935.69	5011.81	n.a.	278	n.a.	46415.90	13857.30	0.278[a]
Lu	5008.50	5152.00	n.a.	1054	n.a.	n.a.	15400.00	1.054[a]
ΣREE	1468		4774		n.a.	n.a.	n.a.	1.468[b]

n.a.: not available; PNEC is computed on the basis of acute toxicity data in algae, crustaceans, fish, and benthos. The minimum level is selected and then divided by the evaluation factor (=1000), [a] means the values is cited from Gu et al. (2020), [b] means the value is cited from Lachaux et al. (2022).

Table S3 The exposure parameters and values used in human health risk assessment

Parameters	Units	Children	Adult females	Adult males	Reference
Ingestion rate (IR)	mg/day	1.5	2.66	3.62	Liu et al. (2024)
Exposure frequency (EF)	day/year	365	365	365	Liu et al. (2024)
Exposure duration (ED)	year	6	30	30	Liu et al. (2024)
Average bodyweight (BW)	kg	25.9	64.0	73.0	Liu et al. (2024)
Average exposure time (AT)	day	2190	10950	10950	Sun et al. (2017)

Table S4 Concentration (mg/L) of ions in the Jiulong river water

Sampling sites	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	NO_3^-	SO_4^{2-}	HCO_3^-
N1	1.5	1.1	1.9	0.3	1.1	1.8	2.0	8.8
N2	2.2	1.7	2.7	0.6	1.2	3.0	3.7	12.4
N3	3.0	2.6	5.1	1.1	1.5	7.0	7.8	15.9
N4	21.4	5.6	43.6	8.0	28.5	14.1	71.5	84.9
N5	6.7	3.3	14.4	2.9	6.6	7.9	23.2	30.6
N6	2.9	2.8	18.5	3.1	2.5	6.2	13.3	50.8
N7	2.3	2.8	12.4	1.9	2.2	6.3	8.8	31.3
N8	2.9	2.8	19.2	3.1	2.6	6.6	14.4	48.3
N9	11.1	3.8	23.5	5.9	10.2	6.8	49.3	51.7
N10	7.4	3.6	16.8	3.2	8.3	7.7	23.0	34.8
N11	2.5	2.1	19.3	2.6	2.0	3.2	4.5	61.9
N12	12.7	3.9	17.1	3.1	7.1	8.2	34.6	34.1
N13	2.9	2.6	4.4	0.4	1.6	4.7	3.7	15.4
N14	10.9	4.7	18.1	3.3	7.1	10.6	36.1	32.2
N15	8.6	4.3	22.3	3.2	8.6	11.3	29.7	35.9
N16	5.6	2.9	7.0	1.3	2.5	11.2	3.8	23.0
N17	9.4	5.0	18.3	3.0	7.3	11.3	31.0	33.3
N18	7.4	4.3	15.3	2.3	5.4	10.2	22.1	30.1
N19	8.0	4.5	16.2	2.5	6.0	10.6	24.5	30.1
N20	7.9	4.1	15.6	2.4	6.3	10.3	23.7	28.3
N21	10.2	5.5	13.6	2.6	9.1	14.7	8.4	39.3
N22	9.9	4.6	17.5	2.7	9.5	12.0	23.9	32.2
N23	9.2	4.7	18.0	2.8	10.0	11.9	24.2	33.3
W1	4.5	3.8	8.2	1.2	2.6	5.1	4.2	39.3
W2	20.0	4.8	9.3	1.5	22.6	8.8	7.1	34.0
W3	5.1	3.6	7.7	1.1	3.1	12.2	4.9	37.1
W4	9.6	5.0	12.0	1.8	6.8	8.0	10.3	48.1
W5	11.2	8.7	19.0	4.1	12.9	52.0	17.5	22.5
W6	13.8	8.2	18.3	3.9	12.9	44.6	16.8	30.6
W7	14.7	5.0	13.5	1.6	9.5	8.9	10.7	55.4
W8	12.2	7.7	16.0	3.0	10.0	32.2	16.5	34.5
W9	19.8	9.2	19.9	3.4	23.6	20.5	20.8	54.5
W10	23.4	10.0	20.4	4.0	28.3	25.6	22.7	48.6
S1	10.6	6.3	14.5	2.9	9.4	13.1	7.5	55.4
S2	17.8	6.6	13.8	3.3	20.4	16.7	8.8	39.8
S3	30.0	8.5	14.8	4.9	42.0	15.3	15.1	43.7
S4	3133.6	116.0	102.4	360.7	5543.2	11.8	737.7	81.7
E1	87.9	10.9	22.8	12.1	139.2	19.2	39.7	50.8
E2	1620.0	58.7	58.6	182.6	2790.7	14.4	386.3	68.6
E3	1542.7	59.1	54.7	171.9	2694.2	14.5	373.0	67.8
E4	1742.7	68.2	64.8	206.5	3089.8	13.7	424.7	69.0
E5	231.0	17.5	28.2	28.6	424.2	14.3	83.2	49.5

Table S5 Concentration (ng/L) and geochemical parameters of REE in the Jiulong river water

		La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Y	LREE	MREE	HREE	REE	$(La/Yb)_N$	δCe	δEu
North River	min	3	3	1	4	1	2	1	0	1	0	1	0	1	0	9	13	7	2	23	0.10	0.14	0.76
	max	703	955	155	596	123	19	133	19	103	21	61	8	56	9	658	2049	396	151	2460	1.00	0.88	16.95
	average	118	100	27	107	22	6	23	3	19	4	13	2	12	2	125	351	74	33	459	0.47	0.49	5.12
	median	35	30	8	31	6	5	8	1	7	2	6	1	6	1	58	102	26	15	147	0.40	0.47	3.38
West River	min	14	14	5	20	6	6	8	2	8	3	8	2	9	2	83	53	30	23	105	0.10	0.18	0.91
	max	530	618	116	460	90	18	108	17	106	24	77	11	71	11	854	1557	339	195	2091	0.67	0.84	3.69
	average	223	255	51	198	41	13	48	8	49	12	37	5	35	6	379	727	159	95	980	0.42	0.53	2.04
	median	178	205	41	171	36	13	49	7	47	11	33	5	31	5	331	562	159	84	843	0.47	0.5	1.74
South River	min	17	14	3	12	4	47	4	1	3	1	4	1	5	1	56	47	74	11	131	0.08	0.19	11.67
	max	180	70	39	164	32	99	32	6	30	7	25	3	27	7	256	454	178	65	697	0.54	0.65	86.78
	average	71	39	14	61	13	72	16	2	14	4	15	2	18	4	127	185	117	43	345	0.30	0.42	44.72
	median	44	35	7	34	8	71	14	2	12	5	15	2	19	3	97	120	108	48	276	0.29	0.43	40.22
Estuary	min	10	9	2	10	3	5	4	0	4	2	5	1	5	1	42	30	17	13	60	0.05	0.51	3.99
	max	21	26	4	26	6	41	16	2	18	6	21	3	23	4	83	73	83	58	214	0.15	0.73	23.9
	average	16	20	3	18	4	13	10	1	10	3	11	2	12	2	68	57	38	31	126	0.11	0.60	9.73
	median	16	19	4	19	4	6	9	1	9	3	10	1	10	2	75	63	30	27	122	0.11	0.52	6.28
Whole River	min	3	3	1	4	1	2	1	0	1	0	1	0	1	0	9	13	7	2	23	0.05	0.14	0.76
	max	703	955	155	596	123	99	133	19	106	24	77	11	71	11	854	2049	396	195	2460	1.00	0.88	86.78
	average	126	122	29	114	23	15	27	4	25	6	18	3	18	3	179	390	94	49	533	0.40	0.50	8.71
	median	35	35	8	37	7	6	11	1	9	3	10	2	10	2	77	118	39	26	177	0.37	0.48	3.69

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