

Multivariate Statistical Analysis of Hydrochemical Data and Stable Isotopes of Groundwater Contaminated with Nitrate at Huay Sai Royal Development Study Center and Adjacent Areas in Phetchaburi Province, Thailand

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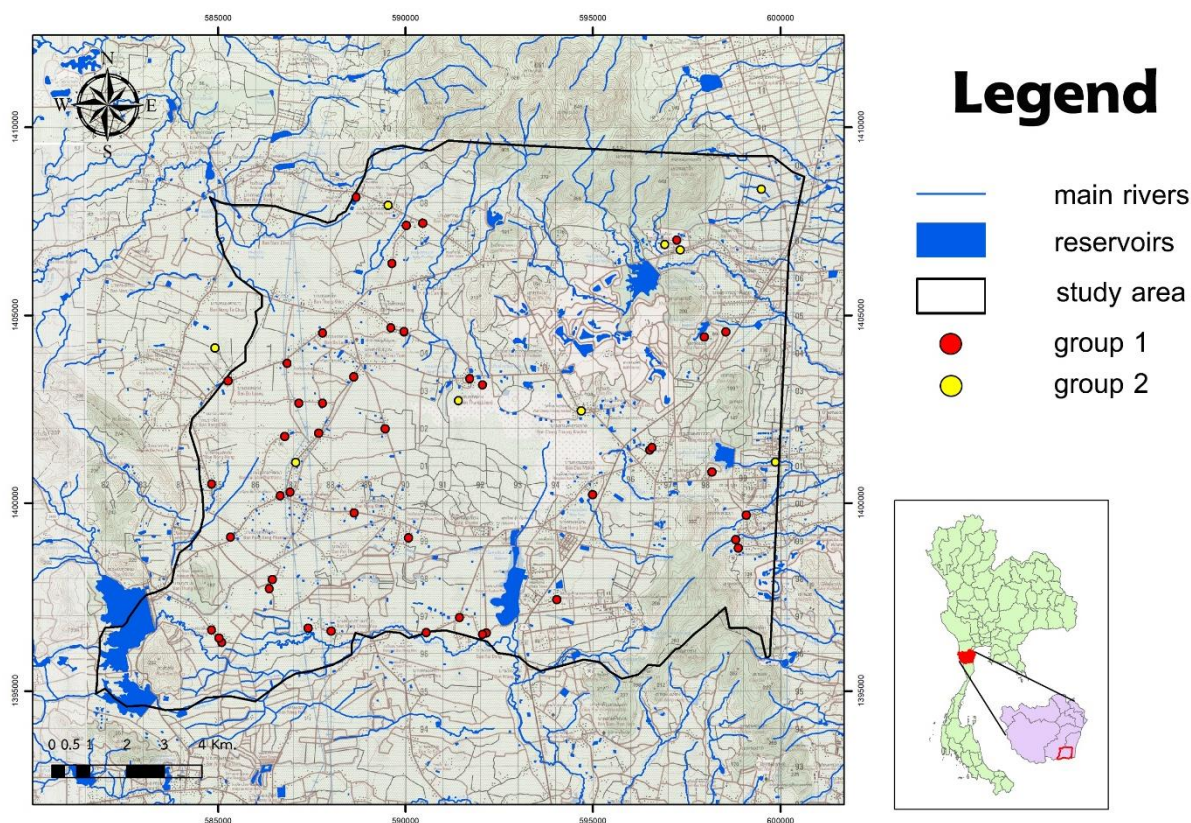


Figure S1 Locations of groundwater wells that were distributed by isotope data ($\delta^{18}\text{O}$, $\delta^2\text{H}$).

Table S1 The measured field parameters of groundwater samples in the both season.

Station	Longitude	Latitude	Surface Elevation (m, amsl)	Rainy season						Summer Season					
				GW level (m, amsl)	Temp (°C)	pH	EC (μS/cm)	TDS (mg/L)	ORP (mV)	GW level (msl)	Temp (°C)	pH	EC (μS/cm)	TDS (mg/L)	ORP (mV)
1	99°48'58.29"	12°41'36.07"	54	-	27.5	7.04	1291	689	170.1	-	27.5	7.74	789	524	135.5
2	99°48'30.60"	12°41'13.47"	59	-	29	7.53	759	405	107.4	-	24	7.37	555	367	197.7
3	99°48'9.64"	12°41'13.60"	60	-	29.5	6.99	1394	741	117.7	47.1	27	7.31	793	524	193.4
4	99°49'1.04"	12°44'11.92"	81	-	27	6.88	1464	783	153.5	-	28	7.26	1113	743	34.6
5	99°49'28.94"	12°44'4.64"	92	-	28.5	6.75	165.2	88	-148.3	-	27	6.71	226	151	-139.3
6	99°49'59.66"	12°43'49.02"	100	-	28	6.93	1388	741	56.5	77.3	29	7.38	645	521	23.5
7	99°49'45.13"	12°43'47.30"	104	97.40	29	6.86	1125	599	98.5	-	27	7.52	635	420	188.3
8	99°49'32.39"	12°43'14.47"	79	-	27	7.12	1941	1036	142.3	-	26	7	2120	1130	-136.9
9	99°49'31.21"	12°42'18.52"	68	-	28	6.88	1669	891	92.5	64.4	28	7.21	778	533	-78.7
10	99°49'42.78"	12°42'15.33"	45	39.2	32.5	8.67	1012	539	54.5	37.09	27	7.73	1342	897	77.3
11	99°47'7.24"	12°41'32.86"	56	-	29.5	6.92	1184	639	124.4	-	27	7.6	753	499	155.4
12	99°50'30.92"	12°41'15.21"	50	44	29.1	6.76	175	93.3	-1.5	47.50	29	7.98	1209	797	-68.4
13	99°48'30.86"	12°42'14.14"	69	57.07	27.9	7.25	2000	1790	-14.1	-	30	7.67	826	777	106.8
14	99°47'59.34"	12°41'47.94"	59	48.85	28.2	7.22	780	417	93.1	50.50	28	7.28	463	308	13.4
15	99°50'41.06"	12°41'34.39"	56	55.49	29	7.12	931	496	138.1	-	25	8.22	1026	661	68.2
16	99°50'52.31"	12°41'28.95"	61	53.51	29.1	7.19	1476	791	110.8	54.50	30.4	7.4	877	633	146.7
17	99°49'25.96"	12°40'51.16"	48	36.67	30.5	6.91	950	506	103.1	37.80	30.5	6.88	835	445	248.8
18	99°48'27.10"	12°40'47.47"	61	-	26.3	7.01	1220	650	171.4	-	27	6.82	1133	604	204.4
19	99°46'52.28"	12°40'3.55"	56	50.02	31	7.37	807	430	86.6	52.80	30	8.07	531	355	84.7
20	99°47'20.94"	12°41'13.64"	60	-	29	6.81	1033	552	95.9	-	29	6.81	1033	552	95.9
21	99°47'56.86"	12°40'44.50"	64	-	28	7.01	1075	577	-2.5	-	29	7.07	1023	545	197.9
22	99°48'6.77"	12°40'22.21"	64	-	28	6.27	1046	554	53.6	-	27	6.6	903	481	-29.7
23	99°48'1.55"	12°39'56.51"	69	-	27	7.11	1353	721	82.2	-	27	7.1	1253	668	181.2
24	99°47'52.98"	12°39'53.41"	67	-	27.7	7.12	1357	726	-120.5	-	26	7.14	1275	681	118.7
25	99°47'9.12"	12°39'17.64"	74	-	32	7.31	2320	1240	86.3	71.70	27	7.77	1376	905	-21.2

Table S1 *conj.*

Station	Longitude	Latitude	Surface Elevation (m, amsl)	Rainy season						Summer Season					
				GW level (m, amsl)	Temp (°C)	pH	EC (μS/cm)	TDS (mg/L)	ORP (mV)	GW level (msl)	Temp (°C)	pH	EC (μS/cm)	TDS (mg/L)	ORP (mV)
26	99°47'45.70"	12°38'40.55"	53	49	29.5	6.97	1347	720	70.5	50.10	28	7.41	824	551	118.8
27	99°47'43.19"	12°38'32.84"	69	-	28	7.2	1241	658	-156.1	-	27	9.18	950	638	179.5
28	99°46'58.21"	12°37'50.26"	76	-	29.5	7.28	1323	705	-50.6	71.50	27.5	8.31	153.5	96.4	154.5
29	99°46'51.80"	12°37'56.96"	83	-	26	7.36	1318	703	54	79.10	28.5	7.56	741	494	-31.7
30	99°47'0.78"	12°37'46.35"	117	113.43	32	7.59	161.9	86	80.8	87.00	27.5	8.31	153.5	964	154.5
31	99°48'17.12"	12°37'58.30"	68	-	27	7.16	1119	599	133.9	63.10	29	7.62	659	443	212.5
32	99°48'37.57"	12°37'55.83"	70	-	28.5	6.69	1050	559	-47.9	66.69	28	7.41	981	655	153.5
33	99°50'1.76"	12°37'54.36"	58	-	26	7.09	806	428	-65.4	-	27	6.88	773	411	193.3
34	99°50'14.56"	12°37'58.82"	58	-	28.5	6.83	995	529	84.1	-	28	7.21	895	429	84.1
35	99°49'46.11"	12°39'16.44"	66	-	28.5	7.31	1260	671	132	51.30	27.5	6.84	1218	650	-27.9
36	99°48'58.05"	12°39'38.24"	63	-	30	7.1	1294	690	28.7	55.70	29	188.6	1213	647	188.6
37	99°50'31.13"	12°38'7.32"	56	-	26	6.84	1062	568	-175	43.50	29	6.69	399	266	190.5
38	99°50'54.82"	12°37'53.68"	40	30	28.5	6.33	1118	594	-91.8	30.82	28.5	7.6	254	170	-297.9
39	99°50'51.37"	12°37'52.58"	55	-	27.2	6.91	1248	668	47.4	-	31	6.87	523	349	145.7
40	99°52'19.26"	12°41'6.11"	58	-	26	7.87	343	183	97.2	-	26	8.03	544	289	166.2
41	99°53'7.68"	12°39'51.60"	54	47.78	26	7.01	2140	1280	108.1	51.55	30	7.58	912	486	145.9
42	99°53'30.75"	12°40'9.46"	73	-	26.5	7.19	1229	658	-93.4	-	27.5	7.03	1429	658	-123.4
43	99°53'21.68"	12°40'33.97"	58	-	29	7.76	354	664	75.3	53.10	29	6.94	2410	1290	195.6
44	99°53'19.98"	12°40'31.79"	59	-	29.9	6.95	1660	886	115	33.95	31.5	7.17	1631	871	170.9
45	99°53'9.58"	12°38'58.18"	83	-	28.3	6.82	1316	705	-24.6	-	29	7.01	1456	723	-28.46
46	99°51'57.27"	12°38'22.55"	50	32	27.5	7.25	1539	821	-115.7	37.25	29	7.35	1575	842	217.3
47	99°52'29.13"	12°39'53.45"	62	-	28	7.8	4270	2430	118.1	-	28	7.46	4450	2490	57.2
49	99°54'44.78"	12°39'35.23"	51	-	25	7.21	1119	595	140.4	-	30	6.98	1340	716	251.1
50	99°54'35.46"	12°39'14.00"	55	-	24.9	7.43	1980	1050	76.4	39.30	32	7.44	1623	864	225.8
51	99°54'37.88"	12°39'6.80"	51	-	25.8	7.25	2340	1250	171.1	-	31	7.13	2070	1110	222.8

Table S1 *conj.*

Station	Longitude	Latitude	Surface Elevation (m, amsl)	Rainy season						Summer Season					
				GW level (m, amsl)	Temp (°C)	pH	EC (µS/cm)	TDS (mg/L)	ORP (mV)	GW level (msl)	Temp (°C)	pH	EC (µS/cm)	TDS (mg/L)	ORP (mV)
52	99°54'14.58"	12°40'12.66"	58	-	29	7.95	961	513	41.9	30.00	31	7.68	416	278	139.6
53	99°54'59.09"	12°44'17.68"	21	15.33	29.2	7.67	741	395	-163.6	-	30.5	7.22	653	225	-133.6
54	99°53'47.24"	12°43'25.23"	50	46.10	28.7	7.21	1308	698	-49.7	44.70	28	8.18	742	1111	116.3
55	99°54'27.28"	12°42'13.97"	46	31	30	6.92	1251	665	101.1	-	30	6.99	564	380	32.3
56	99°54'8.30"	12°42'9.80"	45	27.29	31.5	7.15	1200	639	-18.2	-	30	7.34	503	332	-58.6
57	99°55'11.03"	12°40'21.03"	33	-	32	7.32	1455	778	16.1	-	29.5	7.91	436	291	182
58	99°53'33.67"	12°43'30.09"	63	58	27.7	7.08	1458	778	-134.2	-	28	7.48	1175	748	43.7
59	99°53'44.39"	12°43'33.90"	53	46.23	28.5	6.94	1710	916	99.5	-	31	7.68	71	519	159
61	99°46'55.53"	12°42'1.70"	56	-	28.5	6.85	1542	822	86.2	45.30	28.5	6.85	1542	822	86.2
64	99°49'42.87"	12°42'14.90"	130	-	29	7.53	1165	619	54.5	125.4	28	8.02	915	611	33.7

Table S2 The hydrogeochemical and isotopic of groundwater samples in the rainy season (*NO₃⁻ concentration in the summer season)

Station	Hydrogeochemistry (mg/L)											Isotope (‰)	
	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺	Cl ⁻	Br ⁻	NO ₃ ⁻	NO ₃ ^{-*}	SO ₄ ²⁻	CO ₃ ²⁻	HCO ₃ ⁻	δ ¹⁸ O	δD
1	135.64	13.44	219.30	41.42	0.42	n.a.	0.03	3.3	n.a.	2.00	100	-5.90	-41.15
2	60.92	5.52	67.75	29.37	60.11	2.11	0.08	1.155	10.17	n.a.	66	-6.13	-43.52
3	90.02	8.78	117.20	47.95	169.62	3.60	2.32	1.485	32.47	n.a.	78	-7.86	-54.09
4	91.61	12.84	154.40	39.66	214.74	3.38	5.86	1.32	11.65	n.a.	64	-6.51	-46.39
5	17.38	7.51	0.73	11.51	26.46	0.48	0.11	n.a.	0.36	n.a.	10	-7.52	-51.92
6	79.97	10.96	45.25	49.18	209.89	3.59	0.89	1.98	4.20	n.a.	66	-3.02	-27.80
7	81.72	7.57	33.08	39.12	1.12	n.a.	n.a.	2.64	0.04	n.a.	64	-7.48	-51.05
8	154.32	35.59	101.23	83.91	293.14	5.51	0.11	5.00	0.34	8.00	100	-7.79	-53.09
9	155.38	25.40	57.70	41.24	225.23	4.31	2.06	2.64	7.68	n.a.	108	-7.97	-54.83
10	90.95	17.64	42.85	14.55	164.06	2.00	8.62	1.98	13.99	n.a.	56	-8.30	-56.46
11	82.15	8.46	93.95	44.58	83.37	3.09	5.31	1.32	8.16	8.00	102	-5.82	-41.54
12	32.52	9.22	5.84	7.67	97.41	2.18	8.76	1.785	28.89	6.00	34	-7.63	-52.40
13	179.40	24.52	95.90	54.02	291.27	4.57	0.90	2.499	8.24	n.a.	114	-7.86	-53.52
14	26.5	7.79	114.10	28.75	45.86	2.12	0.58	n.a.	5.66	4.00	70	-6.55	-42.74
15	63.44	15.37	92.35	31.01	132.88	2.20	0.08	1.785	25.09	n.a.	64	-7.73	-53.03
16	93.66	7.54	81.00	30.63	149.87	2.90	1.42	n.a.	46.59	4.00	134	-7.90	-54.13
17	66.14	9.45	111.20	35.59	66.01	2.34	0.25	n.a.	5.60	8.00	84	-6.53	-45.02
18	97.6	1.73	48.10	33.55	97.66	2.80	11.79	1.98	8.72	n.a.	84	-7.84	-53.58
19	116.42	57.93	18.84	25.52	136.10	1.51	46.85	1.815	6.29	n.a.	40	-8.08	-54.95
20	133.60	9.03	53.90	34.64	73.73	2.45	5.96	n.a.	10.03	6.00	92	-7.95	-53.67
21	98.53	8.83	59.55	39.25	92.84	2.57	11.00	1.65	12.14	n.a.	76	-7.99	-54.23
22	103.45	13.41	7.44	18.90	148.29	1.73	0.25	1.98	22.34	n.a.	38	-7.99	-53.89
23	77.25	12.14	36.13	48.38	189.86	3.57	4.95	1.98	14.61	n.a.	72	-7.62	-51.92
24	96.76	11.50	54.35	45.79	190.59	3.66	7.01	2.64	13.84	n.a.	72	-7.55	-50.86
25	160.85	2.64	71.13	99.86	345.26	5.95	2.51	3.96	0.51	n.a.	120	-7.45	-50.85
26	195.90	7.75	47.80	48.92	117.90	3.38	0.64	1.98	22.82	4.00	114	-7.70	-53.01
27	96.07	9.58	49.85	52.85	85.68	2.65	5.86	1.32	23.82	n.a.	84	-7.71	-52.95

Table S2 *conj.*

Station	Hydrogeochemistry (mg/L)										Isotope (‰)		
	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺	Cl ⁻	Br ⁻	NO ₃ ⁻	NO ₃ ^{-*}	SO ₄ ²⁻	CO ₃ ²⁻	HCO ₃ ⁻	δ ¹⁸ O	δD
28	125.20	5.39	17.00	44.92	145.73	2.99	0.16	0.33	0.17	6.00	110	-7.92	-54.27
29	172.25	6.33	27.80	32.90	21.75	3.08	n.a.	2.64	7.92	10.00	142	-8.07	-55.39
30	16.93	5.21	3.86	4.47	18.23	0.41	n.a.	0.33	0.52	n.a.	10	-8.43	-56.75
31	117.12	7.74	50.85	44.34	38.60	2.61	0.37	1.32	12.80	6.00	96	-8.22	-54.97
32	76.49	7.52	65.53	42.10	165.46	2.56	12.76	0.66	14.69	n.a.	70	-7.71	-52.26
33	78.58	6.35	41.83	28.34	37.75	2.05	0.17	0.495	10.17	n.a.	70	-8.00	-54.22
34	96.02	9.90	48.25	37.66	81.66	2.57	2.83	n.a.	8.25	n.a.	86	-7.36	-50.61
35	49.91	8.72	83.35	43.86	81.41	2.29	1.40	3.213	5.12	n.a.	66	-7.94	-53.22
36	124.20	7.32	105.75	58.99	135.93	3.12	7.72	n.a.	9.78	n.a.	130	-7.98	-54.39
37	97.61	9.86	29.45	39.15	63.43	2.50	2.13	1.428	7.86	n.a.	64	-8.22	-55.71
38	103.14	11.67	76.75	43.12	75.00	2.95	0.06	2.142	1.04	n.a.	92	-8.29	-55.94
39	88.30	12.31	44.90	51.80	83.21	3.21	0.67	1.428	5.79	n.a.	94	-7.10	-48.61
40	54.86	16.47	46.00	6.23	12.50	0.79	0.92	n.a.	3.51	n.a.	34	-8.01	-54.27
41	285.90	34.22	78.95	20.69	314.97	4.75	49.74	3.927	103.36	n.a.	116	-7.77	-53.31
42	118.22	7.88	107.0	21.08	143.59	2.74	0.58	2.856	3.11	n.a.	82	-8.05	-54.58
43	106.32	23.28	47.05	10.45	88.74	1.55	0.03	n.a.	13.63	n.a.	48	-7.70	-52.19
44	159.54	26.64	190.70	32.05	246.78	4.23	4.57	2.678	2.89	n.a.	114	-7.12	-49.11
45	128.94	8.05	158.25	21.79	154.83	2.54	22.44	6.069	18.89	n.a.	86	-6.61	-46.05
46	173.20	16.86	166.55	30.67	229.50	4.20	0.20	n.a.	3.54	n.a.	102	-7.30	-49.97
47	685.20	22.29	76.35	31.16	528.09	8.83	1.91	n.a.	101.70	18.00	212	-7.19	-49.35
49	166.80	8.41	99.45	23.79	131.09	3.70	16.55	2.499	0.32	n.a.	66	-5.60	-43.32
50	324.95	2.70	165.40	43.10	296.37	4.37	4.39	1.071	55.80	n.a.	102	-7.93	-55.12
51	92.48	7.15	226.95	36.72	327.79	4.20	13.62	n.a.	202.20	14.00	98	-7.20	-49.47
52	67.16	6.76	134.20	15.37	45.81	2.55	2.87	1.785	15.21	4.00	88	-7.16	-49.78
53	78.34	14.25	94.05	8.75	109.67	1.60	4.59	1.964	11.84	2.00	44	-7.97	-54.73
54	184.06	5.37	69.20	12.52	149.27	2.61	0.05	1.428	51.37	6.00	58	-4.35	-33.65
55	84.16	2.39	101.50	21.94	164.24	3.10	n.a.	0.714	2.14	n.a.	60	-5.53	-36.36

Table S2 *conj.*

Station	Hydrogeochemistry (mg/L)										Isotope (‰)		
	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺	Cl ⁻	Br ⁻	NO ₃ ⁻	NO ₃ ^{-*}	SO ₄ ²⁻	CO ₃ ²⁻	HCO ₃ ⁻	δ ¹⁸ O	δD
56	87.52	6.26	149.40	21.64	160.61	2.93	n.a.	2.499	47.06	n.a.	56	-7.74	-52.44
57	171.20	11.17	99.45	21.99	211.76	2.81	2.96	1.785	10.77	n.a.	76	-7.39	-50.66
58	288.35	2.24	25.45	0.30	179.85	3.11	6.14	2.142	26.05	n.a.	104	-7.29	-49.00
59	64.26	2.29	117.70	19.96	256.50	3.83	n.a.	n.a.	38.88	n.a.	94	-7.87	-54.23
61	183.64	7.89	147.95	53.84	146.15	4.17	8.36	n.a.	16.58	n.a.	110	-8.52	-58.02
64	95.45	11.51	40.05	9.54	171.40	2.30	5.89	2.64	86.53	n.a.	60	-5.37	-41.69