

Supplementary Material

Evaluation of Temporal Contribution of Groundwater to a Small Lake through Analyses of Water Quantity and Quality

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Table S1. On-site water quality parameters and major ion concentrations for surface waters (S1-S3).

Site	Sampling time	DO (mg/L)	Eh (mv)	pH	EC (µS/cm)	Alk (mg/L as CaCO ₃)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Si (mg/L)	Cl (mg/L)	NO ₃ (mg/L)	SO ₄ (mg/L)	CBE
DL							0.02	0.1	0.1	0.01	0.03	0.03	0.03	0.02	
S1	Oct. 19, 2018	9.7	N/A	8.1	306.2	100.0	40.5	6.9	5.3	5.7	5.0	6.9	3.4	22.2	1.1
	Nov. 16, 2018	N/A	451.1	8.1	359.3	112.0	43.5	6.8	4.8	5.1	2.0	4.3	<DL	65.6	-10.4
	Dec. 21 2018	N/A	205.7	7.1	389.1	109.7	50.3	7.6	5.3	4.9	0.1	11.9	3.3	37.4	-0.9
	Jan. 07, 2019 ^a	N/A	N/A	N/A	N/A	30.9	8.3	1.1	1.2	1.8	0.2	2.9	0.5	5.9	-17.9
	Feb. 27, 2019	13.3	399.9	8.4	365.8	92.3	57.0	7.8	5.4	4.3	<DL	12.9	2.0	42.8	8.6
	Mar. 16, 2019	12.8	332.9	8.8	485.3	119.8	56.7	7.9	5.4	4.2	<DL	11.7	0.5	38.6	3.8
	Apr. 20, 2019	11.4	373.6	8.5	717.8	116.0	51.5	8.1	5.4	3.8	<DL	12.2	<DL	37.8	1.7
	May. 18, 2019	9.4	391.4	8.7	332.4	89.5	47.3	7.9	5.4	3.5	0.0	12.2	<DL	34.4	8.2
	Jun. 19, 2019	7.1	N/A	8.0	386.1	109.9	37.4	7.6	5.4	3.6	0.7	12.1	<DL	27.6	-5.3
	Aug. 03 2019	7.3	387.3	7.8	356.9	97.8	38.1	7.4	5.2	4.8	1.6	13.6	1.7	23.7	-1.9
S2	Oct. 19, 2018	8.1	N/A	7.7	298.0	102.0	41.3	7.1	5.3	5.7	5.2	7.7	3.2	23.8	0.6
	Nov. 16, 2018	N/A	462.2	8.1	338.1	113.8	45.0	7.1	5.4	5.1	2.3	3.6	<DL	56.4	-5.7
	Dec. 21 2018	N/A	222.9	8.4	327.6	106.0	50.7	7.4	5.1	4.7	<DL	11.8	3.0	37.4	0.3
	Jan. 07, 2019 ^a	N/A	N/A	N/A	N/A	39.9	21.0	7.5	7.9	10.6	0.2	21.6	4.9	42.5	-7.8
	Feb. 27, 2019	12.9	390.1	8.6	366.0	114.0	58.6	7.9	5.3	4.2	<DL	10.1	2.3	39.0	5.2
	Mar. 16, 2019	13.0	326.0	8.8	395.9	121.0	55.8	7.7	5.3	4.1	<DL	11.8	0.5	40.0	1.9
	Apr. 20, 2019	10.2	399.9	8.7	326.3	104.0	50.6	7.9	5.4	3.9	0.0	12.1	0.1	38.0	4.5
	May. 18, 2019	8.2	320.4	8.2	806.7	97.7	47.5	8.0	5.6	3.7	0.1	12.2	0.1	34.9	5.4
	Jun. 19, 2019	7.8	N/A	7.8	1241.0	102.0	36.7	7.3	5.2	3.4	0.7	12.1	<DL	28.0	-4.2
	Aug. 03 2019	9.4	379.8	8.3	300.6	98.0	37.8	7.5	5.2	4.2	1.7	12.5	1.9	22.9	-1.7
S3	Oct. 19, 2018	6.5	N/A	7.5	298.6	103.9	39.1	7.0	5.2	5.9	5.2	9.7	4.8	31.4	-7.5
	Nov. 16, 2018	N/A	443.1	7.7	336.2	116.2	44.2	7.1	5.4	5.3	2.4	10.8	3.3	34.9	-6.9
	Dec. 21 2018	N/A	244.9	8.0	353.9	103.8	48.3	7.2	5.0	4.8	<DL	12.8	3.3	33.7	-0.6
	Jan. 07, 2019	N/A	253.9	9.3	356.5	118.0	53.3	7.7	5.4	4.8	<DL	12.3	3.1	38.7	1.6
	Feb. 27, 2019	12.8	392.5	8.5	360.3	105.9	57.0	7.8	5.4	4.2	<DL	12.9	2.0	43.2	4.2
	Mar. 16, 2019	12.4	353.0	9.0	347.2	137.0	55.5	7.8	5.3	4.2	<DL	11.5	0.5	37.6	-2.0
	Apr. 20, 2019	10.0	363.0	8.8	339.7	98.2	48.1	8.0	5.5	4.0	0.0	12.2	<DL	37.9	5.0
	May. 18, 2019	9.2	322.0	8.8	531.8	89.8	46.9	8.1	5.6	3.8	<DL	12.2	<DL	34.5	8.3
	Jun. 19, 2019	9.7	N/A	8.7	364.9	80.0	35.9	7.5	5.5	3.6	0.7	12.4	<DL	27.9	4.0
	Aug. 03 2019	5.5	386.5	7.7	309.5	104.0	39.5	7.7	5.4	5.5	1.8	14.6	2.9	24.8	-4.0

DL: Detection limit, N/A: Not applicable. DO = dissolved oxygen, EC = electrical conductivity, Alk = alkalinity, CBE = charge balance error. CBE was calculated using the PHREEQC geochemical modeling program [1] with PHREEQC database. ^aBecause the lake was covered with a thick sheet of ice in January 2019, samples were collected from the ice layer and analyzed after melting at the laboratory (sample S3 was not frozen since it was located at the surface water outlet).

Table S2. On-site water quality parameters and major ion concentrations for groundwaters (G1-G4).

Site	Sampling time	DO (mg/L)	Eh (mv)	pH	EC (µS/cm)	Alk (mg/L as CaCO ₃)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Si (mg/L)	Cl (mg/L)	NO ₃ (mg/L)	SO ₄ (mg/L)	CBE
DL							0.02	0.1	0.1	0.01	0.03	0.03	0.03	0.02	
G1	Oct. 19, 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Nov. 16, 2018	N/A	N/A	N/A	N/A	115.9	49.6	7.0	5.8	3.0	3.6	13.6	0.2	40.5	-1.8
	Dec. 21 2018	N/A	244.9	7.4	321.3	108.2	53.5	7.0	6.0	1.7	4.3	22.5	0.2	43.5	-1.3
	Jan. 07, 2019	N/A	386.4	7.8	355.1	107.9	52.6	6.8	5.6	1.9	3.1	15.1	0.9	39.8	0.6
	Feb. 27, 2019	6.4	413.9	7.2	344.0	74.1	52.0	6.8	5.6	1.8	2.4	14.6	5.2	40.0	5.6
	Mar. 16, 2019	6.6	324.0	7.1	441.6	109.7	52.4	6.7	5.7	2.1	2.2	13.4	4.0	40.7	-3.3
	Apr. 20, 2019	7.7	366.0	7.2	520.2	99.5	51.4	6.4	5.8	1.9	2.3	13.2	4.3	39.4	-1.6
	May. 18, 2019	7.2	322.7	7.4	406.8	103.9	54.3	7.0	6.3	2.1	3.0	13.1	5.9	37.8	-0.6
	Jun. 19, 2019	5.4	N/A	6.9	576.7	107.8	56.9	7.6	3.8	1.0	7.2	7.8	2.4	84.2	-8.8
	Aug. 03 2019	7.3	352.1	7.2	347.3	51.9	39.8	5.4	3.2	1.2	7.9	8.9	3.9	76.2	-10.4
G2	Oct. 19, 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Nov. 16, 2018	N/A	N/A	N/A	N/A	47.9	50.5	7.1	6.7	2.4	6.0	18.7	7.6	57.1	4.8
	Dec. 21 2018	N/A	263.1	6.9	368.0	86.0	57.7	7.5	6.9	1.4	7.4	20.3	25.3	48.7	-14.8
	Jan. 07, 2019	N/A	305.9	7.4	384.7	70.9	54.7	7.5	6.9	1.4	7.3	20.9	23.3	47.5	-12.0
	Feb. 27, 2019	7.0	408.6	7.1	360.7	46.0	52.2	6.5	6.1	1.1	6.4	19.2	26.8	45.5	-12.3
	Mar. 16, 2019	4.5	318.5	6.7	715.5	83.7	52.8	7.0	6.8	1.1	6.8	19.3	25.7	47.4	-18.2
	Apr. 20, 2019	6.2	351.1	6.7	558.1	87.8	55.3	7.0	7.2	1.1	7.2	18.4	26.3	47.0	-17.6
	May. 18, 2019	8.2	331.1	7.5	622.5	83.9	54.7	6.7	6.9	1.6	7.2	16.6	15.7	40.7	-6.6
	Jun. 19, 2019	5.2	N/A	7.0	475.7	104.1	50.0	6.3	6.9	1.8	7.2	16.1	11.0	37.3	-10.3
	Aug. 03 2019	6.5	357.9	7.4	312.4	91.9	38.2	5.1	5.5	1.6	6.1	11.2	3.4	30.1	-7.7
G3	Oct. 19, 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Nov. 16, 2018	N/A	-51.4	6.9	2810.0	1642.6	520.7	101.6	13.7	6.5	8.8	47.7	<DL	0.4	3.4
	Dec. 21 2018	N/A	-1.1	7.0	2853.0	1758.8	584.5	110.9	15.5	6.3	12.8	57.7	<DL	0.3	6.8
	Jan. 07, 2019	N/A	101.3	7.6	3123.0	1779.7	618.0	118.2	15.5	6.1	11.7	53.2	<DL	<DL	9.5
	Feb. 27, 2019	2.9	106.5	7.3	2802.0	1205.1 ^a	545.8	102.9	11.0	5.5	10.6	42.6	<DL	0.4	21.4
	Mar. 16, 2019	3.1	139.8	6.9	2884.0	1706.7	581.6	106.6	13.0	5.6	10.9	44.0	<DL	0.4	6.9
	Apr. 20, 2019	0.2	158.1	6.7	2690.0	1606.6	518.4	105.1	11.1	4.6	9.5	49.2	<DL	0.4	5.5
	May. 18, 2019	0.1	137.9	6.8	2481.0	1485.5	499.0	98.9	12.6	6.3	7.6	47.0	<DL	0.5	6.7
	Jun. 19, 2019	2.8	N/A	7.0	3019.0	1203.0	443.9	90.7	14.4	6.9	11.6	49.5	<DL	0.8	10.6
	Aug. 03 2019	1.2	300.2	7.2	2346.0	1245.6	401.5	82.3	15.3	7.6	12.7	43.8	<DL	0.9	3.6
G4	Oct. 19, 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Nov. 16, 2018	N/A	N/A	7.2	N/A	1121.8 ^a	574.3	102.1	13.4	7.2	12.2	44.1	0.6	0.3	26.0
	Dec. 21 2018	N/A	144.2	6.8	2715.0	1643.7	550.5	98.2	13.6	6.8	12.2	44.7	0.6	1.0	5.8
	Jan. 07, 2019	N/A	58.8	7.4	3085.0	1730.0	614.3	107.9	14.0	6.3	12.1	44.8	<DL	0.4	10.8
	Feb. 27, 2019	2.9	80.7	7.1	3050.0	1669.9	597.4	115.3	13.9	5.7	12.0	51.1	<DL	0.4	13.0
	Mar. 16, 2019	2.3	136.7	6.9	2894.0	1858.5	597.6	113.8	14.0	5.9	12.2	53.0	<DL	0.3	6.5
	Apr. 20, 2019	0.2	176.0	7.1	2421.0	1575.7	537.0	96.2	10.3	4.9	9.2	44.1	<DL	0.5	6.4
	May. 18, 2019	0.6	142.3	7.2	3077.0	1551.3	544.2	95.0	12.2	6.4	8.8	47.1	<DL	0.3	9.1
	Jun. 19, 2019	0.1	N/A	7.2	3074.0	1191.9	425.1	84.5	14.4	8.4	12.9	50.7	0.5	0.7	8.5
	Aug. 03 2019	0.5	200.6	6.8	2060.0	921.8	342.6	72.9	13.9	8.0	13.5	47.8	0.8	1.3	-7.2

DL: Detection limit, N/A: Not applicable. DO = dissolved oxygen, EC = electrical conductivity, Alk = alkalinity, CBE = charge balance error. CBE was calculated using the PHREEQC geochemical modeling program [1] with PHREEQC database. ^aSamples were analyzed after allowing particles suspended in the water samples to settle.

References

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