Supplementary Information (SI)

Table S1 the temporal resolution surface water quality studies

No of samples	Water body	Frequency									
		Random/unknown	Daily	Weekly	Biweekly	Monthly	Quarterly	Seasonally		Yearly	Remark
								Dry	Wet		
1-5	Lake	-	-	-	-	-	-	(Masresha et al., 2011)	(Masresha et al., 2011)	-	(Bedada et al., 2019)[h]
	River	-	-	-	-	-	-	(Jebessa and Bekele, 2018), (Masresha et al., 2011), (Prabu et al., 2011)[5], (Tarekegn & Truye, 2018)[5], (Kassegne et al., 2018)[5]	(Masresha et al., 2011), (Prabu et al., 2011)[5], (Kassegne et al., 2018)[5]	-	
5-10	Lake	(Teklay and Amare, 2015)[5]	-	-	-	-	-	-	-	-	
	River	-	-	-	(Akalu et al., 2011)	-	-	(Tadesse et al., 2018)[6]	-	-	
10-15	Lake	-	-	-	-	(Degefu et al., 2011)[1]	-	(Haile and Mohammed, 2019)[3], (Gebreyohannes et al., 2015)[6],	-	-	
	River	(Olbasa, 2017)	-	-	-	-	(Degefu et al., 2013)[4]	(Mulu et al., 2013)[*], (Feyissa and Bekele, 2018)[*], (Haile and Mohammed, 2019)		-	
15-20	Lake	-	-	-	-	-	-	-	-	-	
	River	-	-	-	-	-	-	(Keraga et al., 2017a)[1] (Eliku and Leta, 2018), (B.Abate et al., 2015)[6]	(Keraga et al., 2017a)[1] (Eliku and Leta, 2018)	-	
20-25	Lake	-	-	-	-	(Abhachire, 2014)[1]	-			-	(Itanna, 2002)[9]

[1] Twice in each season, [3] – two years, [4] - for one year, [5]- only one time, [6] – Monthly, [7]- from spring and reservoir, [*] - biweekly for two months,

	River	-	-	-	-	(Abhachire, 2014)[1]	-	(Melaku et al., 2007), (Kassegne et al., 2018)[5]	(Kassegne et al., 2018)[5]	-	
> 25	Lake	-	-	-	-	(Tesfay, 2007)[4]	-	-	-	(Chernet et al., 2001)[3]	(Eskinder, 2019)[8]
	River	(Niguse et al., 2018)	-	-	-	(Keraga et al., 2017b)[2], (Tesfay, 2007)[4] (Dirbaba et al., 2018)[10], (Yimer and Jin 2020)[2]	-	(Adugna et al., 2019)[3], (B.Abate et al., 2015)[6], (Bedada et al., 2019) , (Haddis et al.,2014)[3], (Awoke et al., 2016), (B.Abate et al., 2015)	(Adugna et al., 2019)[3], (Eskinder, 2019), (Awoke et al., 2016), (Eskinder, 2019)[1]	-	
No data	Lake	(Dinka, 2017)[5], (Tafesse et al., 2015)	-	-	-	-	-	(Dsikowitzky et al., 2013), (Mesfin et al., 1988)	-	-	(Awol, 2018)[7],
	River	(Tamiru, 2001) (Gebre et al., 2016)[5], (Tafesse et al., 2015)	-	-	-	-	-	(Tadesse et al., 2018),	-	-	

[2] Greater than 10 years, [8] – bimonthly, wet season & industrial, [9] – from vegetables, soil river, [10] – only for one month, [f] – flow in rainy time [h] - Hospital

Table S2, Summary of major surface water quality studies in different parts of Ethiopia

Study area/site	Studied surface water quality indicators	Value	Reference
Hawassa Textile Industry	Tem (°C)	17.80-25.75	(Tafesse et al., 2015)
	pH	8.080-11.21	
	EC (µs/cm)	31.01-46.30	
	TDS (mg/l)	277.0-900.4*	
	TSS (mg/l)	90.50-147.0 *	
	BOD (mg/l)	93.00-188.0 *	
	COD (mg/l)	189.6-264.0 *	
Southern eastern part of Ethiopia, Anderacha district, Sheka Zone	Tem (°C)	19.10-24.94 [b]	(Awol, 2018)
	pH	7.24-8.07	
	EC (µs/cm)	112.36-1626.67	
	TH CaCO3 (mg/l)	393-522*	
	Nitrate (mg/l)	Not detectable - 0.96	
	Nitrite (mg/l)	Not detectable - 0.51	
	Ammonia (mg/l)	0.03-0.84	
	Phosphate (mg/l)	1.32-3.20[b]	
	Chloride (mg/l)	2.13-36.16	
	Carbonate (mg/l)	not detectable	
Lake Hawassa	PH	5.85 to 9.21	(Haile and Mohammed, 2019)
	Tem (°C)	20.56 to 28.30	
	DO (mg/l)	4.76 to 8.59	
	TDS (mg/l)	928.3	
	EC (µS/cm)	741.7 to 1956.0	
	turbidity (NTUs)	8.37 to 177.0	
	F^- (mg/l)	15.3[b]	
	nitrate (mg/l)	2.83 to 6.79	
	sulfate (mg/l)	8.4 to 18.5	
	phosphate (mg/l)	0.3 to 1.9[b]	
	fluoride (mg/l)	11.8 to 17.3	
	BOD5 (mg/l)	63.4 to 168.2[b]	
	TH CaCO3 (mg/l)	52.6 to 72.6	
	Alkalinity CaCO3 (mg/l)	10.0 to 19.3	
Lake Hawassa	Tem (°C)	21.23	(B.Abate et al., 2015), (Worako, 2015)
	pH	7.54	
	DO (mg/l)	17.85	
	TDS (mg/l)	450.1	
	turbidity (NTU)	8.44	
	COD (mg/l)	48.73	
	BOD_5 (mg/l)	117	
	F^- (mg/l)	12.8	
	$NO3^-$ (mg/l)	5.27	
	PO_4^{3-} (mg/l)	1.12	
	NO^{2-} (mg/l)	0.04	
	TN (mg/l)	5.42	

	TP (mg/l)	0.37	
	Cl^- (mg/l)	30.84	
	Chl-a (µg/l)	25.45[3]	
Lake Gudera / Wetland, West Gojjam Zone	Temp (^0C)	(21.89, 19.58)[d]	(Brehan, 2017)
	pH	(8.38, 8.17)[d]	
	EC (µS/cm)	(88, 81.5)[d]	
	DO (mg/l)	(7.16, 8.34)[d]	
	TDS (mg/l)	(38.02, 61)[d]	
	salinity	(0.04, 0.04)[d]	
	alkalinity (mg/l)	(72.5, 79)[d]	
	Phosphate (mg/l)	(0.18, 0.17)[d]	
	Ammonia (mg/l)	(0.18, 0.055)[d]	
	Nitrite (mg/l)	(0.018, 0.0216)[d]	
	Nitrate (mg/l)	(1.054,0.665)[d]	
	TH (mg/l)	(56, 45)[d]	
	Sulphate (mg/l)	(13,16.5)[d]	
	turbidity (mg/l)	(54,59)[d]	
Lake Haiq	Tem (°C)	(26.46 ± 2.34)	(Teklay and Amare, 2015)
	pH	(8.83 ± 0.07)[b]	
	turbidity (NTU)	1.26 ± 0.04 924.50 to 66.10±1.84[b]	
	EC (µS/cm)	(2,500 and 10,000)	
	TDS (mg/l)	(458.00 ± 14.14 to 463.00 ± 5.66)	
	Alkalinity (mg/l)	(349.53 ± 4.06 to 627.57 ± 8.15)[b]	
	Chloride (mg/l)	(44.86 ± 1.47 to 49.14 ± 0.72)	
	NH_3 (mg/l)	(0.14 ± 0.02 to 1.35 ± 0.21)	
	NO_3 (mg/l)	(0.04 ± 0.01 to 0.29 ± 0.01)	
	SO_4 (mg/l)	(2.18 ± 0.25 to 5.20 ± 0.85)	
Huluka River, Ambo Area	Tem (^0C)	22.4-23 (16.2-17.8)[4]	(Prabu et al., 2011)
	pH	7.91-8.18 (7.42-8.03)[3]	
	EC (µS/cm)	175.1-588.4 (140.2-540.7)[3]	
	TDS (mg/l)	113.8-382.5 (91.1-351.5)[3]	
	$CaCo_3$ (mg/l)	48-91 (38-88)[3]	
	Cl^- (mg/l	18.5-60.8 (13.250.3)[3]	
	Nitrate (mg/l)	0.88-2.8 (1.2-3.5)[3]	
	DO (mg/l)	3.5-6.4 (4.1-7.8)[3b]	
	Phosphate (mg/l)	0.28-1.58 (0.31-1.88)[3e]	
	Sulphate (mg/l)	22.4-40.1 (24.1-48.9)[3]	
Alaltu River, Ambo Area	Tem(^0C)	22.5-231 (17.5-18.1)[3]	
	pH	7.26-8.27 (7.01-8.12)[3]	
	EC (µS/cm)	497-788.4 (398.2-712.6)[3]	
	TDS (mg/l)	323.1-512.5 (258.8-463.2)[3]	
	$CaCo_3$ (mg/l)	78-140 (58-121)[3]	
	Cl^- (mg/l)	27.5-73.5 (21.5-65.3)[3]	
	Nitrate (mg/l)	0.95-3.1 (1.22-3.88)[3]	

[3] - trophic level is on average hyper eutrophic
[4] Wet season

	DO (mg/l)	3.85-5.55 (4.9-6.2)[3]	
	Phosphate (mg/l)	0.43-1.75 (0.55-1.9)[3e]	
	Sulphate (mg/l)	28.1-55.9 (32.1-58.9)[3]	
Awetu-Kito Rivers in Jimma	pH	6.57	(Haddis et al.,2014)
	DO (mg/l)	7.4 - 0.8*	
	BOD5 (mg/l)	330 – 480*	
	NO3-N (mg/l)	1.5 - 7	
	NO2-N (mg/l)	0.21	
	PO4 (mg/l)	1*	
	EC (µS/cm)	80-400	
	TDS (mg/l)	120-800	
	chloride (mg/l)	5.5 - 51	
Rebu River in Oromia region	Tem (^{0}C)	22.5[c]	(Tadesse et al., 2018)
	pH	10.5[c]	
	EC (µS/cm)	1592.6 [c]	
	TDS (mg/l)	2359.5[c]	
	Turbidity (NTU)	800[c]	
	Salinity	2440[c]	
	NO_3^- (mg/l)	324.5[c]	
	PO_4^{3-} (mg/l)	163.3[c]	
	NO_2^- (mg/l)	0.58	
	SO_4^{2-} (mg/l)	96	
	NH_3 (mg/l)	15.8[c]	
Elala River, Mekelle, Tigray	EC (µS/cm)	904.11 to 2156.11[b]	(Gebreyohannes et al., 2015)
	Turbidity (NTU)	21.07 to 34.99[b]	
	TDS (mg/l)	700.22 to 1328.22[b]	
	T. alkalinity (mg/l)	131.85 to 267.26[b]	
	TH (mg/l)	198.67 to 478.67[b]	
	chloride (mg/l)	47.32 to 259.43[b]	
	COD (mg/l)	16.02 to 32.53[b]	
	SO_4 (mg/l)	271.82 to 384.07[b]	
	NO_3_N (mg/l)	6.82 to 62.38[b]	
	PO_4 (mg/l)	0.03 to 0.14[b]	
	TP (mg/l)	0.04 to 0.19[b]	
River Gudar, Oromia region	Alkalinity (mg/l)	154±15.556	(Olbasa, 2017)
	pH	8.44	
	EC (µS/cm)	316.47 ± 72.802	
	Turbidity (NTU)	1.23-4.25	
	TDS (mg/l)	149.37 ± 20.64	
	NO_3 (mg/l)	5.23-7.55	
	NH_4 (mg/l)	41.00 ± 1.19	
	SO_4 (mg/l)	35.03-97.05	
	PO_4 (mg/l)	3.50 ± 0.32	
	TSS (mg/l)	121.80-130.00	
	Chloride (mg/l)	3.72-5.32	
	Carbonate (mg/l)	2.65-4.70	
	Bicarbonate (mg/l)	117.66-138.74	
	TH CaCO3 (mg/l)	156.87 ± 8.46	

Blue Nile, Omo-Gibe, Tekeze, and Awash river basins[5]	TN (mg/L)	7.3, 20.3, 2.6, 1.5 (< 0.3 concern level)	(Awoke et al., 2016)
	TP (mg/L)	0.4, 0.3, 0.9, 0.2 (< 0.015 concern level)	
	DO (mg/L)	6.2, 6.1, 6.8, 6.8 (> 7 concern level)	
	BOD5 (mg/L)	12.2, 2.7, 6.9, 13.3 (< 3 concern level)	
	pH	7.4, 7.2, 7.8, 7.6 (6.5 – 9 concern level)	
	EC (µS/cm)	122, 117, 192, 560	
Blue Nile, Omo-Gibe, Tekeze, and Awash river basins[6]	TN (mg/L)	11.1, 17, 30.8, 3.1 (< 0.3 concern level)	
	TP (mg/L)	1, 0.2, 12.5, 2 (< 0.015 concern level)	
	DO (mg/L)	4.9, 5.7, 2.6, 4.9 (> 7 concern level)	
	BOD5 (mg/L)	18.4, 108, 508, 29 (< 3 concern level)	
	pH	7.2, 7.3, 7.2, 6.3 (6.5 – 9 concern level)	
	EC (µS/cm)	92, 140, 580, 514	
Blue Nile and Omo-Gibe river basins[7]	TN (mg/L)	9.3, 22 (< 0.3 concern level)	
	TP (mg/L)	1.3, 0.3 (< 0.015 concern level)	
	DO (mg/L)	5.9, 4.7 (> 7 concern level)	
	BOD5 (mg/L)	17.6, 64 (< 3 concern level)	
	pH	7.1, 6.8 (6.5 – 9 concern level)	
	EC (µS/cm)	95, 101	

b - exceed WHO standard; # - exceed FAO standard; * - exceed Ethiopian EPA standard; c - exceed EDWQ (2010); *d* - exceed USEPA 2015 freshwater bodies
e - exceed (EC) European community standard, *a* - exceeds EEPA and UNIDO slaughterhouse effluent discharge limit, *f*- Australia-New Zealand (ANZE 2000)

[5] Agriculture impacted river basins (the value is in their respected order)
[6] Urban impacted river basins (the value is in their respected order)
[7] Coffee impacted river basins (the value is in their respected order)

Table S3 summary of surface water quality studies in different parts of Awash Basin

Study area/site	Parameters analyzed/results		Remark	Reference
Awash in late, koka reservoir, Awash out late	Tem (°C)	19.1 to 23.6	highest during dry season and the lowest during wet season, no significant spatial variation	(Eliku and Leta, 2018)
	pH	6.08 to 8.47	highest during dry season and the lowest during dry season, significant variation in mean among the sampling sites	
	turbidity (NTU)	29.27 to 159.51	highest during wet season and the lowest during dry season, significant spatial and seasonal variation	
	EC (µS/cm)	261.7–742.62		
	NO3-N (mg/l)	0.28 to 28.8	highest during dry season and the lowest during wet season, significant spatial variation	
	NO2-N (mg/l)	0.06 to 0.92	highest during dry season and the lowest during wet season	
	NH4-N (mg/l)	0.11 and 1.47	highest during dry season and the lowest during wet season	
	TN (mg/l)	0.82 to 84.53	highest during dry season and the lowest during wet season	
	TP (mg/l)	0.02 to 0.31	no a significant spatial and seasonal variation	
	DO (mg/l)	3.02 to 13.51	higher in wet season than in dry season	
	BOD (mg/l)	13.69 to 83.37	significant spatial variation; no significant seasonal variation	
	COD (mg/l)	16.13 to 150.38	the mean is a significant spatial variation but no seasonal variation	
Tinishu Akaki River, Addis Ababa	Tem °C	12.4 to 22.1	above the maximum permissible limit of CCME guidelines	(Melaku et al., 2007)
	pH	7.1 to 8.9	within the limit of the CCME guidelines	
	EC (µS/cm)	56 to1268	within permissible limits of the WHO	
	TDS (mg/l)	0 to 639	negligible temporal and considerable spatial variations, marked increase from upstream to downstream	
	DO (mg/l)	0.1 to 6.7	decreasing in downstream of the river	
	COD (mg/l)	4.0 to 533	spatially varied along the river course	
	BOD5 (mg/l)	2.7 to 204.5	decreasing in downstream of the river	
	HCO_3^- (mg/l)	48 to 168	exceeded common natural concentrations world rivers by 9.2	
	SO_4^{2-} (mg/l)	4.8 to 70.8	exceeded common natural concentrations world rivers by 6.8	
	NO_3^- (mg/l)	1.7 to 9.2	exceeded common natural concentrations world rivers by 19	
	NO_2^- (mg/l)	0.1 to 1.2	decreasing in downstream of the river	
	PO_4^{3-} (mg/l)	0.04 to 15	exceeded common natural concentrations world rivers by 390/ decreasing in downstream of the river	
	Cl^- (mg/l)	3.9 to 193	exceeded common natural concentrations world rivers by 27.2	

	NH_3 (mg/l)	0.4 to 35	decreasing in downstream of the river	
Shegole, Tinishu Akaki and Jemo rivers, Addis Ababa …(Dry season)	DO (mg/l)	(0.18, 3.16, 2.49)		(Adugna et al., 2019)
	pH	(7.76, 7.94, 8.01)		
	PO_4–P (mg/l)	(45.55, 20.97, 41.46) [a,e,d,f]		
	NO_3–N (mg/l)	(2.39, 1.31, 1.46) [a,e,d,f]		
	NO2–N (mg/l)	(0.9, 2.74, 2.62) [a,e,d,f]		
	NH4–N (mg/l)	(2.56, 2.24, 3.16) [a,e,d,f]		
	Turbidity (NTU)	(239, 35, 54)		
Shegole, Little Akaki and Jemo rivers, Addis Ababa …(Wet season)	DO (mg/l)	(5.43, 7.29, 5.16) [a,e,d,f]		
	pH	(8.18, 8.27, 8.47)		
	PO_4–P (mg/l)	(14.77, 8.92, 16.55) [a,e,d,f]		
	NO_3–N (mg/l)	(1.88, 2.05, 2.36)		
	NO2–N (mg/l)	(5.37, 10.26, 11)[a,e,d,f]		
	NH4–N (mg/l)	(0.97, 0.75, 1.76)		
	Turbidity (NTU)	(376, 661, 302)		
Shankela River, Addis Ababa	Turbidity (NTU)	83.14 [b*]		(Tarekegn & Truye, 2018)
	TSS (mg/l)	142.2 [b*]		
	COD (mg/l)	81.6 [b*]		
	BOD (mg/l)	91.52 [b*]		
	NO_3^- (mg/l)	0.34		
	NH_3 (mg/l)	18 [b*]		
	NO_2^- (mg/l)	0.38 [b*]		
	PO_4^{-3} (mg/l)	19.44[b*]		
(Kera, Luna)[8] slaughter houses	pH	(7.30, 6.81)		(Mulu et al., 2013)
	Tem (^oC)	(26.55; 22.09)		
	EC (µs/cm)	(1614.6; 3850) [a]		
	turbidity (NTU)	(566.66 160.33) [a]		
	TS (mg/l)	(7885.3; 1176) [a]		
	TSS (mg/l)	(3835.3; 125.66) [a]		
	TP (mg/l)	(202; 61.7) [a]		
	PO_4^{-3} (gm/l)	(67.3; 28.3) [a]		
	Nitrite (gm/l)	(1513.3; 49.33) [a]		
	Nitrate (mg/l)	(1450 ; 13.7) [a]		

[8] Their value is in their respected order

	Ammonia (mg/l)	(103.3; 345.7) [a]		
	Sulfate (mg/l)	(693.3; 31.3) [a]		
	Sulfide (mg/l)	(1.83; 0.14) [a]		
	DO (mg/l)	(3.75; 0.97) [a]		
	COD (mg/l)	(11546.7; 431.7) [a]		
	BOD5 (mg/l)	(3980; 177.3) [a]		
(Mojo and Akaki)[4] River	pH	(6.91 - 7.46); (6.84 - 7.47)		(Mulu et al., 2013)
	Tem (°C)	(21.50 - 22.45);(23.71 23.20)		
	EC (µs/cm)	(1564.66-2930);(1235.33-1290.33)		
	Turbidity (NTU)	(134.66-416.66);(350-483.33)		
	TS (mg/l)	(932-2331.33); (725.33-1248.66)		
	TSS (mg/l)	(154-886); (304.33-456)		
	TP (mg/l)	(0.85-46.13);(20.50-75.33)		
	PO_4^{-3} (mg/l)	(0.46-28); (9.6-16.70)		
	Nitrite (mg/l)	(220-26.66);(153.33- 597.0)		
	Nitrate (mg/l)	(6.26-42.66);(140-140.33)		
	Ammonia gm/l	(10.66-212.33);(41.25-47.91)		
	Sulfate (mg/l)	(22.660-103.33); (52-61.33)		
	Sulfide (mg/l)	(0.11-0.2); (0.37-0.38)		
	DO (mg/l)	(3.75; 0.97)		
	COD (mg/l)	(295-1080);(260-1373.33)		
	BOD5 (mg/l)	(84-265.67); (95.66-555.33)		
Anmol Paper Factory, Ginchi area	BOD5 (mg/L)	470-2499.3[b]*		(Feyissa and Bekele, 2018)
	COD (mg/L)	2969 - 5848.6[b]*		
	TP(mg/L)	0.37 - 0.42[b]		
	TN (mg/L)	7.79 - 20[b]		
	Turbidity (NTU)	118.28 - 499.32[b]*		
	TS (mg/L)	1512 - 3432[b]		
	TDS (mg/L)	1032 - 3134[b]*		
	TSS (mg/L)	298 - 726[b]*		

	EC (µS/cm)	1576 - 4720[b]*		
	PH	3.23 – 10.66[b]*		
	T. Hardness (mg/L)	49.5 - 3335		
	Alkalinity (mg/L)	ND – 2000		
	CO3 2- (mg/L)	ND _ 281		
	HCO3- (mg/L)	ND - 2440		
	Chloride (mg/L)	186.22 - 3818.7[b]*		
	Sulphate (mg/L)	26.7 - 282.32		

b - exceed WHO standard; # - exceed FAO standard; * - exceed Ethiopian EPA standard; c - exceed EDWQ (2010); *d* - exceed USEPA 2015 freshwater bodies e - exceed (EC) European community standard, *a* - exceeds EEPA and UNIDO slaughterhouse effluent discharge limit, *f*- Australia-New Zealand (ANZE 2000)

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