

Table18. Heavy metals average concentration value in different sampling points

parameters	Sampling sites in lake									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Cd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Cr	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Zn	0.317	0.305	0.188	0.162	0.234	0.175	0.116	0.123	0.162	0.161
Pb	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ni	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Fe	0.18	0.071	0.072	0.078	.073	0.075	0.074	0.072	0.078	0.08
Cu	0.046	0.006	0.005	0.011	0.005	0.005	0.005	0.005	0.005	0.01
Mn	0.489	0.056	0.039	0.043	0.036	0.034	0.056	0.052	0.043	0.040

Note: nd-refers to non-detectable

Appendix8: Morphometric features of the Lake Hawassa

Parameters	Measurements/units	Information source
Length	18km	
Breadth	10km	
Average depth	11m	Elias,2000
Maximum depth	22m	
Volume	1.3km ³	Tenalem,1998
Water surface area	88 or 129km ² (varies according to author) In average the area was 108km ²	Elias, 2000; Girma & Gunnel A.,2009; Yemane G., 2004; Arkady M.D & Brook ,2008
Drainage basin area(catchment areas)	1250Km ²	Girma & Gunnel,2009
Shoreline length	50-65km	
Elevation	1685m.a.s.l	Present study
Electrical conductivity	790μS/cm	
Mean annual Rainfall	960mm	
Average temperature	19.8°C	
Average annual inflow	1440mm	Arkady M.D & Brook ,2008
Precipitation	950mm	
Average annual Outflow	570mm(underground)	
Evaporation	1440mm	
Average increment, ΔH	53.4	

Appendix1. Classification of the Lake Hawassa water quality for irrigation use according to Richard classification (Richard, 1954) for irrigation use

Site	Station value	December	January	February
S1	S2C2	S1C2	S2C3	S2C3
S2	S2C3	S1C2	S2C2	S2C3
S3	S2C3	S1C2	S2C3	S2C3
S4	S2C3	S1C2	S2C3	S3C3
S5	S2C3	S1C2	S2C3	S2C3
S6	S2C3	S1C2	S2C3	S2C3
S7	S2C3	S2C2	S2C3	S3C3
S8	S2C3	S1C2	S2C2	S2C3
S9	S2C3	S1C2	S2C2	S2C3
S10	S2C3	S1C2	S2C3	S2C3

Note: The lake water quality was acceptable in sampled sites and good in site1, as variables rated shows the quality for irrigation use is good in December, acceptable in January (good in site 2,8&9) & February (poor in site 4&7).

Table 20. The chemical composition (nutrients, ions and others) and trace/heavy metals in mg/l (except EC and pH) of the Lake Hawassa for comparison

parameter	Talling and Talling (1965)	Wood and Tallin g, 1988	Kebede et al., 1994	Alema yehu, 2008	Berha nu and Lem ma, 2009	Telford (1998) as cited in Ataro et al., 2003	Zinabu and Pearce , 2003	Yosef et al., 2010 (unpubl - ished)	Analys ed value of present work
pH		8.8	8.8	8.5	8.9				7.54
DO				5.9				6.3	17.85
COD				19.2				1133.3*	48.73
BOD				67.8					117.00
NO ₂ ⁻					0.01				0.037
NO ₃ ⁻			0.0349	4.4	0.66			2.47	5.27
NH ₄ ⁺			0.0057		0.2			103.3*	ND
PO ₄ ³⁻		0.005	0.012		0.01			187	1.12
Na ⁺	235	218	137.1	150	170.4				331.14
TDS				549	580.8			411	450.14
EC(μ S/cm)	1050	840	830	845	835			814	750.10
Cr							0.0057	0.0059	ND
Ni						0.0015	ND	-	ND
Pb						0.00747	ND	0.0067	ND
Cd						0.00047	ND	0.0013	ND
Zn						0.09011	0.0016	79	0.194
Cu						0.00539	ND	-	0.01
Fe						0.21	ND	0.27	0.085
Mn						0.02454	0.0026	-	0.089

Table19. Maximum allowable concentrations levels (mg/l except for EC and pH) of chemical parameters in drinking water according to EU (1998) and WHO (1993&1998)

Parameters	EU standards	WHO standards	Present study value of the lake
Cd	0.005	0.003	ND
Cl	250(i)	200	30.84
Cr	0.05	0.05(p)	ND
Cu	2	2(p)	0.01
F	1.5	1.5	12.83
Fe	0.2(i)		0.085
Pb	0.01	0.01	ND
Mn	0.05(i)	0.05(ATO)	0.089
Na	200	200	331.14
Ni	0.02	0.02(p)	ND
NH ₄	-	0.05	ND
NO ₃	50	50	5.271
NO ₂	0.5	0.2(p)	0.037
Zn	-	5	0.194
Total hardness	-	100-500	121.87(Ca+Mg)
EC(μS/cm)	2500	-	750.1
pH	>6.5, <9.5	6.5-8.5	7.54

Note: The bold one indicates parameters which are above the guideline values for drinking aspect

Table16. Mean total and fecal coliform viable count of the lake water and standards

Sampling point		Mean bacterial count	
		TC(MPN/100ml)	FC(MPN/100ml)
S1		12333.33	213.33
S2		15833.33	130
S3		12166.67	63.33
S4		9500.00	78.33
S5		12833.33	46.67
S6		6000.00	66.67
S7		8666.67	58.33
S8		10666.67	85.00
S9		10000.00	91.67
S10		220833.33	163.33
Standards	Canada ,1992	-	200
	USEPA, 1989	-	200
	WHO, 1989	500	100
	Australia,1990	-	150 (for primary contact)
		-	1,000 (for secondary contact)
	CCEM, 1999	<5000	<1,000 (other than direct contact)
		<1,000	<200 (for direct contact recreation)
	BSI, 2003	<500	<100

Table15. Summary statistics of different indices for the lake water

Parameter	Mean min(meq/l)	Mean max(meq/l)	Grand mean $\pm$ SE(meq/l)
SAR	12.195(S1)	16.008(S7)	13.370 $\pm$ 0.002
SSP	83.778(S10)	88.341(S2)	86.012 $\pm$ 0.005
MAR	93.837(S2)	95.369(S10)	94.515 $\pm$ 0.007
KR	5.709(S10)	7.183(S7)	6.273 $\pm$ 0.002
TH	106.068(S2)	137.156(S10)	121.869 $\pm$ 0.043
pH	6.978(S1)	7.732(S4)	7.543 $\pm$ 0.005
EC	701.167(S1)	757.500(S4)	750.1 $\pm$ 0.052
TDS	420.844(S1)	454.667(S2)	450.14 $\pm$ 0.039
Ca ²⁺	0.117(S10)	0.145(S7)	0.128 $\pm$ 0.000
Mg ²⁺	1.995(S2)	2.626(S10)	2.310 $\pm$ 0.001
Na ⁺	13.091(S1)	18.013(S7)	14.404 $\pm$ 0.001
K ⁺	1.777(S7)	2.175(S4)	1.894 $\pm$ 0.000

Cl(mg/l)	228.951(S2, 5, 7)	33.087(S4)	30.841±0.006
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