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Assessment of Surface and Ground Irrigation Water Quality for Small Scale Irrigation in East Shoa Zone of Oromia, Ethiopia

Abay Challa*, Anbese Ambomsa, Zelalem Shelemew

Adami Tulu Agricultural Research Center, Zeway, Ethiopia

Email address:
abaychalla@gmail.com (A. Challa), anbeseamboma@gmail.com (A. Ambomsa), yewl.as.ge@gmail.com (Z. Shelemew)
*Corresponding author

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Abstract: Irrigation with poor quality waters may bring undesirable elements to soil in excessive quantities affecting its fertility. The seasonal variation in surface and ground water quality of different district in East Shoa zone has been evaluated for two years from 2013/14 to 2014/15 for assessing the suitability of water for irrigation purpose. In the present study water samples were collected from River, Lake and ground water and analyzed for ten parameters of physical and chemical properties. The analyzed water quality parameters show seasonal variation and high concentration in dry season compared to wet season due to dilution effects. Electrical conductivity, pH, ionic composition, sodium adsorption ratio (SAR) & total dissolved solids (TDS) were calculated using the standard equations. Analysis showed a wide range of electrical conductivities that varied from 332-2627.5 µS/cm and salinity ranged between 197.9-1681.6mg/L. The SAR in the study area lies between 1.42 and 22.09 in most irrigation water sources. Considering SAR as important parameter of suitability for irrigation, most of the results are under usual range compared to the irrigation water standards, except for some samples collected from underground. The mean pH values of almost all water sources were between 7.58 and 8.19 which can be categorized as normal range for irrigation purpose. The results concluded that water quality at some of the locations is above permissible limit for irrigation and needs proper monitoring to preserve and maintain its quality for agricultural purpose. Since water quality alone would not sufficient enough to evaluate potential salinity hazard of irrigation water, consideration should be given to crop, soil, climate, agronomic and irrigation management practices. Therefore the present study only serves as baseline survey for future research needs.

Keywords: Irrigation Water, Salinity, Permissible Limits, Seasonal Variation, Ionic Composition

1. Introduction

Water quality is becoming of increasing concern both from a supply point of view and with respect to the environmental impacts. Definition of water quality depends on the desired use of water [6, 8]. Therefore; different uses require different criteria of water quality as well as standard methods for reporting and comparing results of water analysis [13]. Water quality for agricultural purposes is determined on the basis of the effect of water on the quality and yield of the crops, as well as the effect on soil characteristics [3].

There is increasing need to use waters of mid Rift Valley of Oromia Region for agricultural purpose; but, there seems to be little knowledge as to whether these water bodies are chemically suitable for agricultural purpose. Utilization of water bodies without information on the chemical composition could be threat and cause degradation of the environment [16]. The importance of water quality becomes more significant in arid and semi arid climates due to the lack of natural leaching of deposited salts and high rate of evaporation [11]. All irrigation water whether diverted from surface streams or pumped from wells, carry certain chemical substances in solution, dissolved originating from weathering of the rocks and soil and dissolving of lime, gypsum and other salt sources as water passes over or percolates through them [15]. The amount and kind of these dissolved constituents determine the quality of the water for irrigation use. Thus, evaluation of water bodies for their suitability, particularly with regard to their chemical compositions, is critical. Although, information on major ions and nutrients are available for Ethiopian rift valley [7, 4], this information is mostly from short-time studies and does not reveal a full picture of the chemical composition of different irrigation water source in mid rift valley of Oromia region over an extended period of time. Quality of irrigation water is not constant over the seasons. Salt concentration of rivers, lakes and manmade reservoirs may increase toward the end of summer. Relative change of the concentration depends on storage volume of the reservoirs. Salt concentration change is 10-20% in large bodies of water, whereas as high as 100% in small ponds, lakes and reservoirs [8]. Deep ground water wells show the least fluctuations in salt concentration; while, shallow wells may show considerable changes. Thus, quality of irrigation water must be assessed considering its seasonal fluctuations in salt concentration.

Therefore, Knowledge of the chemical composition and quality–related issues of water bodies' for irrigation purpose are of great importance. In this study, water bodies like River, Lakes and Ground water of mid rift valley of Oromia region have been assessed during dry and wet regime for two consecutive years. Thus, the proposed research was aimed to assess the irrigation water quality of surface and ground water and provide information on future proper use of water for irrigation purpose and management interventions.

2. Materials and Methods

2.1. Study Area

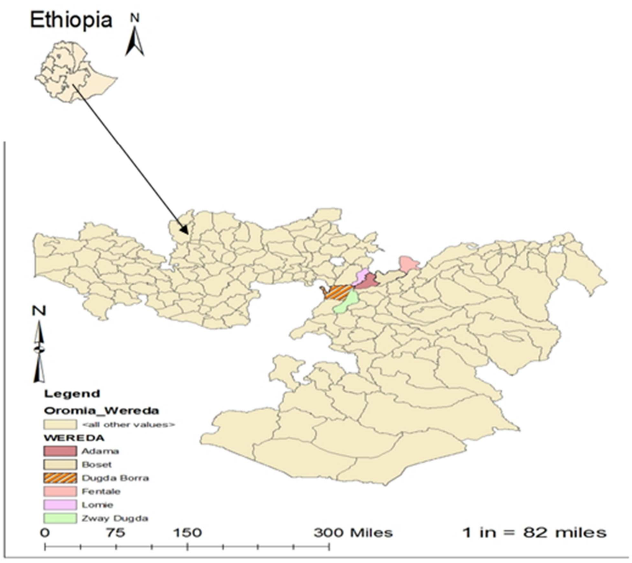

Figure 1. *Location map of the study area.*

The study was conducted in mid rift valley of Ethiopia; East Shoa Zone in some districts namely Fentale, Adama, Lume, Dugda and Adami Tulu Jido kombolcha. These districts were selected based on some saline indicters on irrigated farm and yield reduction raised by farmers during problem identification stage. The area is found within the mid rift valley (situated at 7°09''N to 8°45'N and 38°32'E to 39°17'E). The mid rift valley has an erratic, unreliable and low rain fall, averaging between 500 and 900mm per annum [2]. The annual daily maximum temperature varies between 24.2 and 30.5°C and the annual daily minimum temperature between 10.4 and 16.8°C [5]. The water bodies studied here were Awash River at different district lining between Lume and Fentalle, Koka and Zeway Lake and ground water in East Shoa. Before collecting water samples first the sampling area were classified based on source of water for irrigation. This is required to determine the effect of the sources of water for irrigation on the buildup of soil salinity and other problems in the area.

2.2. Water Sampling

As part of a study on seasonal changes in the irrigation water quality, the chemical composition of water bodies were determined during wet and dry seasons between 2013/14 and 2014/15 years. River, Lakes and ground water were used as sampling points. At each sampling point, two liters water sample were taken using labeled and clean polyethylene bottle every quarter. Methods of sampling were varies depending on different sources of water. For instance, samples from rivers were taken from the fastest flowing part at mid-way along the width of the river while the samples from lakes were taken from where it is assumed to be a central part of them. A sample from deep well has been taken after some minutes of pumping [8]. All samples collected from water bodies were from surface layer except for deep well, which was at 13 meters depth of well. Finally, irrigation water samples were transported immediately after collection and reserved in the refrigerator. Samples brought to the laboratory were analyzed without delay to prevent biological transformation.

2.3. Methods of Analysis

The samples were analyzed for pH, electrical conductivity (EC), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), chloride (Cl^-), calcium (Ca^{2+}), magnesium (Mg^{2+}) and sodium (Na^+). The pH and Ec were read on a pH-meter and conductivity- meter, respectively. CO_3^{2-} and HCO_3^- were determined by the titration method. Ca^{2+} and Mg^{2+} were determined by the EDTA titration method while Na^+ was determined by flame photometry. The Cl^- was determined by barium sulfate turbidimetric or gravimetric method [1], depending on concentrations in the samples. Then sodium adsorption ration (SAR), an important empirical measure of the suitability of water for irrigation, was calculated as:

$$SAR = \frac{Na^+}{[(Ca^+ + Mg^+)/2]^{1/2}}$$ (Richards, 1954 cited in [3].

The TDS values displayed by the conductivity/TDS meter were calculated from the specific conductance of the water samples and could be approximated by the following equation TDS = ke EC [10], Where TDS is expressed in milligrams per liter and EC is the electrical conductivity in microsiemens per centimeter at 25°C (specific conductance).

***Table 1.** The permissible limits for classifying the suitability of irrigation water.*

Some of Irrigation water quality parameters	permissible limits in irrigation water	source
SAR	0-15	
Ec (µS/cm)	0-3000	
TDS (mg/L)	0-2000	
pH	6.5-8.4	
Na^+(meq/L)	0-40	Ayers and Westcot, 1985
Ca^{2+} (meq/L)	0-20	
Mg^+ (meq/L)	0-5	
CO_3^{2-}+ HCO_3^-(meq/L)	0-10	
Cl^-(meq/L)	0-30	

2.4. Statistical Analyses

Descriptive statistics such as mean and range were used to describe the irrigation water quality parameters.

3. Result and Discussion

***Table 2.** Mean values of conductivity (µS/cm), salinity (mg/L) and pH of River in the study area. Values in brackets () are permissible limits in irrigation water. N represents sample size.*

Site location	Water source	N	EC (µS/cm)(0-3000)		TDS (mg/L)(0-2000)		pH (6.0-8.5)	
			range	mean	range	mean	range	mean
Gidara	Awashriver	8	170-453.7	344.7	108.8-290.4	220.6	7.83-8.08	7.94
Diresede	Awashriver	8	176.6-469.5	332	103.46-290.5	212.48	7.94-8.34	8.03
Fateledy	Awashriver	6	253-424.2	370	161.9-271.5	236.8	7.69-8.0	7.87
Ilala	Awashriver	8	155-570	379.8	99.2-289.9	243.1	7.93-8.24	8.06
waktiyo	Awashriver	8	238.5-454.5	346.1	152.6-290.9	221.5	7.88-8.17	8.01
Kobolito	Awashriver	8	192.7-457	372.85	174.4-292.5	238.6	7.55-7.93	7.58
Lume	Awashriver	8	175-753.5	434.2	112-482.24	277.9	7.62-8.27	7.93

***Table 3.** Mean values of conductivity (µS/cm), salinity (mg/L) and pH of ground water in the study area. Values in brackets () are permissible limits in irrigation water. N represents sample size.*

Site location	Water source	N	EC (µS/cm) (0-3000)		TDS (mg/L) (0-2000)		pH (6.0-8.5)	
			range	mean	range	mean	range	mean
wenjii	Ground water	6	1203-1389.5	1285.1	769.7-889.3	822.5	7.64-8.25	7.86
Tuchisumayan	Ground water	8	1825.5-2330	2050	1168-1491	1312	7.73-8.16	7.95
Shubigamo	Ground water	8	1196-1335	1252	765.4-854.4	801.3	7.61-8.18	7.89
Korke Adi	Ground water	6	2379-2970	2627.5	1522.5-1900.8	1681.6	7.32-8.08	7.78

***Table 4.** Mean values of conductivity (µS/cm), salinity (mg/L) and pH of Lake in the study area. Values in brackets () are permissible limits in irrigation water. N represents sample size.*

Site location	Water source	N	EC (µS/cm) (0-3000)		TDS (mg/L) (0-2000)		pH (6.0-8.5)	
			range	mean	range	mean	range	mean
Batigarmama	Koka Lake	8	209.35-425	308.3	133.9-272	197.9	7.65-8.19	8.01
Korke Adi	Lake (ziway)	8	600-1359	947.35	384-869.8	606.3	7.79-8.45	8.04
Wayu gebrel	Lake (ziway)	8	649.5-995	836.5	415.7-636.8	535.4	7.39-8.31	7.78
Ziway	Lake	8	380-549.5	466.85	243.2-351.7	220.6	7.76-8.74	8.19

Table 5. *Mean comparison of seasonal variation of water quality parameters over two consecutive years of study period.*

Site (PA)	Year data taken	source	Parameters N	Na^+ (meq/L)	Ca^{2+} (meq/L)	Mg^{2+} (meq/L)	(CO_3^{2-} + HCO_3^-) (meq/L)	Cl^- (meq/L)	PH	SAR	EC (µS/cm)	TDS (mg/L)
				mean	mean	mean	mean	mean	Mean	mean	Mean	mean
Gidara	2006	Awash river	4	1.3	1.04	0.81	2.45	0.49	7.9	1.36	296.7	189.89
	2007	Awash river	4	1.84	1.36	0.8	2.82	0.63	7.97	1.77	392.7	251.33
Diresede	2006	Awash river	4	1.53	1.23	0.79	2.71	0.48	7.97	1.52	269.9	172.74
	2007	Awash river	4	2.44	1.59	0.65	2.9	0.88	8.08	2.31	394.1	252.22
Fateledy	2006	Awash river	3	1.6	1.19	0.97	3.21	0.51	7.8	1.54	279.4	178.82
	2007	Awash river	3	2.69	1.6	0.88	3.37	0.88	7.94	2.41	460.6	294.78
Ilala	2006	Awash river	4	1.48	1.34	0.97	2.87	0.47	7.99	1.38	367	234.88
	2007	Awash river	4	2.84	1.59	1.04	2.89	0.78	8.13	2.48	392.6	251.26
waktiyo	2006	Awash river	4	1.45	1.23	0.73	2.94	0.57	7.9	1.47	265.1	169.66
	2007	Awash river	4	2.25	1.39	1.2	3.02	0.77	8.11	1.98	427	273.28
wenjii	2006	Ground water	3	5.14	1.44	0.81	12.17	1.02	7.79	4.85	1205.2	771.33
	2007	Ground water	3	10	3.9	1	11.83	1.14	7.93	6.39	1365	873.6
Kobolito	2006	A. river	4	1.09	1.4	0.58	3.14	0.46	7.53	1.09	338.7	216.77
	2007	A. river	4	2.34	1.71	0.85	3.26	0.84	7.64	2.07	407	260.48
Batigarmama	2006	Koka Lake	4	0.87	1.22	0.76	2.69	0.49	7.95	0.88	234.6	150.14
	2007	Koka Lake	4	2.12	1.67	0.68	2.89	0.77	8.06	1.96	382	244.48
Lume	2006	Awash river	4	1.69	2.1	0.91	3.43	1.2	7.89	1.38	456.7	292.29
	2007	Awash river	4	3.13	2.07	1	3.45	1.25	7.96	2.53	411.7	263.49
Tuchisumayan	2006	Ground water	4	22.22	0.87	1.3	15.01	2	7.92	21.37	1783.3	1141.31
	2007	Ground water	4	22.37	0.94	0.98	15.24	1.46	7.98	22.82	2316.7	1482.69
Shubigamo	2006	Ground water	4	14.64	0.78	1.22	11.43	0.73	7.81	14.66	1250	800
	2007	Ground water	4	11.97	0.55	0.82	11.51	0.5	7.98	14.49	1254	802.56
Korke Adi	2006	Lake	4	7.43	0.99	0.8	8.02	1.03	7.99	7.86	868	555.52
		Ground water	3	25.81	1.62	0.8	16.55	1.95	7.83	23.47	1980	1267.2
	2007	Lake	4	10.93	1.82	1.34	8.08	1.17	8.09	8.7	1026.7	657.09
		Ground water	3	25.96	2.25	1.25	18.12	1.2	7.74	19.64	3275	2096
Wayu gebrel	2006	Lake	4	5.07	1.29	1.27	6.73	0.9	7.8	4.49	816.7	522.69
	2007	Lake	4	5.16	1.69	1.34	6.85	0.6	7.76	4.19	856.3	548.03
Ziway	2006	Lake	4	2.58	0.84	1	3.76	0.87	7.98	2.69	460	189.89
	2007	Lake	4	2.93	1.26	0.89	3.85	0.57	8.4	2.82	473.7	251.33

Table 6. *Mean concentration (meq/L) of major ions and Sodium adsorption ratio (SAR) in Oromia mid rift valley irrigation water source, N is sample size values in brackets () are permissible limits in irrigation water. Values in bold and under line are above permissible limits in irrigation water.*

Site location	Water source	N	Na^+ (0-40)		Ca^{2+} (0-20)		Mg^{2+} (0-5)		CO_3^{2-} + HCO_3^- (0-10)		Cl^- (0-30)		SAR (0-15)	
			range	mean	range	mean	range	mean	range	mean	range	mean	range	mean
Gidara	Awash river	8	0.75-2.43	1.57	0.84-1.51	1.2	0.43-1.09	0.81	1.51-3.59	2.64	0.24-0.7	0.56	0.95-2.11	1.565
Diresede	Awashriver	8	0.77-3.03	1.98	1.03-1.76	1.41	0.37-1.11	0.72	1.45-4.02	2.84	0.42-0.94	0.68	1.05-2.49	1.91
Fateledy	Awashriver	6	1.03-2.16	2.15	1.29-1.92	1.39	0.48-1.28	0.93	2.41-4.27	3.29	0.43-1.01	0.69	1.09-2.48	1.97
Ilala	Awash river	8	0.74-3.17	2.16	1.30-1.75	1.46	0.32-1.86	1.01	1.46-4.37	2.88	0.22-1.03	0.63	0.83-2.31	1.93
waktiyo	Awash river	8	0.87-2.95	1.85	1.0-1.64	1.31	0.51-1.58	0.96	1.92-4.03	2.98	0.36-0.95	0.67	1-2.27	1.72
Kobolito	Awash river	8	0.68-2.56	1.72	1.17-1.76	1.55	0.37-1.12	0.72	2.16-4.32	3.2	0.55-0.86	0.65	0.78-2.07	1.58
Lume	Awash river	8	1.18-3.74	2.41	1.2-2.73	2.08	0.4-1.32	0.96	1.35-3.81	3.44	0.55-0.86	1.23	1.36-2.62	1.95

Table 7. *Mean concentration (meq/L) of major ions and Sodium adsorption ratio (SAR) in Oromia mid rift valley irrigation water source, N is sample size values in brackets () are permissible limits in irrigation water. Values in bold and under line are above permissible limits in irrigation water.*

Site location	Water source	N	Na^+ (0-40)		Ca^{2+} (0-20)		Mg^{2+} (0-5)		CO_3^{2-}+HCO_3^- (0-10)		Cl^- (0-30)		SAR (0-15)	
			range	mean	range	mean	range	mean	range	mean	range	mean	range	mean
wenjii	Ground water	6	3.65-9.52	7.57	1.13-3.49	2.67	0.68-1.16	0.91	11.06-13.5	12	0.81-1.19	1.08	3.73-6.23	5.62
Tuchisumayan	Ground water	8	17.35-27.18	22.29	0.64-1.18	0.91	0.78-1.8	1.14	14.13-16.32	15.13	1.28-2.19	1.73	20.5-22.31	22.09
Shubigamo	Ground water	8	10.13-19.51	13.31	0.41-0.93	0.66	0.48-1.39	1.02	10.68-12.75	11.47	0.38-0.85	0.62	15.2-18.09	14.57
Korke Adi	Ground water	6	14.51-35.4	9.18	0.75-2.72	1.41	0.26-1.68	1.07	15.86-20.64	8.05	0.62-1.28	1.1	20.47-23.5	21.55

Table 8. *Mean concentration (meq/L) of major ions and Sodium adsorption ratio (SAR) in Oromia mid rift valley irrigation water source, N is sample size values in brackets () are permissible limits in irrigation water. Values in bold and under line are above permissible limits in irrigation water.*

Site location	Water source	N	Na^+ (0-40)		Ca^{2+} (0-20)		Mg^{2+} (0-5)		$CO_3^{2-}+HCO_3^-$(0-10)		Cl^- (0-30)		SAR (0-15)	
			range	mean	range	mean	range	mean	range	mean	range	mean	range	mean
Batigarmama	Koka Lake	8	0.59-1.2	1.5	1.18-1.7	1.44	0.42-1.12	0.72	1.56-3.76	2.79	0.37-0.96	0.63	0.66-2.02	1.42
Korke Adi	Lake (ziway)	8	5.8-11.5	8.28	0.9-1.61	1.94	0.21-1.6	1.03	5.16-11.17	8	0.76-1.57	1.55	8.26-8.48	8.28
Wayu gebrel	Lake (ziway)	8	2.94-7.0	5.12	1.17-1.9	1.49	0.83-1.91	1.31	5.00-8.25	6.79	0.5-1.1	0.75	2.89-5.11	4.34
Ziway	Lake	8	2.2-3.16	2.75	0.94-1.33	1.05	0.71-1.26	0.94	3.19-4.30	3.81	0.56-.98	0.72	2.43-2.77	2.75

Table 9. *Sodicity and salinity class of water samples collectedfrom different site and water bodies.*

Site location	Water source	SAR	Sodicity Class	EC (µS/cm)	Salinity Class
Gidara	Awashriver	1.565	Low (S1)	344.7	Medium (C2)
Diresede	Awashriver	1.915	Low (S1)	332	Medium (C2)
Fateledy	Awash river	1.975	Low (S1)	370	Medium (C2)
Ilala	Awashriver	1.93	Low (S1)	379.8	Medium (C2)
Waktiyo	Awashriver	1.725	Low (S1)	346.05	Medium (C2)
Kobolito	Aawsh river	1.58	Low (S1)	372.85	Medium (C2)
Lume	Awashriver	1.955	Low (S1)	434.2	Medium (C2)
Wenjii	Ground water	5.62	Low (S1)	1285.1	High (C3)
Tuchisumayan	Groundwater	22.095	High (S3)	2050	High (C3)
Shubigamo	Ground water	14.58	Medium (S2)	1252	Medium (C2)
Korke Adi	Ground water	21.555	High (S3)	2627.5	Very High (C4)
Batigarmama	Koka lake	1.42	Low (S1)	308.3	Medium (C2)
Korke Adi	Lake (zeway)	8.28	Low (S1)	947.35	High (C3)
Wayu gebrel	Lake (zeway)	4.34	Low (S1)	836.5	High (C3)
Zeway	Lake	2.755	Low (S1)	466.85	Medium (C2)

3.1. Salinity and Conductivity of Irrigation Water Source

3.1.1. Salinity and Conductivity of River

Awash River at different sampling point show a wide range of salinity and conductivity measurements that varied from 212.48 to 277.9 mg/L and 332µS/cm and 434.2µS/cm respectively (Table 2). The average mean of Awash River at different sites are under usual range for irrigation in terms of the TDS and EC [3], and thus could be regarded as suitable for irrigation.

3.1.2. Salinity and Conductivity of Ground Water

The irrigation water samples collected from ground water from different sites of mid rift valley show a wide range of salinity and conductivity measurements that varied from 801.3 to 1681.6 mg/L and 1252µS/cm and 2627.5µS/cm respectively (Table 3). Irrigation water samples collected from underground water of two peasant associations (Tuchi-sumayan &Korke Adi) which are found in Dugda district were showed that, the area are under increasing water quality problem (Table 3). The chemistry of those underground waters is probably influenced by their leaching and accumulation of dissolved salts. Unless management practices may be done, using underground water for irrigation purpose in Tuchi-sumayan and Shubi-gamo PA will result in sever salinity problem in very near future. Hence, those sites need special attentions.

3.1.3. Salinity and Conductivity of Lake

The irrigation water samples collected from Zeway and Koka Lakes at different sites show a wide range of salinity and conductivity measurements that varied from 197.9 to 606.3 mg/L and 308.3µS/cm and 947.35µS/cm respectively (Table 4). The mean values of salinity and conductivity of those lakes at different sites are under usual range for irrigation in terms of the TDS and EC [3]. Therefore, those lakes could be regarded as suitable for irrigation purpose. The concentrations of both of salinity and conductivity of water sample from lakes were found in a decreasing order (Zeway lake at Kore Adi site > Zeway lake at Wayu gebrel > Zeway lake at municipal > Koka Lake). The high mean value of both the salinity and conductivity for Zeway Lake at Korke Adi site is probably influenced by saline surface runoff and accumulation of dissolved salts from agricultural land and road. On other way, the Lake is under great pressure at this site from the surrounding huge number of cattle for grazing and drinking. So, further investigation on soil is needed in this site to know the source of salt.

A study on the seasonal variation of salinity of Lake has shown that the salinity values of irrigation water from Zeway and Koka Lakes at different site vary during the wet and dry seasons. Seasonal analyses of electrical conductivities of irrigation water sample showed that wet regime were lower than the dry regime. The lower limit under range indicates the laboratory result in wet regime while upper limit shows in dry regime (Table 5). The reason for this could be due to the dilution effect of non-saline surface run off and less evaporation rate during the wet seasons.

3.2. pH of Irrigation Water

pH of irrigation water source in mid rift valley:-

The mean pH values of Awash River at different sampling sites is about 7.9 (Table 2), hence, it categorized under usual ranges for irrigation purpose [3]. The same is true for ground water at different sampling sites, which is about 7.87 (Table 3). The mean pH values of Zeway and Koka Lakes is about

8.0 (Table 4), with high value indication at Zeway Lake. But there was a large fluctuation over the study period. This suggests that the suitability of the water source for irrigation, with respect to their pH values, is seasonally variable.

3.3. Ionic Composition of Irrigation Water

3.3.1. Ionic Composition of River

Na^+ was the most dominant cation with range 1.57 to 2.41meq/Lat all sampling location of Awash River and CO_3^{2-} + HCO_3^- (total alkalinity) was the major anions with range of 2.64 to 3.44 meq/L (Table 7). It is interesting to note that none of the cations and anions was found in concentration higher than the permissible limits in any sampling location of Awash River [3]. The concentrations of cations of water sample from Awash River at different sampling location were found in a decreasing order for both cation ($Na^+>Ca^{2+}>Mg^{2+}$) and anion ($(CO_3^{2-} + HCO_3^-)>Cl^-$). The total alkalinities in the study area were mainly due to HCO_3^-, while carbonate was not detected in most sampling location of Awash River. The river of study area are originating from the highlands which feed it the most dilute waters (waters of very low ionic content), hence it has low ionic composition. However, evaporative concentrations and the addition of saline thermal waters, that obtains the solutes from rocks through which they pass, may sometimes lead to higher concentration of solutes in the rivers [14].

Irrigation water sample analysis of Awash River at different sites has shown that ionic compositions vary during wet and dry seasons. The ionic composition of samples taken from all sites showed wet regime was lower than the dry regime. The lower limit under range indicates the laboratory result in wet regime while upper limit shows in dry regime (Table 6). Moreover, the variations were seen between the two consecutive years of the study period (Table 5). The analysis of water sample of later year was showed higher ionic composition than the first year. The reason for this could be due to the accumulation of dissolved salt as result of evaptransparation and long dry spell during the second year of study period.

3.3.2. Ionic Composition of Ground Water

Na^+ and CO_3^{2-} + HCO_3^- (total alkalinity) were the most dominant cation and anion ranging 9.18 to 22.29 meq/L and 8.05 to 15.13 meq/L in all ground irrigation water used as sampling points respectively (Table 8). Total alkalinity (CO_3^{2-} + HCO_3^-) from two PA of Dugda district was found to be higher than the permissible limits for irrigation (Table 7), while in the rest of study area they were found in the range of permissible limits to be used for irrigation [3]. In these PA it is also possible to note that the composition of Ca^{2+} and Mg^{2+} are lower as compared to other sites, while composition of Na^+ was found to be higher. The lower in calcium and magnesium possibly due to precipitation as carbonates when the water is concentrated by transpiration and evaporation. The concentrations of cations of water sample from ground of Wenji and korke Adi were found in a decreasing order as $Na^+>Ca^{2+}>Mg^{2+}$, while, it were found in a decreasing order as $Na^+>Mg^{2+}>Ca^{2+}$ in Tuchisumaya and Shubigamo sites (Table 7). Similarly, the concentrations of anions were found in the decreasing order of $(CO_3^{2-} + HCO_3^-)>Cl^-$ in all ground irrigation water used as sampling points.

Although, the concentration of Na^+ were found to be in usual ranges for irrigation water in study sites there are an indication for potential sodium hazards. Especially for those PAs'in the Dugda district, special attention should be given for irrigation water source used from underground.

3.3.3. Ionic Composition of Lake

Similar to River and Ground irrigation water source above, Na^+ was the most dominant cation with range 1.50 to 8.28 meq/L at all location of Lake irrigation water sampling point and CO_3^{2-} + HCO_3^- (total alkalinity) was the major anions with range of 2.79 to 8.0 meq/L (Table 8). The same to Awash River the lakes of study area are originating from the highlands which feed it the most dilute waters (waters of very low ionic content), hence it has low ionic composition compare to ground water source.

Concentrations of Cl^-: Concentrations of Cl^-in all the water samples were lower than the permissible limits in irrigation waters (Table 6, 7 & 8) [3].

3.4. Sodium Adsorption Ratio (SAR) of Irrigation Water Source

3.4.1. Sodium Adsorption Ratio (SAR) of River

The sodium adsorption ration (SAR) of river at sampling location were showed variation ranging 1.56 to 1.97 (Table 6). Although the amount and combination of many substances define the suitability of water for irrigation and the potential for the plant toxicity, SAR is the most important determinant. Hence by considering SAR as an indicator of suitability of water for irrigation, water samples taken from Awash River at different sampling location can be considered suitable for irrigation [3].

3.4.2. Sodium Adsorption Ratio (SAR) of Ground Water

The sodium adsorption ration (SAR) of ground irrigation water from sampled well showed variation from 5.62 to 22.09 (Table 6). The ground irrigation water samples taken from Tuchi-sumayan, Korke Adi and shubi-gamo PAs'were high and regarded as unsuitable for continuous use of irrigation based on their SAR values (Table 7) according to classification standard stated for irrigation water quality by [3].

3.4.3. Sodium Adsorption Ratio (SAR) of Lake

Sodium adsorption ratio (SAR) content in Lake in the study area showed variation from 1.42 to 8.28 (Table 8). Similar to water sample taken from Awash River at different sites water sample taken from all the Lakes can also be considered suitable for irrigation [3].

4. Conclusion and Recommendation

Analysis result of sample collected from different irrigation water source of mid rift valley of Oromia region indicated that water from Awash River at different district can be suitable for irrigation purpose. Lake zeway and koka can also be confidently assumed to be suitable for irrigation based on almost all aspects of their chemical composition. Irrigation waters containing high concentration of Na^+ are of special concern because of sodium's effects on the soil, and the so-called sodium hazard, which is expressed in terms of SAR. Based on their SAR values water samples taken from two PA (Korke Adi and Tuchi-sumayan) of Dugda district were regarded as unsuitable for irrigation purpose. This unsuitability of irrigation water also intensified by high total alkalinity (CO_3^{2-} + HCO_3^-), which were above permissible limits for irrigation. The Cl^- which is one of the toxic ions for irrigated crop was below the permissible limits and this information would be important if any of these water sources will be used for irrigation.

The water quality of samples from the study area showed that about 60% of the samples fell in the C2-S1 category (medium salinity with low sodicity hazard), 20% of the samples fell in the category C3-S1 (high salinity with low sodicity hazard), 6.66% of the samples fell in the category C2-S2 (medium salinity with medium sodicity hazard), 6.66% of the samples fell in the category C3-S3 (high salinity with high sodicity hazard), and 6.66% of the samples fell in the category C4-S3 (very high salinity with high sodicity hazard). It was irrigation water from underground which fell in the category of very high in salinity and high in sodicity hazards.

Finally, although this paper deals with the suitability of the irrigation waters of mid rift valley of Oromia region in light of their chemical composition only, it is not possible to classify different qualities of irrigation water with cut boundaries, and therefore one must consider plant, soil, climatic conditions as well as existing agronomic and irrigation practices in deciding the usefulness of the water for irrigation. Even those water bodies that are assumed to be suitable for irrigation could develop problems over long term use. Hence, the reference given here should only be taken as an initial point of study. It is evident that the waters from the different area of east Shoa zone of Oromia region that have been assumed to be unsuitable for irrigation here, could be acceptable for irrigation when evaluated in combination with the other factors mentioned above, or if certain management options are applied. Therefore, future study should focus on soil type and tolerance of crops to be used. This study output can be used by planers, managers, investors and agriculturalist as basic information.

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