Assessment of soil salinity and irrigation water quality at Tahtay-adyabo district, Northwestern Tigray, Ethiopia

Abstract

A study was conducted in Tahtay Adyabo northern Ethiopia to assess the salinity and irrigation water quality at farmer-level irrigation sites in 2012. irrigation sites was identified and sampling units was assigned. 38 soil samples were collected from 19 plots (Dugub, Endaserawat, Mytewldish, Egum dima, and scattered wells) at depths of 0-30cm and 30-50cm, along with 21 water samples from 14 wells and 7 rivers. These samples were then analyzed at the Shire Soil Laboratory for salinity and fertility parameters.The results showed that the salinity status of surface soil at 0-30cm depth for dugub, scattered wells, and myteweldish was 75% non-saline and 25% slightly saline. For Endaserawat, 50% was slightly saline, 25% moderately saline, and 25% strongly saline. Egum Dima showed 67% slightly saline and 33% moderately saline. In subsurface soil at 30-50cm depth, dugub, scattered wells, and myteweldish were 75% non-saline and 25% slightly saline, while Endaserawat was 25% slightly saline and 75% moderately saline, and Egum Dima was 67% slightly saline, 16.5% moderately saline, and 16.5% strongly saline.Water analysis for the wells showed that out of 14 samples, 21% were non-saline, 21% were slightly to moderately saline, and 57% were severely saline. For the rivers, out of 7 samples, 43% were slightly to moderately saline and 57% were severely saline. Overall, out of 21 water samples from wells and rivers, 14% were non-saline, 29% were slightly to moderately saline, and 57% were severely saline. In general, the salinity status in Dugub, Endaserawat, Mytewldish, and Egum Dima varies from non-saline to strongly saline, but the severity is more pronounced in Endaserawat and Egum Dima.This salinity is attributed to the parent material and the water table. Crop selection , integration of organic matter, applying extra irrigation water and regular salinity monitoring is recommended, to optimize the productivity of the soils in the irrigation site..

Key words: *irrigation water quality,Soil salinity,salinity management and Tahtay adyabo,.*

,Introduction

Soil Salinity is the presence of excessive concentrations of soluble salts, basically sodium,chlorides and sulfates(1). Salinity problems are common in arid and semi-arid regions of the world where rainfall is insufficient to satisfy crop water requirements (2). This results in the accumulation of soluble salts on the surface or subsurface of the soil profile, which affects plant growth and development (3, 4).Salinization is the severe form of land degradation because reclamation is costly once affected (2). Great early civilizations like those in Mesopotamia, which developed in the Tigris and Euphrates rivers, were based on fertile soil in the river deltas. However, they could not last due to severe long-term salinization (5). Soil salinity and alkalinity problems are particularly severe in developing countries, especially arid and semi-arid regions, resulting in damage to the livelihoods of people in the short term and long term effects on the food security of the country (6, 7).Though soils salinity occur in all continents and under almost all climatic conditions, their distribution is relatively extensive in arid and semi-arid regions. The nature and properties of these soils are also diverse, requiring specific approaches for their reclamation and management to maintain their long-term productivity. For any long-term solutions, it is necessary to understand the mode of origin of salt-affected soils and classify them based on their physio-chemical characteristics, processes leading to their formation, and likely approaches for their reclamation and successful management (8).In addition to these, heavy fertilizer application, the use of poor quality irrigation water, and inadequate drainage have contributed to rising groundwater tables, leading to salinity-induced land degradation. The occurrence of potential sodicity hazards happens both in the soil and in the irrigation water, and their study indicates the need for selecting salt-tolerant crops and good water management by using appropriate irrigation methods to sustain productivity (9, 10).

Based on the claims of local farmers and expert assessments, a study was conducted in Tahtay Adyabo, specifically in Mentebteb, to assess soil salinity and irrigation water quality in small-scale irrigation at the farmers' level. Although different attempts have been made by various researchers, there has never been a comprehensive study of the soil salinity and irrigation water quality problems in the study area. Hence, the main goal of this study was to assess soil salinity and irrigation water quality in small-scale irrigation at the farmers' level in Tahtay Adyabo, specifically in Mentebteb.

2. Materials and Methods

2.1 description of the study area

The research was conducted in Tahtay Adyabo, specifically within the Mentebteb district in northwestern Tigray, Ethiopia. Its precise geographical coordinates are depicted on the map provided below.

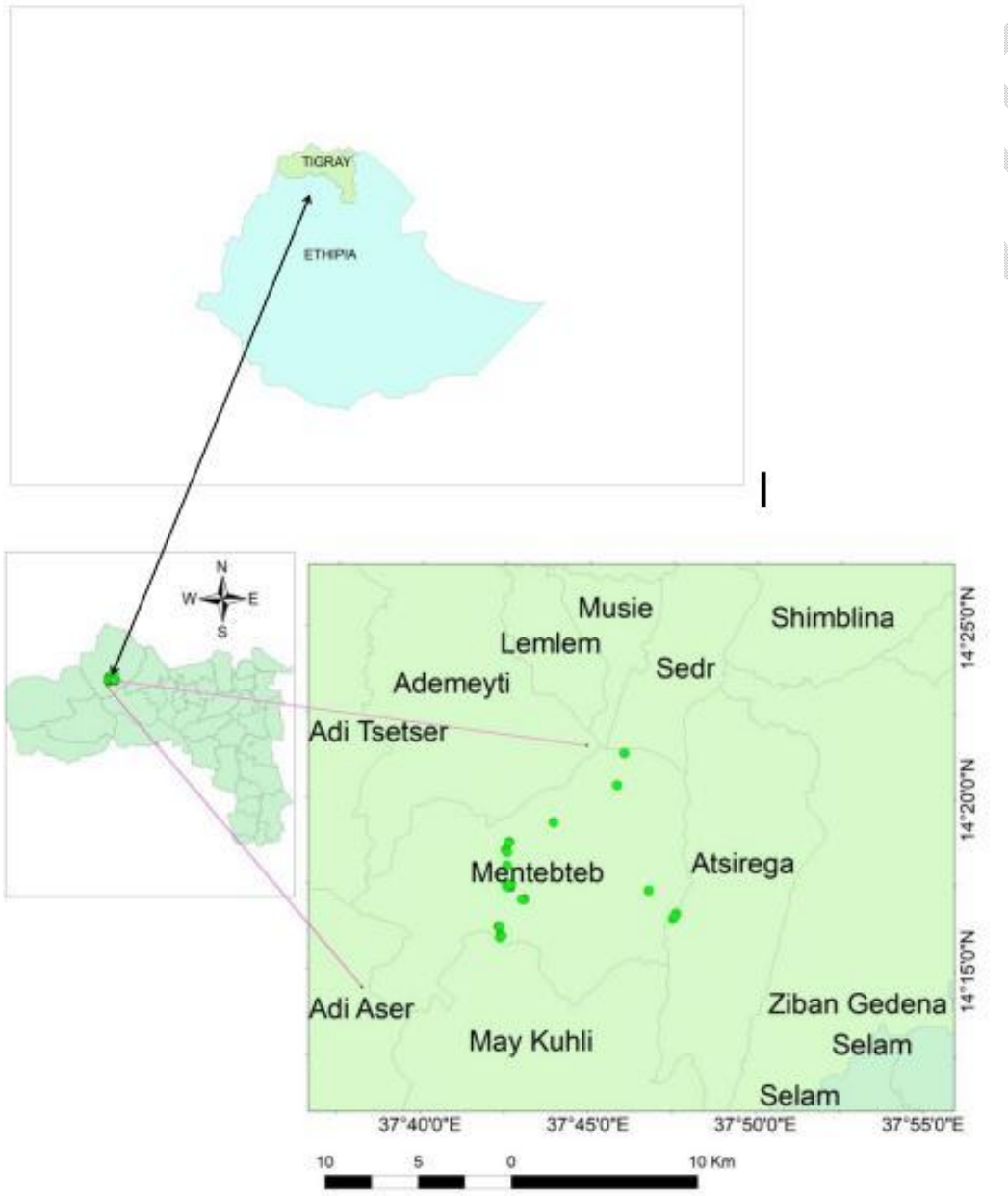


Figure 1. The study map of the mentebteb irrigation site

2.3. Methods

2.3.1 Selection of site for soil and water samples:

Per the requests made by local farmers and experts, Mentebteb Tabia was chosen as the location for the evaluation of soil salinity and water quality. The wereda bureau of water resources supplied geographical data for each irrigation site (BOWR,.2012) unpublished. These XY coordinates were then transformed into KML format using ArcGIS 10.4, allowing them to be accessed on a tablet through the Locus free application. Subsequently, mobile or tablet GPS applications were utilized to locate each irrigation site using these secondary geographical coordinates.

2.3.2 Soil and water sampling:

After the secondary XY point data was converted to KML format, it was uploaded to a tablet (mobile device) and then exported to the Locus free application. Each point was then tracked using GPS to determine the sample locations. A total of 38 soil samples (at depths of 0-30 cm and 30-50 cm) and 21 water samples (14 from wells and 7 from rivers) were collected and georeferenced on-site, as the locations obtained from the secondary data may vary slightly from the actual on-site locations. Approximately 1 kg of soil sample was collected in plastic bags, and one liter of water sample from the irrigation water sources was collected in clear plastic containers labeled with each sample's information.

2.3.3 parameters analyzed at Soil and water laboratory

The soil samples were collected, air-dried, ground, and sieved through a 2 mm sieve in the preparation room to prepare them for laboratory analysis. In the laboratory, the samples underwent analysis for physical properties such as texture and bulk density, as well as for pH, electrical conductivity (EC), organic carbon (OC), available phosphorus (P), cation-exchange capacity, and exchangeable bases (Ca, Mg, K, and Na) among other soil chemical properties. Additionally, key salinity indicators including sodium adsorption ratio (SAR), total dissolved solids (TDS), exchangeable sodium percentage (ESP), and

percentage base saturation (PBS) were determined using empirical formulas as indicated in equations 1 to 4.

2.3.4 2.3.4 Analysis of soil physico-chemical properties

The soil particle size distribution, or texture, was determined using the Bouyoucos hydrometer method in accordance with (11). Bulk density was ascertained from undisturbed soil samples collected via core samplers, weighed at field moisture content, and subsequently dried at 105°C.Soil pH was measured using the potentiometer method (pH meter), a widely recognized and precise technique for determining soil pH. This method involves creating a soil-water suspension by mixing soil with distilled water. after stirring and settling of the mixture, the pH of the soil is measured using a pH meter, at 1:5 soil-to-water ratio as described by(12), was used. The Walkey-Blak method, involving wet oxidation and subsequent titration analysis, was employed to determine soil organic carbon content in percentage (13)

The Olsen method, utilizing sodium bicarbonate as the extracting solution, was utilized to determine the available phosphorus. The exchangeable bases (Ca, Mg, K, and Na) in the soil were determined from the leachate of a 1 molar ammonium acetate solution at pH 7.0, employing the ammonium acetate method. Exchangeable Ca and Mg in the extract were measured via titration method, while K and Na were assessed using a flame photometer from the same extract (14). Similarly, the cation exchange capacity (CEC) was assessed by leaching the ammonium acetate-extracted soil samples with a 10% NaCl solution and determining the ammonium ion amount in the percolate using the Kjeldahl procedure, and reported as CEC (15). Total nitrogen was determined using the digestion method (16).

2.3.5 Water quality analysis

The collection and handling of irrigation water samples from both wells and rivers adhered to the procedures outlined by the US Soil Salinity Laboratory (17). Each sample unit yielded one liter of water sample for analysis, focusing on parameters such as pH, EC, Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}. TDS and SAR were determined using empirical formulas. Furthermore, the computation of the sodium adsorption ratios (SAR) for both soil solution and irrigation water samples was conducted as per standard protocols (18).

$SAR = Na^{+}/[(Ca^{2+} + Mg^{2+})/2]^{1/2}$----------(1)

TDS=ECw*640----------(2)

$PBS = (Na^{+} + Ca^{2+} + Mg^{2+} + K^{+})/CEC*100$----------(3)

$ESP = Na^{+}/ (Na^{+} + Ca^{2+} + Mg^{2+} + K^{+})*100$----------(4)

2.3.6 Data analysis and interpretation

The laboratory-generated data were analyzed and compared in accordance with the standard rates described for different parameters (19).

3. RESULT AND DISCUSSION

3.1 Soil analysis and interpretation

Table1. Soil chemical parameters and their properties in Dugub site.

Code	P^H	rating	ECe	rating	CEC	rating	Ex. K^+	Ex. Na^+	Ex. Ca^{2+}	Ex. Mg^{2+}	SAR	PBS	ESP	**Tex**
			ds/m		Meq/100g of soil							%		
sol1-30	6.9	N	2.11	SLS	45.4	VH	0.27	0.25	6.4	5.2	0.110	26.69	2.08	**C**
sol1-50	7.19	N	1.38	NS	31.2	H	0.22	0.35	4.4	4.8	0.162	31.33	3.63	**C**
sol2-30	6.93	N	1.66	NS	26.4	H	0.29	0.27	4	5.6	0.113	38.48	2.64	**C**
sol2-50	9.03	VSAL	1.98	NS	43	VH	0.14	0.69	5.2	6.8	0.264	29.82	5.37	**C**
sol3-30	6.86	N	1.68	NS	26.8	H	0.25	0.26	3	0.2	0.582	13.86	7.01	**C**
sol3-50	6.7	N	0.95	NS	28.6	H	0.26	0.29	5	1.4	0.242	24.28	4.12	**C**
sol4-30	6.71	N	1.015	NS	25	H	0.22	0.23	1.2	7.2	0.084	35.36	2.55	**CL**
Sol4-50	6.9	N	2.11	SLS	45.4	H	0.27	0.25	6.4	5.2	0.11	26.69	2.08	**CL**

Abbreviations: N=Neutral, VSAL=Very strongly alkaline, SLS= Slightly saline, NS=None saline, VH=Very high, H=high, C=Clay, CL=Clay Loam, P^H = hydrogen ion concentration, ECe=electrical conductivity of saturated past, CEC= Cation exchange capacity, EX.(K^+,Na^+,Ca^{2+},Mg^{2+})= Exchangeable (potassium, sodium, calcium and magnesium) respectively, SAR=sodium absorption ratio, ESP=Exchangeable sodium percentage, PBS=percentage base saturation.

According to the findings presented in Table 1, the soil at the farm level in Tahtay Adyabo, specifically in the Mentebteb district, was evaluated for general salinity, sodicity, and fertility. The results indicate the absence of saline and sodicity conditions within the 0-30cm and 30-50cm depths of the Dugub farm level irrigation. The pH levels remain neutral except for plot 2 at a depth of 30-50cm, which exhibits highly alkaline properties. The soil's cation exchange capacity (CEC) is notably high, and the percent base saturation (PBS) is well within the expected range. Overall, the soil is devoid of salinity and sodicity concerns, making it fertile for a wide range of agricultural crops (17).

Table 2 Soil salinity parameters for Endaserawat.

Code	pH	rating	ECe ds/m	rating	CEC	rating	Ex. K^+	Ex. N^+	Ex. Ca^{2+}	Ex. Mg^{2+}	SAR	PBS	ESP	**Tex**
					meq/100g of soil							In %		
sol5-30	7.53	SLAL	2.1586	SLS	15.2	M	0.05	0.44	0.2	5.6	0.185	41.36	6.95	**SCL**
sol5-50	8.11	MAL	4.128	MS	38.4	H	0.13	0.18	1.6	8.4	0.061	26.85	1.72	**C**
sol6-30	7.2	N	3.0143	SLS	28.6	H	0.12	0.22	3.6	4.4	0.106	29.17	2.65	**CL**
sol6-50	8.18	MAL	4.4505	MS	35.4	H	0.13	0.35	6.2	6	0.145	35.82	2.79	**C**
sol7-30	7.94	MAL	5.246	MS	26.8	H	0.15	0.42	4.4	4.8	0.192	36.46	4.29	**CL**
sol7-50	8.04	MAL	5.203	MS	38.4	H	0.12	0.39	8.8	2.6	0.241	31.01	3.27	**CL**
sol8-30	9.38	VSAL	8.858	STS	29.4	H	0.11	5.05	16.4	7.8	1.807	99.86	17.19	**CL**
sol8-50	6.95	N	1.1524	NS	27.4	H	0.17	0.20	4.4	0.2	0.450	18.16	4.05	**C**

Abbreviations: N=Neutral, VSAL=Very strongly alkaline, SLS= Slightly saline, NS=None saline, VH=Very high, H=high, C=Clay, CL=Clay Loam, P^H = hydrogen ion concentration, ECe=electrical conductivity of saturated past, CEC=Cation exchange capacity, EX.(K^+,Na^+,Ca^{2+},Mg^{2+})= Exchangeable (potassium, sodium, calcium and magnesium) respectively, SAR=sodium absorption ratio, ESP=Exchangeable sodium percentage, PBS=percentage base saturation.

According to the findings presented in Table 2, the soil in Tahtay Adyabo, specifically in the Mentebteb district, was evaluated for general salinity, sodicity, and fertility status at the farm level. The results indicate a range from medium to slightly saline overall, with no sodicity issues, except for sample number 8 which demonstrates strong salinity and a sodium hazard at the surface (0-30 cm) and non-salinity with no sodium hazard at the sub-surface (30-50 cm) for the Endaserawat farm level irrigation. pH levels suggest that the soil is moderately alkaline throughout the depth, except for plot 8 at the surface (0-30 cm) which shows very strong alkalinity, while the sub-surface (30-50 cm) is neutral. The soil's cation exchange capacity (CEC) is rated as high. The percent base saturation (PBS) serves as the primary indicator of fertility, showing favorable conditions at the study site. Overall, the soil is medium to slightly saline with no sodicity issues, except for plot 8 at the surface, indicating sodicity problems. Further investigation into management options is recommended(20).

Table 3. Soil salinity parameters for the site in Myteweldish.

Code	pH	rating	ECe	rating	CEC	rating	Ex. K^+	Ex. N^+	Ex. Ca^{2+}	Ex. Mg^{2+}	SAR	PBS	ESP	**Tex**
			ds/m		meq/100g of soil							In %		
sol9-30	7.25	N	1.844	NS	24	M	0.28	0.25	1	4.8	0.114	26.38	3.93	**C**
sol9-50	6.14	SLAL	1.419	NS	29	H	0.19	0.20	4.6	1	0.200	20.66	3.35	**C**
sol10-30	6.25	SLAL	2.033	SLS	21.8	M	0.13	0.18	1.2	4.6	0.083	28.03	2.90	**CL**
sol10-50	5.81	MAL	1.401	NS	30.4	H	0.17	0.20	1	5	0.090	20.97	3.16	**C**
sol11-30	5.78	MAL	1.8667	NS	16.6	M	0.11	0.12	2.4	3.2	0.066	35.12	2.02	**L**
sol11-50	7.88	SLAL	2.846	SLS	40.8	VH	0.18	0.19	0.8	8.6	0.064	23.95	1.91	**C**

Abbreviations: N=Neutral, VSAL=Very strongly alkaline, SLS= Slightly saline, NS=None saline, VH=Very high, H=high, C=Clay, CL=Clay Loam, P^H = hydrogen ion concentration, ECe=electrical conductivity of saturated past, CEC=Cation exchange capacity, EX.(K^+,Na^+,Ca^{2+},Mg^{2+}) = Exchangeable (potassium, sodium, calcium and magnesium) respectively, SAR=sodium absorption ratio, ESP=Exchangeable sodium percentage, PBS=percentage base saturation.

Based on the findings presented in table 3, a comprehensive assessment of the soil at the farm level in the Tahtay Adyabo, specifically the Mentebteb district, was conducted to evaluate its general salinity, sodicity, and fertility status in relation to irrigation. The results indicate that the soil exhibits no salinity or sodicity issues, except for sample numbers 10 and 11, which showed slight salinity at the surface (0-30) and sub-surface (30-50) levels, respectively in Myteweldih irrigation site.The pH levels of the soil reflect a predominantly medium to slightly alkaline nature throughout the depth, with the exception of plot 9 at the surface (0-30), which exhibited a neutral pH. Furthermore, the cation exchange capacity (CEC) of the soil was observed to be medium to high, displaying an increasing pattern across different depths. Conversely, the percent base saturation (PBS) was rated as medium to high and displayed a decreasing trend with depth. The textural class of the soil varied from clay to clay loam.In summary, the assessment indicates that the soil is non-saline, free from sodicity hazards, and holds significant fertility potential for various agricultural crops(20, 21).

Table 4 Soil salinity parameters for Asphalt and ela kidane, ela haile, and ela abraha

Code	P^H	rating	ECe	rating	CEC	rating	Ex. K^+	Ex. N^+	Ex. Ca^{2+}	Ex. Mg^{2+}	SAR	PBS	ESP	**Tex**
			ds/m				Meq/100g of soil					In %		
sol12-30	8.05	MAL	2.597	SLS	32.2	H	0.40	0.16	1.8	7.2	0.061	29.71	1.72	**C**
sol12-50	8.18	MAL	3.690	SLS	32.6	H	0.43	0.29	2.8	0.8	0.319	13.22	6.62	**SACL**
sol13-30	8.08	MAL	4.028	MS	19.2	M	1.53	0.12	4.4	1.6	0.093	39.85	1.54	**SACL**
sol13-50	6.04	MAL	2.137	SLS	23.4	M	0.27	0.10	1	2.2	0.065	15.23	2.72	**SACL**
sol14-30	6.3	SLAL	4.056	MS	21	M	0.41	0.06	1.8	3.8	0.032	28.89	1.03	**L**
sol14-50	6.54	SLAL	2.498	SLS	35.8	H	0.15	0.21	1.6	6	0.087	22.23	2.67	**L**

Abbreviations: N=Neutral, VSAL=Very strongly alkaline, SLS= Slightly saline, NS=None saline, VH=Very high, H=high, C=Clay, CL=Clay Loam, P^H = hydrogen ion concentration, ECe=electrical conductivity of saturated past, CEC=Cation exchange capacity, EX.(K^+,Na^+,Ca^{2+},Mg^{2+})= Exchangeable (potassium, sodium, calcium and magnesium) respectively, SAR=sodium absorption ratio, ESP=Exchangeable sodium percentage, PBS=percentage base saturation.

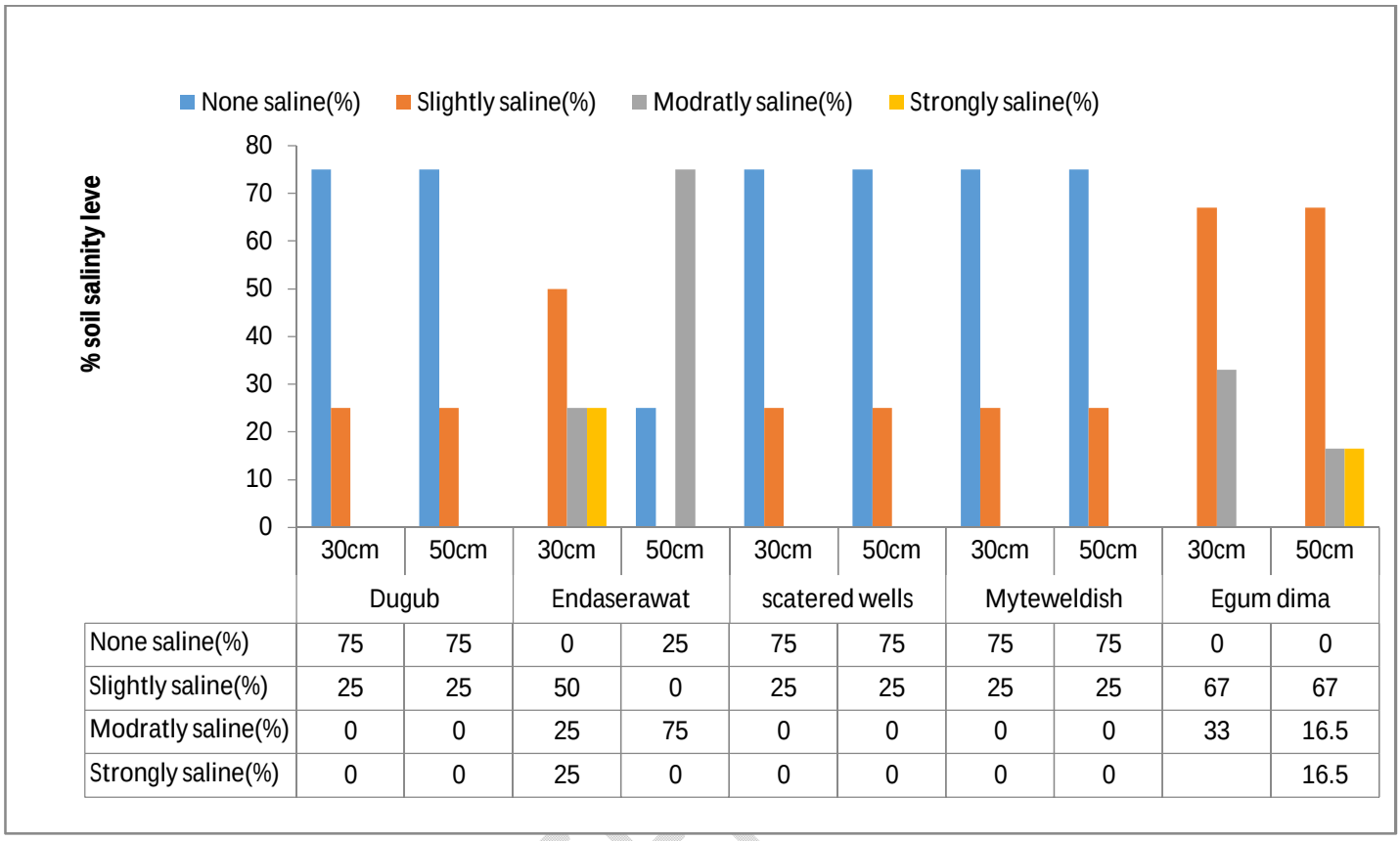
The findings presented in Table 4 reflect the assessment of soil salinity, sodicity, and fertility within the irrigation system at the farm level in Tahtay Adyabo, particularly in the Mentebteb district. It should be noted that the wells were non-operational during the sampling period. The results indicate that the soil obtained from Ela Kidane, Ela Haile, and Ela Abraha within the farm-level irrigation exhibits varying degrees of salinity, ranging from slight to medium, at 0-30cm and 30-50cm depths. The pH levels suggest a medium to slightly alkaline nature throughout the soil depth. Furthermore, the cation exchange capacity (CEC) of the soil is categorized as medium to high, displaying an increasing trend with depth. The percent base saturation (PBS) is rated as medium to high. based on the textural class ranges from loam to sand clay loam. In summary, the soil presents as non-saline with no sodicity hazard and possesses significant fertility potential for various agricultural crops(22).

Table 5. Soil salinity parameters for Degum dima and enda bula

Code	P^H	rating	ECe	rating	CEC	rating	Ex. K^+	Ex. N^+	Ex. Ca^{2+}	Ex. Mg^{2+}	SAR	PBS	ESP	**Tex**
			ds/m		meq/100g of soil							In %		
sol15-30	6.74	N	3.044	SLS	28	H	0.16	0.38	4.8	3.2	0.210	30.48	4.41	**SACL**
sol15-50	6.63	N	2.574	SLS	38.6	H	0.18	0.38	3.6	4	0.192	21.15	4.71	**L**
sol16-30	7.74	SLAL	5.158	MS	28	H	0.30	1.12	4	5.8	0.465	40.08	9.98	**SL**
sol16-50	7.53	SLAL	2.645	SLS	31.6	H	0.18	0.29	3	4	0.145	23.63	3.87	**SAL**
sol17-30	8.16	MAL	3.443	SLS	22.2	M	0.24	0.48	4.2	3.2	0.269	36.58	5.92	**L**
sol17-50	7.56	SLAL	2.554	SLS	51.4	VH	0.32	0.33	7	5.8	0.138	26.17	2.47	**C**
sol18-30	7.7	SLAL	3.457	SLS	44.8	VH	0.34	0.35	2.8	11.2	0.105	32.79	2.38	**SCL**
sol18-50	7.91	MAL	4.695	MS	53.6	VH	0.25	0.44	10.8	6.2	0.177	33.01	2.49	**C**
sol19-30	8.2	MAL	4.459	MS	48.8	VH	0.37	1.01	8.2	7.6	0.365	35.20	5.86	**C**
sol19-50	9.98	VSAL	10.40	STS	51.8	VH	0.35	0.39	9.6	5.9	0.160	31.34	2.40	**L**

Abbreviations: N=Neutral, VSAL=Very strongly alkaline, MAL= moderately alkaline, SAL=Slightly alkaline, SLS= Slightly saline, NS=None saline, VH=Very high, H=high, C=Clay, CL=Clay Loam, P^H = hydrogen ion concentration, ECe=electrical conductivity of saturated past, CEC=Cation exchange capacity, EX.(K^+,Na^+,Ca^{2+},Mg^{2+})= Exchangeable (potassium, sodium, calcium and magnesium) respectively, SAR=sodium absorption ratio, ESP=Exchangeable sodium percentage, PBS=percentage base saturation.

As per the findings presented in table 5, the soil in the Tahtay Adyabo region, specifically in the Mentebteb district, was evaluated for overall salinity, sodicity, and fertility status in the farm-level irrigation. The outcomes indicate varying levels of salinity from slight to moderate, with no sodicity issues observed for Egum dima and Enda bula at both 0-30cm and 30-50cm soil depths. However, it is worth noting that plot 19 at a subsurface depth of 30-50cm exhibited significant salinity and alkalinity, while plot 15 showed slight salinity throughout the depth. Furthermore, there is a discernible increasing trend of salinity and alkalinity with depth. The pH levels suggest a moderately to slightly alkaline soil profile across the depth. Additionally, the soil's cation exchange capacity (CEC) is rated as high to very high, while the percent base saturation (PBS) is classified as medium to high. The textural composition ranges from clay to sandy clay loam. In summary, the soil in Egum dima and Enda bula exhibits salinity characteristics but poses no sodicity risks, and it demonstrates good fertility potential for a wide range of agricultural crops(10).



	30cm	50cm	30cm	50cm	30cm	50cm	30cm	50cm	30cm	50cm
	Dugub		Endaserawat		scatered wells		Myteweldish		Egum dima	
None saline(%)	75	75	0	25	75	75	75	75	0	0
Slightly saline(%)	25	25	50	0	25	25	25	25	67	67
Modratly saline(%)	0	0	25	75	0	0	0	0	33	16.5
Strongly saline(%)	0	0	25	0	0	0	0	0		16.5

Figure 2, Status of soil salinity levels for mentebteb irrigation sit.

3.2 Irrigation Water quality analysis and interpretation

Table 6. water quality parameters of dugub and ratings based on (18)

location	code	pH	rating	ECw(ds/m	rating	TDS(ppm)	rating	Ex. N(meq/L	SAR	rating
dugub	W1	6.4	NR	0.632	NS	404.48	None	0.0357	0.016	None
dugub	W2	5.79	NR	0.553	NS	353.92	None	0.0509	0.025	None
dugub	W3	5.85	NR	0.645	NS	412.8	None	0.0522	0.023	None
dugub	R1	7.3	NR	1.3	S to M	832	S to M	0.0691	0.029	None

Abbreviations: W=Well, NR=normal range,NS=None saline, S to M=slight to medium ,P^H = hydrogen ion concentration, ECw=electrical conductivity of water, TDS=Total dissolved solids, $Ex.N^+$, Exchangeable sodium, SAR=sodium absorption ratio.

According to the data presented in table 6, the pH level of the tested irrigation water indicates that it is suitable for irrigation (18). Additionally, the ECw values obtained from wells W1, W2, and W3, along with the empirically calculated TDS values, suggest that there are no salinity or sodium hazard issues, as the SAR value is rated as very low, indicating no sodium hazard. In comparison, the water from the river shows a slightly to moderately elevated rate of salinity. Overall, the irrigation water quality for Dugub is deemed suitable for use, but caution is advised regarding the continued use of river water, as it may lead to salinity problems(23).

Table 7. Water quality parameters of Enda serawat and ratings based on (18)

Location	Code	PH	rating	ECw(ds/m)	rating	TSS(PPM)	rating	Ex. Na(meq/L)	SAR	rating
Enda Serawat	R2	7.82	NR	4.2	Sever	2688	Sever	0.1426	0.056	None
Enda Serawat	R3	7.85	NR	4.26	Sever	2726.4	Sever	0.1400	0.044	None
Enda Serawat	R4	7.68	NR	4.81	Sever	3078.4	Sever	0.1348	0.047	None
Miflah bun	R5	7.6	NR	5.01	Sever	3205.12	Sever	0.1809	0.063	None
Myteweldish	R6	7.12	NR	0.734	S to M	469.76	S to M	0.0357	0.019	None
Myteweldish	R7	6.71	NR	0.911	S to M	583.04	S to M	0.0526	0.028	None

Abbreviations: R=River, NR=normal range S to M=slight to medium, P^H= hydrogen ion concentration, ECw=electrical conductivity of water, TDS=Total dissolved solids, $Ex.N^+$,= Exchangeable sodium, SAR=sodium absorption ratio.

As per the findings presented in table 7, the pH level of the irrigation water indicates no adverse impact for irrigation(18). The ECw from the river and the empirically calculated TDS values suggest severe salinity issues for Endaserawat and Miflah bun, and mild to moderate issues for myteweldish. The SAR value, which is lower than 0.070, indicates no sodium hazard for the locations listed in table 7 (22).In summary, the irrigation water quality for Endaserawat is deemed unsuitable for irrigation. While the water for Miflah bun is deemed slightly suitable for irrigation, caution is advised due to the potential development of salinity issues with continuous use(24).

Table 8. Water quality parameters of Asphalt and ratings based on(18)

Location	Code	PH	rating	ECw(ds/m)	rating	TSS(PPM)	rating	Ex. Na(meq/L)	SAR	rating
Main road	W4	8.4	NR	3.95	Sever	2528	Sever	0.3130	0.117	None
Main road	W5	7.5	NR	5.007	Sever	3204.48	Sever	0.2948	0.104	None
Main road	W6	8.4	NR	4.46	Sever	2854.4	Sever	0.3474	0.125	None
Ela kidane	W7	7.6	NR	3.66	Sever	2342.4	Sever	0.0622	0.020	None
Ela Abraha	W8	7.4	NR	1.31	S to M	838.4	S to M	0.0626	0.026	None
Ela Haile	W9	7.5	NR	1.85	S to M	1184	S to M	0.1117	0.043	None

Abbreviations: W=Well, NR=normal range, S to M=slight to medium, P^H = hydrogen ion concentration, ECw=electrical conductivity of water, TDS=Total dissolved solids, Ex. Na^+= Exchangeable sodium, SAR=sodium absorption ratio.

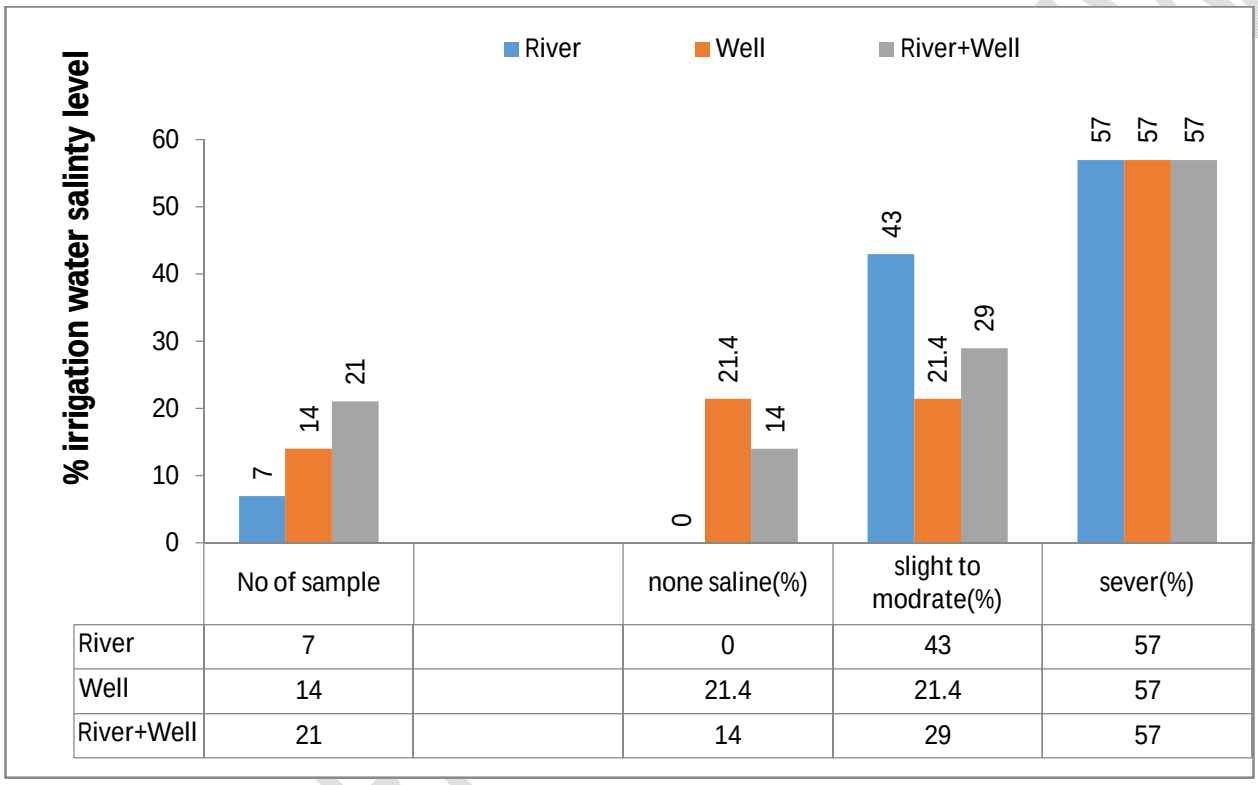
Based on Table 8, the pH level of the irrigation water tested indicates no significant impact on irrigation (18). However, the empirical calculation of the TDS value based on the ECw measurements from wells W4 to W9 suggests severe salinity issues. Despite this, there is no sodium hazard due to the low SAR value of less than 0.13, which is considered negligible. In general, the irrigation water quality for the wells listed in Table 8 presents severe problems, except for the last two wells, Ela Abrha and Ela Haile, which are deemed slightly to moderately suitable for use(20, 21).

Table 9. Water quality parameters of egum dima and enda bula and ratings based on(18)

Location	Code	PH	rating	ECw(ds/m)	rating	TDS(PPM)	rating	Ex. Na(meq/L)	SAR	rating
egum dima	W10	8.15	NR	3.51	Sever	2246.4	Sever	0.2104	0.066	None
egum dima	W11	7.33	NR	4.68	Sever	2995.2	Sever	0.2452	0.075	None
egum dima	W12	7.61	NR	3.009	Sever	1925.76	Sever	0.1696	0.059	None
Enda bula	W13	7.62	NR	2.87	S to M	1836.8	S to M	0.1626	0.059	None
Enda bula	W14	7.68	NR	4.92	Sever	3148.8	Sever	0.2383	0.083	None

Abbreviations: W=Well, NR=normal range, S to M=slight to medium, P^H= hydrogen ion concentration, ECw=electrical conductivity of water, TDS=Total dissolved solids, ex. Na^+=Exchangeable sodium, SAR=sodium absorption ratio.

The pH level of the irrigation water, as outlined in table 9, is within the acceptable range. Analysis of the water has revealed no negative impact on irrigation(18). Furthermore, the ECw value for wells W10-W14, along with the empirically calculated TDS value, indicates significant salinity issues but no sodium hazard, as the SAR value is notably low and rated as having no adverse effects. In summary, the irrigation water quality for Egum Dima, as detailed in table 9, suggests severe salinity challenges(25).



	No of sample		none saline(%)	slight to modrate(%)	sever(%)
River	7		0	43	57
Well	14		21.4	21.4	57
River+Well	21		14	29	57

Figure 3. Status of water quality at mentebteb at farmer level irrigation site

4. Conclusion and recommendation

4.1. Conclusion

The examination of soil salinity levels was conducted at depths of 0-30cm and 30-50cm, and the results were compared against the established standards. The analysis revealed the salinity status of the surface soil taken from depths of 0-30cm in Dugub, Scattered Wells, and Myteweldish, indicating that 75% of the samples were non-saline and 25% were slightly saline. In Endaserawat, 50% of the samples were slightly saline, 25% were moderately saline, and 25% were strongly saline (miflah bune). Similarly, in Egum Dima, 67% of the samples were slightly saline and 33% were moderately saline. Concurrently, the subsurface soil taken from depths of 30-50cm in Dugub, Scattered Wells, and Myteweldish showed that 75% of the samples were non-saline and 25% were slightly saline. In Endaserawat, 25% were slightly saline, and 75% were moderately saline, while in Egum Dima, 67% were slightly saline, 16.5% were moderately saline, and 16.5% were strongly saline.The water analysis from 14 well samples revealed that 21% were non-saline, 21% were slightly to moderately saline, and 57% were severely saline. From the 7 river samples, 43% were slightly to moderately saline, and 57% were severely saline. Overall, the analysis of 21 water samples (river + well) showed that 14% were non-saline, 29% were slightly to moderately saline, and 57% were severely saline. These results indicate the presence of salinity issues in both water and soil samples. With the exception of wells 1, 2, and 3 in Dugub, the entire water sample, including both river and well samples, exhibited poor quality for irrigation.

The soil analysis in the study area indicated slightly to moderately saline conditions, except in Dugub and Myteweldish, where the soil ranged from non-saline to slightly saline. The degree of salinity was highest in Endaserawat and Egum Dima.

4.2. Recommendation

Based on the of the study conducted in Mentebteb indicates, there is presence of salinity development in the irrigation sites of Enda Serawat and Egum Dima. This salinity is attributed to the parent material and the water table. Consequently, management options like,selection of salt tolerant crops which are more resilant to saline conditions, integration of organic matter, applying extra irrigation water to remove salts around root zonesand regular salinity monitoring is recommended, to optimize the productivity of the soils in the irrigation site of mentebteb.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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