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Evaluation of Soil and Water Quality of Lake Gerio Irrigation Project of Upper Benue River Basin Development Authority Yola, Nigeria

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***Abstract*—** *Soil and water samples were collected during the irrigation period of Sept. 2019. The samples were taken at three places (Upstream, midstream and downstream) of each of the four sectors of the Project at the depths of 1-15cm and 15-30cm below the surface. Water samples were taken from the lake Gerio, main canal, distributaries, canals, field drains and collector drains of sector I, II, III, IV and at the main collector drain. All the samples (Soil and Water) were analyzed for their chemical constituents to evaluate their quality for irrigation purposes, it was found that, the chemical compositions of the soil were still within acceptable limits (pH range 4.56 - 6.89, EC range 0.18- 3.21 ds/m, ESP range 5.00 - 11.00%, and SAR range 0.31 - 0.68. The irrigation water (pH range 6.87 - 7.40, EC range 0.05 - 0.76 ds/m, ESP range 7.00 - 11.00% and SAR range 0.63 - 0.95) is exceptional quality and can be used for irrigation of most crops on most soil with little or no likelihood of salinity development, except on low permeable soils or soil, with restricted drainage. The main drain water (pH = 6.43, EC = 1.85ds/m, ESP = 10.00% and SAR = 0.64) shows that it can be recycled for irrigation purposes especially in the Semi - arid region of northern Nigeria where water is the major limiting factor for crops production.*

Keywords— *Irrigation, Water quality, acidity, absorption.*

I. INTRODUCTION

The importance of irrigation in the world today cannot be overemphasized That, "The pressure of survival and the need for additional food supplies are necessitating a rapid expansion of irrigation throughout the world" (Ghuhati, 1964) Even though, irrigation is a top priority in the arid region of the world, it is also becoming increasingly important in humid region. Arid and Semi-Arid regions are areas with limited rainfall and crops ate produced mostly once in a year with sometimes crops failure because of inadequate precipitation to meet ci ops water requirement

Crops production through Irrigation in arid regions is a necessity to meet food requirements of the ever increasing population in such regions.

In the Sudan to Sahel Savannah regions of Nigeria are located in semi-arid region with annual it rainfall of less than 1000 mm. The land cultivation is traditionally once in a year due to the short duration rainy season, which lasts 4-5 months only. The need to feed and improve the standard of living of the ever-increasing human population led to the introduction of the irrigation schemes by Nigerian governments in the last 20 years. This has facilitated the cultivation of the same land twice or more in a year and has improved the farmers' standard of living. The development of irrigation is also brought about changes in the existing natural ecosystem including the soil'. The development of secondary salt-affected soils is one of such changes, which have been attributed to irrigation (Singh and Maurya, 1979). The presence of salts can drastically alter the physical, Chemical and biological properties of soil and impair its productivity (Brandy and Weil, 1999).

Under saline condition nutrient toxicity and imbalance and increased osmotic potential are common Problems lo plants (Berutein, 1974). Evaluation of soil and water quality of irrigation scheme helps to monitor rate of salt build up so that necessary management practice can he Put place as a control measure. Gerio irrigation project was one of the public irrigation schemes developed by upper Benue river basin development authority aimed at increasing crops production and livelihood of rural farmers. The project was established more than 20 years ago and there is need to evaluate the quality of soil and water in the project for possible recycling of the water to improve its efficiency and take necessary measures to protect the environment.

II. MATERIALS AND METHODS

The Study Area

The study area lies within latitude 9^0 and 23N and longitudes 120 21' and 120 28'. The source of water used for the irrigation is the lake Gerio. The area has two distinct season dry and wet with temperature and humidity varying with the seasons. The wet season begins in April and end in November. The mean annual rainfall for the area is 982mm, while the temperature ranged from 270c to 400c. The vegetation is the savannah type (Sudan Savanah). The soil is fertile alluvia with poorly developed soil deposit due to the probable geological youthfulness of the soil (UBRBDA 1983). The food crop cultivated at the irrigation site are rice, maize and vegetables.

Field Works

Reconnaissance survey of the area was conducted in order to select soil and water sampling points. Soil and water samples were taken from different places. Soils were sampled at upstream, midstream and downstream sectors, at 1-15cm and 15-30cm (sector L Il and IV) making a total of 18 soil samples using soil auger. The water samples were taken from main lake, main canal at three stations (upstream, midstream and downstream), distributaries canals, field drains of sector I,

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II, III and IV and at main collector drain giving a total of 17 water samples

Laboratory Works.

Soil samples

The soil samples was left to dry under room condition for three days, the soil samples were then crushed and sieved through a 2mm square grid for testing chemical properties. pH of the soil sample was read directly using H19024 microcomputer pH meter (1:1 soil to water ratio); EC was also read directly using H 18733 EC bridge meter (1:2.5 soil to water ratio); Ca^{2+} and Mg^{2+} by titration method of determining CEC; Na^{+} and K^{+} by absorption spectrophotometer; Al^{3+} and H^{+} by titration method of determining of effective SAR and ESP were calculated using expressions developed by Donahue et al. (1990) and Brandy arid Weil (1999).

$$\text{SAR} = \frac{Na^{+}}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}} \quad (1)$$

$$\text{ESP} = \frac{Exchargeable\ Na^{+},\ Cmol\ Ckg^{-1}}{cation\ excharge\ capacity\ Cmol\ Ckg^{-1}\ x\ 100\%} \quad (2)$$

Irrigation and drainage water samples

The pH and BC of the water samples were also measured directly using pH and BC meters, respectively. Ca^{2}+ and Mg^{2+} were determined Using absorption spectrophotometer. With the determinations of Ca^{2} and Mg^{2+} CEC, Na^{+} and K^{+}, SAR and ESP were calculated using equations I and 2.

III. Results and Discussion

Irrigated Soil Quality

Table I presents the chemical composition of the soil samples. The pH result shows that the toil was more saline at downstream sector with a value of 4.56 indicating acidity.

The BC of the soil of all the sectors were found to be within the acceptable values (<4 ds/rn) compared with soil quality standard given by Bernstain (1974) on salinity level, The F51' values were generally low, as low as 5%, the maximum value of ESP was found to be 11%. This was from a sample collected in sector JET, which could be attributed to the heavy texture soils, which has affinity to sodium ions. The values of ESP in the whole area were below the threshold value of 15% that could initiate considerable particle dispersion and cause stunted crop growth (Shainberg. 1974). This could be attributed to the fact that sandy soil dominates the texture of the soil with high hydraulic conductivity for leaching down salts beyond the root zone by irrigation water or during raining season.

TABLE I. Chemical composition of soil sampled at Sector I, III, IV. Sampling date: 16/09/2019.

Effective	CEC (meg/100g of soil)		Depth (cm)	pH		EC (ds/m)			
Ca^{2+}+Mg^{2+}	Na^{+}	K^{+}	AH^{3+}	H^{+}	ESP (%)	SAR			
Sector I									
Up-stream	1-15	6.89	0.93	17.50	1.35	0.73	0.80	1.20	6.00	0.46
	15-30	6.15	0.83	18.50	1.48	0.82	0.90	1.00	7.00	0.49
Mid-stream	1-15	5.04	2.83	18.25	0.91	0.16	0.50	0.60	5.00	0.30
	15-30	5.32	1.24	20.25	0.99	0.16	0.40	1.00	5.00	0.31
Down-stream	1-10	5.24	1.52	13.00	1.11	0.21	0.40	0.50	8.00	0.44
	15-30	4.56	2.40	16.25	1.27	0.30	0.50	0.60	7.00	0.45
Sector III									
Up-stream	1-15	5.04	0.47	11.75	0.79	0.13	0.60	0.30	6.00	0.33
	15-30	5.13	0.26	14.00	0.99	0.11	0.40	0.30	7.00	0.37
Mid-stream	1-15	5.58	0.21	09.40	1.11	0.28	0.30	0.60	10.0	0.51
	15-30	4.80	0.25	12.75	1.68	0.32	0.40	0.50	11.0	0.68
Down-stream	1-15	4.94	3.21	09.40	0.99	0.16	0.30	0.40	9.00	0.46
	15-30	6.78	2.46	11.00	1.03	0.11	0.40	0.40	8.00	0.44
Section IV									
Up-stream	1-15	6.25	0.58	08.75	1.15	0.13	0.10	0.60	11.0	0.55
	15-30	5.98	0.31	13.00	1.25	0.28	0.20	0.60	10.0	0.60
Mid-stream	1.15	5.35	0.28	08.25	0.91	0.21	0.50	0.50	9.00	0.45
	15-30	5.20	0.18	09.25	0.95	0.23	0.30	0.80	9.00	0.44
Down-stream	1-15	6.27	1.54	15.25	1.35	0.47	0.20	0.50	8.00	0.49
	15-30	4.78	1.08	18.00	1.56	0.51	0.20	0.40	8.00	0.52

Where: ESP = Expected Sodium Percentage. SAR = Sodium Adsorption Ration

Irrigation Water Quality

Table II presents the results of chemical properties of the irrigation water, the results show that the water obtained from the lake and main canal met all aspects of water quality standard as reported by Paliwal (1972), Richards (1954) and Shainherg (1978). The level of the salinity indicated by the EC, showed that the water could be classified in the upper class. Thus, the water can be used 'for irrigation of most crops on most soils with little or no likelihood of salinity development, except on low permeable soils or soil with restricted drainage. (Cl: low Salinity water). The results shows further that the water in the lake and the main canal, with respect to soluble salts, were of high quality and that if any salinity development is experienced in the area it has to be due to poor drainage or soil compaction in future. The lake and canal waters could also be considered to have low alkalinity level as indicated by SAR, "termed low-sodium-water" Hence it can be used continuously for irrigation Purposes without a threat of sodium toxicity due to high ESP in the soil. The pH of the lake and main canal water were generally within the normal range (6.5-8.5) of irrigation water above and below which may indicates acidity or basicity considering the results obtained for distributaries canals of sector 1, II, 111 and 1V,

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as shown in Table II. The salinity value of BC was found to be of low level. Hence, it can be used to irrigate most tropical crops with no threat of salinity build-up. Furthermore, the water in the distributaries was found to be of low alkalinity level, Hence, it can be used continuously for irrigation with no threat of alkalinity development in the soil. Similarly, the pH status indicated the neutrality of the water in the distributaries and found to be suitable for irrigation. The result of the analysis of field drains and collector drains water of sector 1, 11. III and IV as well as that of main collection drain is presented in Table II. The salinity status were found to be of low-levels while some were found to be at medium-level which can be re-used for irrigation with adequate leaching.

TABLE II. Chemical composition of water sampled at Lake Gerio, main canal, distributaries canal field drains and collector drain of Sector I, II, III and IV and main collector drain. Sampling date: 16/09/2019.

Place	pH	EC(ds/m)	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	ESP(%)	SAR
			Lake					
Lake gerio	7.40	0.06	7.21	8.76	2.44	0.61	7.00	0.86
			Main canal					
Up-stream	7.30	0.05	6.41	7.67	2.28	0.59	8.00	0.85
Mid-stream	7.20	0.074	7.21	10.95	2.28	0.42	10.0	0.76
Down-stream	7.00	0.06	8.82	9.86	2.36	0.51	9.00	0.77
			Sector I					
Dist Canal	6.95	0.07	8.02	9.86	2.48	0.47	9.00	0.83
Field Drain	7.04	0.23	11.22	9.86	3.28	0.42	9.00	0.91
Collector Drain	7.08	0.32	10.42	17.52	2.80	0.54	8.00	0.72
			Sector II					
Dist. Canal	6.87	0.07	8.82	8.76	2.52	0.56	10.0	0.78
Field Drain	7.09	0.80	12.83	13.14	2.80	0.49	9.00	0.77
Collector drain	7.04	0.18	9.62	16.43	2.92	0.54	10.0	0.84
			Sector III					
Dist. Canal	7.18	0.05	8.82	9.86	2.36	0.47	9.00	0.83
Field Drain	7.13	0.09	15.23	12.05	2.92	0.42	9.00	0.91
Collector drain	7.10	0.22	11.22	18.62	3.17	0.51	10.0	0.83
			Sector IV					
Dist. Canal	7.26	0.005	11.22	13.14	2.00	0.63	8.00	0.67
Field Drain	6.99	0.42	16.83	12.05	2.97	0.37	9.00	0.80
Collector drain	7.08	0.76	11.22	17.52	2.88	0.61	9.00	0.76
			Main drain					
Main Collector Drain	6.43	1.85	16.03	19.72	2.72	0.66	10.0	0.64

IV. CONCLUSION

The study to evaluate the extent of soil and water quality levels at the lake Gerio irrigation project was conducted. It was the first time such quality evaluation was done in the irrigation project more than 25 years after project commencement. Soil and water samples were taken at different locations and depths, which were subjected to laboratory analysis using standard procedures. The various quality indicators such as level of alkalinity and salinity and other chemical properties were used for the samples classifications. Base on the results obtained and the discussion given, the following conclusions are drawn; the irrigation water at Lake Gerio irrigation project, having satisfied all the required quality needed is of exceptionally good quality with respect to all aspects of water quality criteria for irrigation. The field and the collector drains water can both be reused (recycled) for irrigation with normal leaching with no threat for salt build-up. Soil salinity and alkalinity levels were found to be relatively low, but the rate of development can only be determined after next evaluation in the next 4-6 years to me. However, there was potential for the development of sodium salt in sector III, which could cause alkalinity. The sector has heavy textured soil. Soil structural improvement using organic manure is recommended to enhance soil porosity for effective leaching.

REFERENCES

[1] Braildy, N.C. and Weil. R.R. (1999). The nature and properties of soil. 12üi edition. Prentice hall. Inc. New Jersey. 1 18-l69pp.
[2] Bernstein, L. (1974). Crop growth and salinity in drainage for Agriculture. (J.V. Schilfgaard, e.d.) American Soc. Of Agron. Madison, Wisconsin: 33-35
[3] Maurya, P.R. (1982). Development of Salinity and Alkalinity in irrigated soil of Nigeria. Proc. 4 Afro-Asia. Paper presented at regional conf. of ICID. Lagos, Nigeria, H; l-1.
[4] Mudiare, O.J. and A.D. Mohammed, (1978), Determination of Changes in Soil and Water Quality at the Kadawa Sector of the Kano River Irrigation Project Department of Agricultural
[5] Engineering, A.B.U Zaria. Journal vol.3 ISSN 1495-61 2lJune 2002.
[6] Richards L. A. (1973). Diagnosis and improvement of saline and alkali soils. U.S. Dept. of Agriculture Handbook 60
[7] Scainberg, I. and Oster, J.D. (1978). Quality of irrigation water report. irit. Information center gaper No. 2
[8] Singh, A., and P.R. Maurya, (1979). Salinity Status and Water Logging in Irrigated Agriculture of Northern Nigeria. Journal of 6th Nigerian National Irrigation Seminar pro. 1.
[9] UBRDA. (1993).Upper Benue River Basin Development Authority Report, Yola- Nigeria, pp7-12