Gombe Journal of Geography and Environmental Studies (GOJGES)

Vol. 4 No. 2 Dec. 2024
e-ISSN: 2714-321X

p-ISSN: 2714-3201

http://www.gojgesjournal.com

Gombe Journal of Geography and Environmental Studies (GOJGES) Vol. 4 No.2 Dec. 2024, e-ISSN: 2714-21X; p-ISSN: 2714-3201

ASSESSMENT OF SALINITY AND SODICITY OF WATER USED FOR IRRIGATION IN DADINKOWA IRRIGATION PROJECT, YAMALTU DEBA, GOMBE STATE, NIGERIA

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Abstract

The study assessed the salinity and sodicity of water used for irrigation in Dadin-kowa irrigation project, Yamaltu-Deba Local Government, Gombe State, Nigeria. Multistage sampling technique was adopted. Firstly, cluster sampling was used to divide the water sources into Dam, River, Canals and boreholes respectively. Secondly, systematic random sampling technique was used to select 10 water sources within the study area. The parameters evaluated include pH, Electrical Conductivity, Total Dissolve Solid, Sodium Adsorption Ratio, and chlorine. The mean values of water salinity and sodicity indices are EC(2.22µS/cm), Cl(8.67Mg/L), SAR (2.63Mg/L), TDS (45-357Mg/L) and pH (6.7). The result revealed that the irrigation water is within the normal range for crop production and has no restriction for irrigation used. However, it is recommended frequent and constant monitoring of irrigation water be regularly carried out to detect salt built us as soon as it starts manifesting.

Keywords: Salinity, Sodicity, Irrigation water, Dadin-Kowa and irrigation project

1.Introduction

Natural sources of fresh water for irrigation are rivers, lakes, streams, dams and groundwater (Ethan, Olagoke and Yunusa, 2014). Water is the most important input required for plant growth in agricultural production. Irrigation water quality refers to its suitability for use. Good irrigation water quality has the potential to allow maximum yield of crops under good soil and water management conditions. However, poor quality of irrigation water may cause salinity of soil and toxicity to the plant. This will result in impaired growth and reduce yields, unless special management practices are adopted to maintain or restore maximum soil production (Ethan *et al*, 2014).

All irrigation waters contain dissolve salts which dissociate into ions. Ions are electrically charged particles made up of individual elements or combination of elements which are taken up by the plant roots. In the majority of irrigation waters these ions are quite diluted, but in low quality waters can be significant (Philip, 2014). In agriculture, water quality is related to its effects on soil, crops and management necessary to compensate problems linked to water quality. It is very important to note that all problems of soil degradation like salinity, soil permeability, sodicity, toxicity, etc. can be related to irrigation of water quality (Kirda, 2011).

The use of poor quality water in agriculture does not only lead to degradation of soil physical properties, but also reduces crops production (Banderi*et al.*, 2012). Irrigation agriculture played an important role in ensuring food security for billions of people in the past but their current and future state of affairs leaves much to be desired due to low crop yield and land degradation (Mason, 2002). Because of the erratic pattern of rainfall, both large and small scale commercial farms use rivers, streams and other water resources for irrigation without paying attention to it quality and impact on land and crop losses. In as much as, the quantity of water required to meet the demand of crop is vital, so is the quality (Philip, 2014). Knowledge of irrigation water quality is critical to understanding management for a long-term productivity. Irrigation water quality is evaluated based upon total salt content, sodium and specific iron toxicities. Salt affected soils develop from a wide range of factors, including soil types, field slopes and drainage, irrigation system type and management, fertilization and manuaring practices and other soil and water management practices (Ethan *et al*, 2014).

Many of researches and studies have been carried out in various aspects of irrigation, Abdulkadir (2000) planning and management of large scale irrigation, Oyeniyi (2000) improved small scale irrigation and agricultural changes, Sangari (1991, 2000), comparative analysis of traditional and modern system of irrigation agriculture and fuel scarcity and small-scale Fadama irrigation development respectively, Musa (2008) looked at changes in some soil properties at the Dadin-kowa irrigation project phase 1. Samuel (2009), researched on properties and distribution of irrigated soils along Wongo stream, Kwadon Yamaltu Deba. Adams (2014) looked at socio-economic effects of small scale irrigation in Kwadon, Yamaltu Deba but none of these focuses on the salinity and sodicity of water under irrigation in the study area. It is against this background that the present study seeks to bridge the gap. The overall objective of this study is to assess salinity and sodicity levels of irrigation water for surfaces and subsurface sources in Dadin-kowa irrigation project and its suitability for irrigation.

2.0 Study Area

The study was carried out at the Dadin-kowa irrigation project located in Dadin-kowa town, about 35km away from the capital of Gombe state, along Gombe-Biu road, Yamaltu-Deba L.G.A., Gombe State, North Eastern Nigeria. It Lies on Latitude 10˚ 17’N and 10˚18’N, Longitude 11˚ 30’E and 11˚ 32’E (Figure.1) and on an altitude of 218 meters above sea level (Musa, 2008).

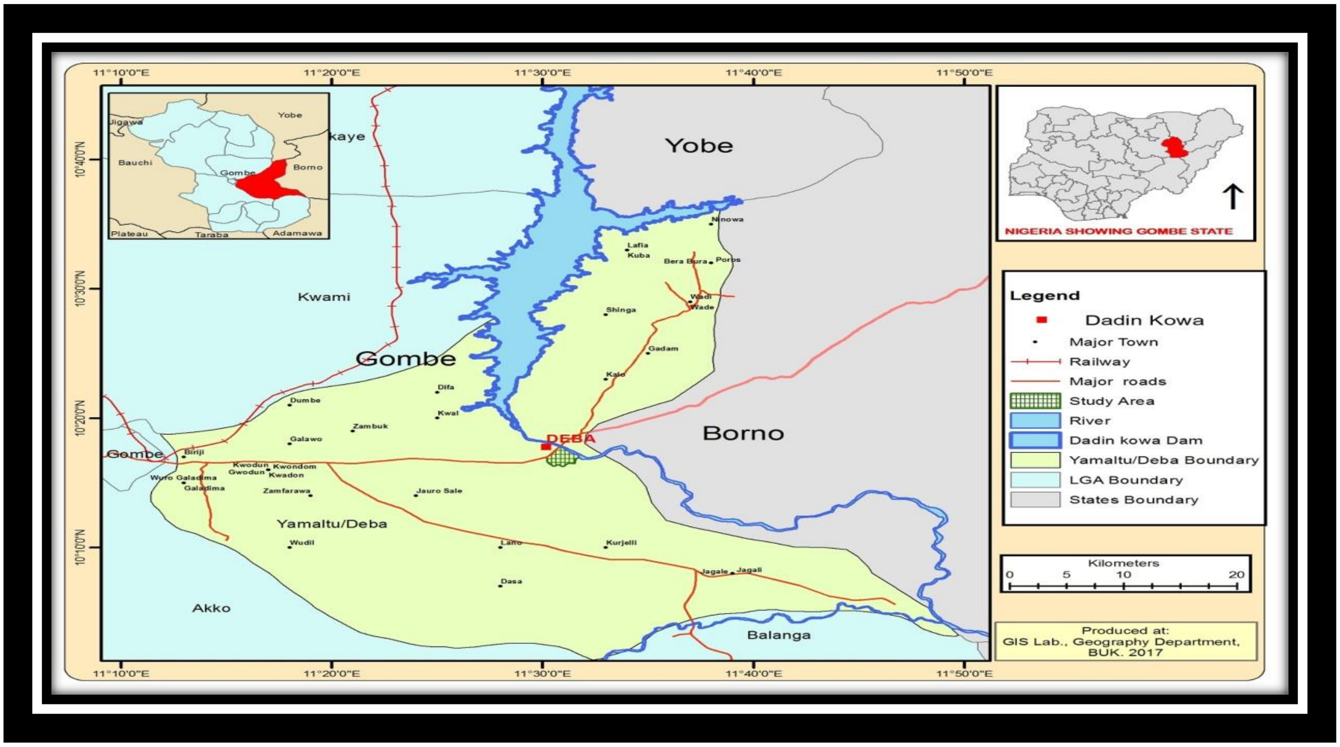

Figure 1: Study area showing Dadin-kowa Dam and irrigated areas.
Source: GIS Lab, Geography Department BUK. (2017)

3.0 Methodology

To assess the salinity and sodicity of irrigation water of the study area, Multi stage sampling technique was adopted. Firstly, cluster sampling was used to divide the water sources into Dam, River, Canals and boreholes respectively. Secondly, systematic random sampling technique was used; where the various sources were listed alphabetically and serially numbered. Thereafter, every first and last water source was selected to give a total of 10 water samples from the study area for salinity and sodicity investigation. GPS locations of Water samples from various sites within the study area were recorded. Two (2) Samples were collected from the dam being the major source of water for the irrigation project; Two (2) samples were collected along the river Dadin-kowa, three (3) samples at the main canals, three (3) samples at boreholes within the scheme in plastic bottles of 500ml. The bottles preceding use in the field were cleaned by washing with detergent and tap water followed by sequential rinses with tap water and dried. At the sampling points, bottles were rinsed thrice with water before samples were collected. Each bottle was filled to the brim with the sample water and tightly sealed as early as possible to avoid exposure to air. The bottles were wiped dry and clearly labeled using permanent ink and good quality labels. Each labeled sample was recorded in a field book with unique number and exact sampling location as described by Philip, (2014). The analysis was done using Atomic Absorption Spectrometer (AAS) for cations, EDTA titration for anions, pH meter and electrical conductivity meters for pH and EC. Sodium

Adsorption ratio (SAR) was calculated from the formula:

SAR = Na/ [($\sqrt{Ca + Mg}$)/2] ………………………………………………………………… (1)

4.0 Result and Discussion

The salinity and sodicity levels of irrigation water was determined using EC, SAR,pH, TDS and Cl.

Table (1) Irrigation Water Quality Results of Dadinkowa Irrigation Project

ID	**PH**	**EC**	**CL**	**C**	**BI-C**	**Na**	**K**	**Ca**	**Mg**	**TDS**	**SAR**
	1:1	µS/cm	MgL^{-1}	MgL^{-1}	MgL^{-1}	MgL-1	MgL^{-1}	MgL^{-1}	MgL^{-1}	MgL^{-1}	MgL^{-1}
1	8.5	94	8.86	0	27.45	3.47	3	7.2	3.92	47	2.08
2	8.3	89	5.31	0	12.2	3.03	7.1	8	2.24	45	1.89
3	8.4	92	5.31	0	21.35	3.05	8	10.4	2.8	46	1.67
4	8.3	714	17.7	0	51.85	18.6	21	61.6	2.8	357	4.63
5	8.4	174	8.86	0	21.35	6.01	10	16.8	1.68	87	2.79
6	8.5	91	7.09	0	15.25	4.01	5.11	8.8	2.24	46	2.41
7	8.4	92	10.6	0	15.25	5.32	9.35	11.2	1.68	46	2.96
8	8.2	360	7.09	0	36.6	10	5.7	41.6	5.04	180	2.92
9	8.3	422	8.86	0	47.75	9.53	4.08	44.8	13.44	211	2.49
10	8.5	100	7.09	0	18.3	4.5	9.6	9.6	2.8	50	2.55
Mean	**6.7**	**222.8**	**8.67**		**26.73**	**6.75**	**8.29**	**22**	**3.58**	**111.5**	**2.63**
Minimum	**8.2**	**89**	**5.31**		**12.2**	**3.03**	**3**	**7.2**	**1.68**	**45**	**1.67**
Maximum	**8.5**	**714**	**17.7**		**47.75**	**18.6**	**21**	**61.6**	**13.44**	**357**	**4.63**
STDEV	**0.10**	**211.69**	**3.58**	**0.00**	**14.04**	**4.86**	**5.07**	**19.70**	**3.52**	**105.78**	**0.82**
VAR	**0.01**	**44813.73**	**12.83**	**0.00**	**197.16**	**23.57**	**25.70**	**388.16**	**12.37**	**11188.72**	**0.67**

Source: Lab Analysis Result, (2018).

The findings of this study revealed that the pH value of the water samples ranges from 8.2-8.5 (Table 1). Generally, pH values for normal irrigation water should be from 6.00-7.00, while values above 7.00 are considered as increasing hazard. The pH is logarithmic meaning that a change of 1.0 unit is ten-fold change in either acidity or basicity. Therefore, change of less than 1.0 unit may be significant. This characteristics or reactions in the soil and water as well as the way plant perform (Adamu, 2012). When the pH is outside this range, it indicates that adequate/appropriate steps/actions will have been taken to remedy this to avoid its negative influence in the crop performance (Aliyu et' al, 2016).

The concentration of total salt in irrigation waters is essential in terms of EC and it may be the most important parameter for assessing the suitability of irrigation waters

(Maurya, 1976). Generally, the ranges considered for irrigation water suitability were 20-300µS/cm being normal, which is increasing severe with respect to salinity hazard (schoeneberger, 2002). Therefore, based on these criteria, all water samples (Table 1) were within the safe limit for irrigation with the exception of sample 4, 8 and 9 being above the normal range.

TDS is also another criterion for assessment of salt content in the water as salt constitute important part of TDS (Adamu, 2013). Water used for irrigation can vary greatly in quality depending upon type and quality of dissolve salts. Salts are present in irrigation water in relatively small amount but significant amounts (Micheal, 1985). Irrigation water with total dissolve solids (TDS) less than 450mg/l is considered good and that with greater than 2000mg/l in unsafe for irrigation purpose (F.A.O, 1985). By this criterion therefore all water sample (Table 1) were suitable for irrigation since they fall within the normal range for irrigation

Basic Cations in Irrigation Water

The normal range of Ca, Mg and K of irrigation water should be 20mg/L and that of Na is 40mg/L (Aliyu et' al, 2016). By this criterion, the calcium content within all the samples could be considered as safe with the exception of sample 4, 8 and 9 (Table 1). While the concentration Mg, K and Na were far below the recommended minimum concentration above. The relatively lower amount of magnesium compared to the calcium may be beneficial because Mg deteriorates soil structure particularly where waters are sodium-dominated and highly saline. The reason for this structural deterioration is that high level Mg usually promotes a higher development of exchangeable Na in irrigated soils (Maurya, 1982).

The study observed that most water samples have chloride level lower than the permissible limit for irrigation of 10mg/L with the exception of sample 4 and 7 (Table 1) and therefore rated low according to (Aliyu et' al, 2016). This indicates that the water will not cause chloride toxicity problem to crops under irrigation.

This study also observed that there were no traces of carbonate in all the water samples of the study. The concentration of bicarbonates in irrigation waters (Table 1) were far above the safe limit according to classification of (Wilcox, 1955). In waters having high concentration of bicarbonates, there is tendency for calcium and magnesium to precipitate as carbonate, resulting in the release of more sodium into the soil solution (sodicity).

The sodium adsorption ratio (SAR) is a parameter that evaluates sodium hazard in relation to calcium and magnesium concentrations. The sodium adsorption ratio is used to predict the potential for sodium to accumulate in the soil, which would result from continued use of sodic water. The (SAR) in (Table 1) is considered low because they are far below the danger limits of >9 considered unsafe for irrigation (Richards, 1954). By this criterion, all water samples of the study area (Table 1) were classified excellent for crop production under irrigation. If these waters were used for irrigation purposes, sodicity hazard might not occur and crops may grow without any deleterious effect on the soil and crop yield (Rhoades, 1982).

The salinity level of the irrigation water of the study area is presented in Table 2

Table 2: Irrigation Water Salinity Level

Parameters	Mean values	salinity Level
EC	2.22 Normal	
SAR	2.63	Normal
Cl	8.67	Normal
pH	6.7	Normal

Source: Field work, (2018)

Table 2 shows that the salinity level of the irrigation water is low because the mean values of all the salinity parameters EC (2.22µS/cm);Cl (8.67Mg/L); SAR (2.63Mg/L) and pH (6.7) were lower than the critical values recommended for irrigation water by Shahinasi and Kashuta (2008).

4.1 Conclusion

The irrigation water of Dadin-kowa irrigation project has been assessed for salinity and sodicity. The findings of this study revealed that, most of the parameters investigated were found within the safe limits and may not have the potential to be hazardous to both soil and crop grown in the study area because the key indicators of salinity and sodicity are within the recommended limit for irrigation purpose. However, it is recommended frequent and constant monitoring of irrigation water be regularly carried out in order to detect salt built us as soon as it starts manifesting

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