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Evaluation Of Surface Water Qualityalong Fadama Area Of Argungu, Kebbi State, Nigeria

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Abstract: ***The surface water along fadama area of Argungu in Kebbi State was assessed to ascertain its current quality status and suitability for irrigation purpose. Each water sample was analyzed following standard procedures. The mean total dissolved solids (TDS) in water was 333.3 mgl^{-1} , electrical conductivity (EC) ranged from 16.16-31.7 (mean 22.85µS/cm), Ca^{++} and Mg^{++} ranged from 0.50-1.72 (mean,0.96mgl^{-1}) and1.22-1.92 (mean, 1.49mgl^{-1}), respectively were low. The remaining basic cations such as K^{+}which ranged from 29.3- 69.1(mean,40.13mgl^{-1}). and Na^{+} which ranged from19.2 – 40.2 (28.7mgl^{-1}) were high in concentrations.The obtained SAR of 26.1. Based on the concentrations of K^{+}, Na^{+} and SAR, the water could be carefully used for irrigation to avoid sodicity problem in future. Thus, light but frequent water application should be practiced to avoid sodium accumulation on the soil surface which would be highly detrimental to the physical properties of the soil.The obtained pH of the surface water of the study area was 8.37 which was within the normal and recommended pH range of 6.5- 8-4 for the safe use of irrigation water as given by Roose and Lelong(1981).***

Keywords: Surface water, quality status and suitability for irrigation.

I. INTRODUCTION

There is a growing human population in the world which means there is need for an increase in food production. However, food production to feed this growing population is decreasing due to poor agricultural practices (Sanda, 2014). One of the means to ameliorate this problem is throughthe use of irrigation practices. However, irrigation is associated with a number of problems ranging from water mismanagement to the use of poor quality irrigation water as a result of salinity, turbidity, heavy metal pollution and other chemicals constituents that make irrigation water of low quality for crop production (Sanda, 2014).

Suitability of water for irrigation is determined by its chemical composition with regard to concentrations and types of soluble salts present. The chemical constituents of irrigation water can affect plant growth directly through toxicity or deficiency and indirectly by altering plants available nutrients. Electrical conductivity (EC) is a good index of salinity hazard while sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) indicate the level of sodium hazard of irrigation water.

Quality of surface water varies from place to place and from season to season. The basis used for determining the suitability of surface water for irrigation includes chemical analysis requiring the determination of concentrations of inorganic constituents such pH,Electrical Conductivity (EC), Total Dissolved Solid (TDS), potassium (K), calcium (Ca), magnesium (Mg), Sodium and ESP. The normal pH range for irrigation water is from 6.5 to 8.4. High pH above 8.5 is often caused by high bicarbonate (HCO3-) and carbonate (CO32-) concentrations known as alkalinity. High carbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in solution. According to

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Mass (1990), alkaline water can intensify sodic soil conditions. While EC is an assessment of all soluble salts in water, sodium hazard is considered separately because of sodium's specific detrimental effects on soil physical properties. The SAR index quantifies the proportion of sodium (Na+) to calcium (Ca++) and magnesium (Mg++) ions in water. Calcium flocculates(hold together), while sodium disperses (pushes apart) soil particles thereby destructing soil structure .

The quality of irrigation water directly influences the quality of the soil and the crops grown on it. Poor quality irrigation water has negative effects on crop productivity, quality of the produce, and health of consumers and the farmers who come in direct contact with such water (Listka*et al*., 2010 and Muthana, 2011). Understanding the quality of irrigation water helps a lot in its management for long-term crops productivity. There are differences in water characteristics, based mainly on geology and climate of the areas. There may also be great differences in the quality of water available on a local level depending on whether the source is from surface water bodies such as rivers and ponds or from groundwater aquifers with varying geological setting, and whether the water has been chemically treated (Ayers &Westcot,1994, Nahid *et al.*,2008).The chemical constituents of irrigation water can affect plant growth directly through toxicity or deficiency, or indirectly by altering nutrients availability to the plant (Ayers and Westcot, 1985; Rowe et al., 1995; Islam and Shamsad, 2009)

Surface water is also suitable for most plants provided that moderate amount of leaching takes place or that plants with moderate salinity tolerance are grown. Shaki and Adeloe (2006), after using both surface and sub-surface water for irrigation concluded that surface water has no salinity or toxicity problem and thus suitable or almost excellent for being used for irrigation. Therefore, this research was aimed assessing the current quality and suitability of surface water along fadama area of Argungu in Kebbi State for irrigation purpose.

II. MATERIALS AND METHOD

A. STUDY AREA AND AGRO-CLIMATE

Argungu is among the local government areas of Kebbi State in Nigeria, situated along Sokoto River Rima and is the headquarter of argungu emirate. It is connected by road to Birnin Kebbi,45 kilometers south and Sokoto state capital 85 kilometers North-east. Argungu local government area is between latitude $12^0 44'$N and $4^0 31'$E. It has a total land area of 1,024sq.km^2. The average maximum monthly temperature ranged from 29.9°C in January to 39.6°C in May with mean value of 34.5°C. Rainfall is low normally around 386mm and is unequally distributed. The rainy season normally extends from June/July to September/October. However, the period between the first and last useful rains is limited to 70 to 90 days only (James,1982). The dominant vegetation is composed of *Azadirachtaindica* (Neem tree), *Acacia senegalensis*(Gum Arabic) and*Adansonia digitata*(African Baobab). Among them are fruit trees such as mango, cashew, guava which have been contributing significantly to the income of farmers in the area.

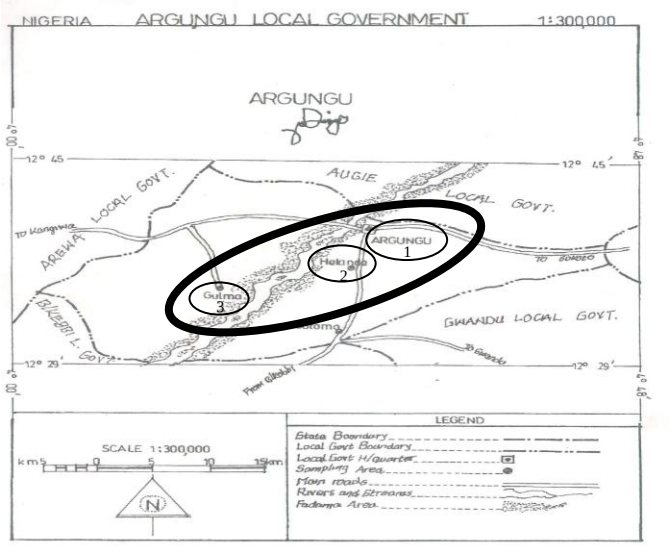

Figure 1: Map of Argungu Local Government Area Showing the Sampling Areas

B. SAMPLING TECHNIQUES

Three villages in Argungu local government area that were adjacent to the river were randomly selected. The villages were Gulma, Helande and Argungu. From each village three samples of surface water were taken at three different spots which were later mixed thoroughly to come up with one blended water sample giving a total of three blended samples. Each sample of water from the surface water body was collected using two-liter water bottle. Each bottle was thoroughly washed using distilled water in the laboratory before taken to the field. This was to avoid contamination of the collected samples. Each water bottle was provided with a cap to ensure that the collected sample was a true representation of the water from the surface water body.

C. WATER SAMPLE ANALYSIS

The procedure described by Chopra and Kanwar (1991) was used for the analysis of water samples. pH and electrical conductivity (EC) meters were used to determine pH and electrical conductivity, respectively. Total dissolved solids (TDS) were determined by evaporation and drying method. Carbonate and bicarbonate ions were determined by Atomic Absorption Spectrophotometer. Potassium and sodium were read on flame photometer. The sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) were calculated as follows:-

$$SAR = \frac{\text{Exchangeable sodium}}{\sqrt{\frac{Ca + Mg}{2}}}$$

$$RSC = (CO_3 + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

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D. STATISTICAL ANALYSIS

The data generated from this research were subjected to descriptive statistics using simple statistical tools such as means, ranges and percentages to compare the differences that existed among the sampling areas.

III. RESULT AND DISCUSSION

Location	TDS	Ca	Mg	K	Na
Gulma	333.3	1.13	1.55	33.6	25.33
Helande	333.3	0.82	1.44	39.4	31.5
Argungu	333.3	0.94	1.46	45.8	29.26
Overall Mean	333.3	0.96	1.48	40.13	28.7

Table 1: TDS and Basic Cations Concentrations (mg/l) of Surface Water in Argungu

The TDS range for surface water under investigation was 0-1000mg/l with mean value of 333.3mg/l. This could be as a result of little or absence of pollutants in the water. However, the data in Table 1 showed that water from Gulma, Heland and Argungu had TDS of <1000mgl$^{-1.}$ Based on criteria given by Todd (1980) that water with TDS 0-1000mg/l rated as fresh, 1000-10,000mg/l as brackish, 10,000-100,000 as saline, the surface water within Argungu local government area with overall mean TDS of 333.3mg/l could be classified as fresh and safe for irrigation. Also based on FAO (1985) classification which stated that, water with TDS in mg//l of <450, 450-2000 and >2000 has respectively no restriction for use, slightly to moderate and severe restriction, respectively, the surface water from Argungu local government area could be used for irrigation without any restriction.

Ranges and overall means for Ca^{++}, Mg^{++}, K^{+} and Na^{+} (mg/l) in the surface water of Argungu local government area were 0.50-1.72 (0.96), 1.29-1.92 (1.48), 29.3-69.1 (40.13) and 19.2-40.2 (28.7)mg/l (Table 1), respectively.

The obtained values of Ca 0.50-1.72 (mean 0.96mg/l) in Table 1 were lower than 29-469 (mean 117)mg/l as reported by Lelong (1981) for west African water and 57mg/l reported by Singh *et'al* (1996) for Kandoli Shela stream water in Sokoto state. Singh (2000a) reported the value for Ca^{++} in the underground water of Kebbi state as 29-467 (mean 117)mg/l while the Zamfara underground water contained the Ca^{++} value of 68-298 (mean 195)mg/l (Singh, 2000b).

The obtained values of Mg^{++} 1.29-1.92 (mean 1.48 mg/l) in the surface water of the study area was lower than 18-898 (mean, 179mg/l) for the underground water in Kebbi state (Singh, 2000a). The obtained Mg value of 1.48mg/lwas also lower than 18-360 (mean 159 mg/l) for the tube well water in Zamfara state (Singh, 2000b).

The values for K^{+} and Na^{+}29.3-69.1(mean 40.13mg/l) and 19.2-40.2 (mean 28.7mg/l), respectively in Table 1 were higher than 0.3-19.0 K^{++} and 0.2-49.0 Na^{++} as obtained in the water of Kebbi state as reported by Singh (2000a) and 0.3-19.0 and 0.2-49mg/l, respectively as reported by Roose and Lelong (1981) for West African water.

Calcium and magnesium salts are known to cause salinity problems. Fortunately, their concentrations in the surface water of Argungu local government area were quite low. This indicated that the water is free from problem of salinity and could therefore be used for irrigation without any restriction. However, based on high concentration of Na and K ions, continuous and excessive irrigation with such water may lead to the problem of soil sodicity and subsequent salinization.

Location	pH	EC(µS/cm)	SAR (mg/l)
Gulma	8.33	24.68	26.9
Helande	8.28	20.09	1.4429.93
Argungu	8.51	23.8	1.4626.74
Overall Mean	8.37	22.85	26.19

Table 2: pH, EC and SAR of Surface Water in Argungu Local Government Area

Table 2 showed that the mean pH value for surface water in the study area was (8.37) with the pH range of 8.00-8.89. Based on this pH value, the water could be good for irrigation when compared with normal pHrange for irrigation water of 6.5- 8.8 as recommended by Roose and Lelong (1981) and Ayer and Wescot (1976). FAO (1985) gave pH range of 6.5-8.4 as normal range for irrigation water.

Surface water from Argungu local government area had EC range of 13.13-31.7 (mean 22.85)µS/cm as shown in Table 2. US salinity laboratory staff (Richard, 1954), classified the irrigation water in four classes based on the concentration of EC as C1-low salinity: EC<250, C2-medium salinity water EC250-750, C3-high salinity water EC>750-2250, and C4-very high salinity: EC>2250 (TDS>1500). FAO (1985) gave another classification (EC in µS/cm) as EC<700: EC 700-3000 and EC>3000 with restriction for use as none, slightly to moderate and severe, respectively. Based on the above classification by U.S salinity laboratory staff Richard (1954) and FAO(1985), the water of the study area could be used for irrigation without any restriction. This agreed with the report by Singh (2000a) whoreported that 98% of the surface water in Kebbi State belonged to C1-C2 low to medium salinity category. The SAR values ranged from 17.45-37.2 (mean, 26.19mg/l) in Table 2. Based on the U.S salinity laboratory staff (Richard, 1954) classification of irrigation water which stated that water with SAR<10, 10-18, 18-26 and >26 is C1-low sodium water, C2-medium sodium water, C3- high sodium water and C4-very high sodium water, the water of the study area with mean SAR of 26.19mg/l could be classified as very higher in sodium and therefore good management practices should be applied when using it for irrigation. As per this SAR, the water could be used for irrigation but with restrictions. Thus light but frequent water application should be practiced to avoid the sodium accumulation on the soil surface. High concentration of sodium in water is undesirable because sodium adsorbed in the soil surface can cause soil aggregates to break down or disperse. This seals the pores and makes the soil impermeable to water.

IV. CONCLUSION AND RECOMMENDATION

The study was undertaken with main objective of assessing the quality of surface water in Argungu local government area as per its suitability for irrigation and offering appropriate management strategies for sustainable crop production in the area.

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The result indicated that the TDS values were in the range 0-1000 (mean 333.3mg/l) while the basic cations in mg/l Ca, Mg, K and Na ranged from 0.50-1.72 (mean 0.96), 1.29-1.92 (mean 1.48), 29.3-69.1 (mean 40.13) and 19.2-40.2 (mean 28.7) mg/l respectively. EC (µS/cm) and SAR were in the ranges 13.13-31.7 (mean 22.85) and 17.45-37.2 (mean 26.19) respectively. The water pH was slightly alkaline with values of 8.00-8.89 (mean 8.37). In terms of TDS 85% of the water samples appeared TDS free and therefore could be safely used for irrigation purpose. On the basis of salinity hazards, measured as electrical conductivity (EC), almost all the surface water belonged to C1- low salinity category and therefore suitable for irrigation. Based on the sodicity hazard expressed as sodium adsorption ratio (SAR) all the water tested SAR within 17.45-37.2 (mean 26.19) and therefore belonged to Ss4- very high sodium water category and therefore the water would be carefully used to avoid problem of sodicity in future. The water contained low concentrations of Mg^{++} and Ca^{++} salts and therefore could be used for irrigation without any restriction or fear of salt build-up.

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