ASPECTS OF THE WATER QUALITY OF RIVER KADUNA FOR DRY SEASON FARMING

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ABSTRACT

The quality of water of river Kaduna for dry season farming use between November to March was determined. The parameters considered for evaluation included salt concentration; the sodium absorption ratio, the variation of some nitrogen compounds between selected locations along the reach of the river spanning the dry season farming areas of its catchment.

Salinity hazard varied from low to medium while the sodium, boron and bicarbonate hazards are minimal. Sulphate ions are minor constituents while the bicarbonate ions constitute a high proportion of the anions. The sodium absorption ratio range between 2.40 – 4.63 which is acceptable for irrigation and there is no significant difference in its variation from location to location considered as pvalue > 0.05. The nitrate and ammonium contents give the same result (P-value >0.05).

In general, the water classed as $^{C}{}_{2}S_{1}$ or better and therefore; the water is suitable for dry season farming. Further microbiological and biochemical investigations are recommended.

Keywords: Dry season farming, river Kaduna, salt concentration, salinity hazards.

INTRODUCTION

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The possibility of farming in the dry season through the provision of irrigation systems would be impossible without adequate supply of water. Adequate in amount and in quality. It is the most valuable asset in irrigated agriculture.

Poor quality of irrigation water will affect crop yields, fertility needs and the irrigation system performance generally. It is therefore important that irrigation water be free from ions which may be toxic to plants or composition that may have detrimental effects on soil physical condition.

Nitrogen is an important nutrient required by plants. Its excess has the same effect as its deficiency. If excessive quantities are present or applied, production of several commonly grown crops may be upset because of over-stimulation of growth, delayed maturity or poor quality (Ayers and Westcott, 1976).

It is therefore necessary to assess the concentration of the major forms of nitrogen in the river where the irrigation water is to be sort in order to guide the local farmers on the management of water and soil to prevent problems associated with excess or deficiency of nitrogen.

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Water samples were retrieved from river Kaduna to analyze and study its quality based on some parameters at different points along the river. The variations of these parameters from location to location were also observed.

1.1 The Study Area

The study was conducted along the stretch of river Kaduna from Rafinguza in the worth to flow mill (Nasarawa) in the south. The city is located on latitude $10^0$16'N and longitude 7^0 27E at an average altitude of 600m above the mean sea level (Maina et al, 2012).

The area falls within the sudan savannah with dry, sub humid with severe deficit in rainfall from October to May each year and a surplus from June to September with an average annual rainfall of 1200mm (Olorunaiye 2003).

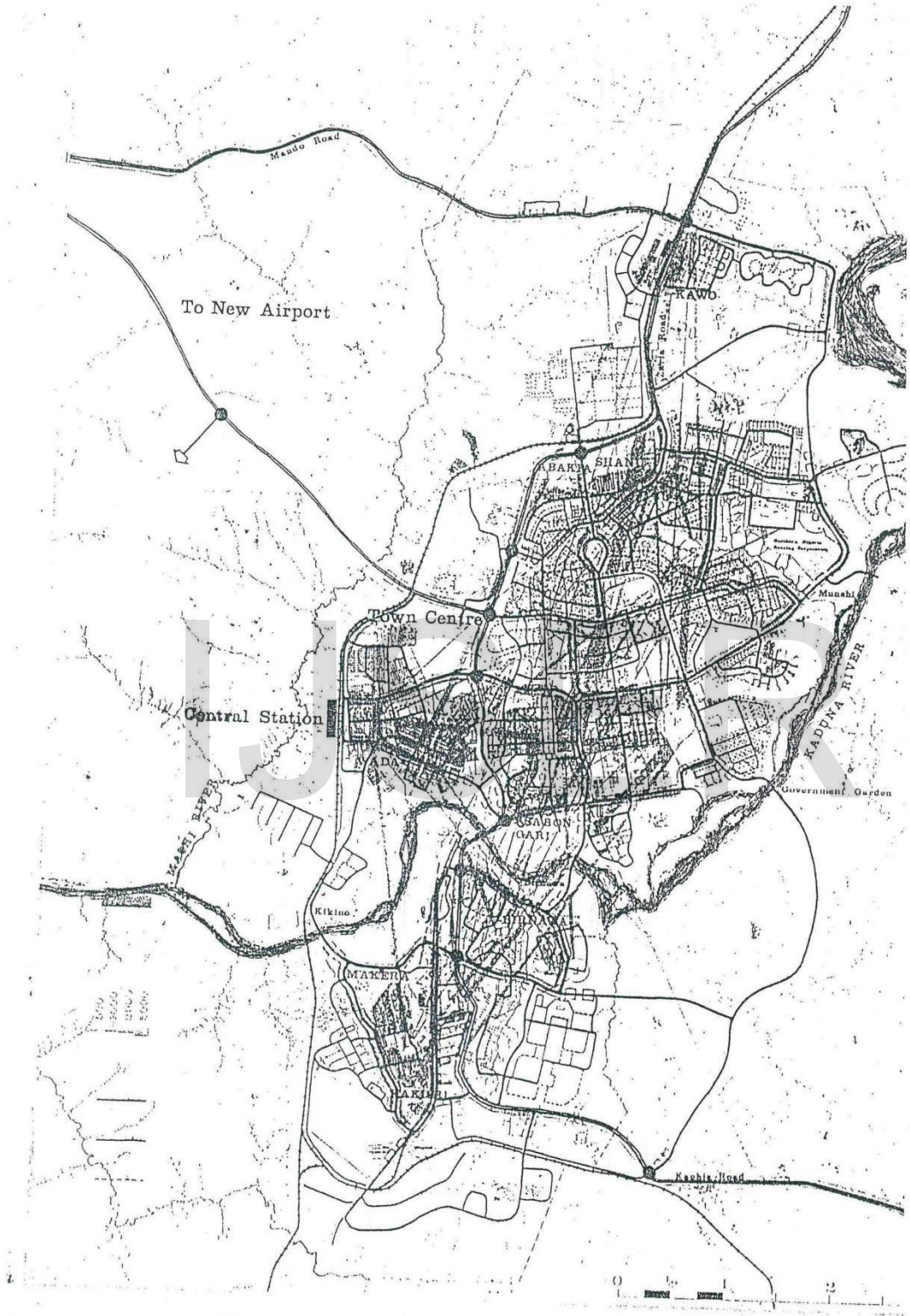

Fig. 2 Location Map of Study Areas

2.0 Materials and Methods

2.1 Sample Collection

Geographic location of sampling points were taken with 78EPS. Four locations were identified: Rafinguza, Babansaura, Government garden and Flourmill (Nasarawa). Water samples were collected using designated plastic bottles.

The first round of sample collection was done in February 2018 followed by the second April of the same year. This periods represent the middle or heart of dry season farming in the zone under consideration.

At each point of collection, three samples were collected to ensure accuracy by replication. A total of twenty four sample containers were first washed with detergent and rinsed with distilled water and then with dilute nitric acid. Samples were stabilized in the refrigerator. The analysis were carried out at the Federal Ministry of Agriculture Laboratory, Kaduna, using standard techniques (U.S Salinity staff, 1989).

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2.2 Laboratory Analysis

The samples were filtered into clean plastic bottles, and the filtrate was made up to 100ml using distilled water. Atomic absorption spectrophotometer (AAS) Thermo Scientific Model 3000 was used for the analysis.

Standard solution for each metal to be tested was prepared and placed in the AAS to analyze. The Hollow Cathode Lamps were loaded in their respective positions. Parameters to be analyzed were selected from the periodic table in the machine. A blank was run through the machine, followed by running a range of prepared standard solutions.

The samples were then run one after the other for the determination of each of the elements as required.

The test procedure was in accordance with APHA, AWWA and WEF (2005) standard method for the examination of each water sample.

TABLE 1 VARIATION OF CHEMICAL PROPERTIES OF WATER SAMPLES AT VARIOUS LOCATION OF THE STUDY AREA

Parameters (constituents)	Unit	R.G			B.S			G.G			F.M		
		1	2	3	1	2	3	1	2	3	1	2	3
PH	-	7.32	7.22 7.35	7.51	7.60	7.31	7.70	7.50	7.36	7.45	7.32	7.15	7.60
Chloride	Mg/l	35.20	34.10	32.40	31.30	30.30	34.10	34.60	35.4	35.20	35.60	35.20	35.60
HCO_3	Mg/l	67.21	65.70	65.63	61.30	58.20	60.09	65.72	66.20	67.01	66.30	60.31	61.33
Boron	Mg/l	0.30	0.21	0.16	0.18	0.17	0.20	0.19	0.21	0.30	0.26	0.24	0.22
NO_3(N)	Mg/l	73	23	11	28	21	20	32	15	15	41	32	20
NH_4(N)	Mg/l	0.88	0.85	0.82	0.87	0.79	0.84	0.86	0.90	0.87	0.88	0.90	0.79
SO4	Mg/l	45.20	44.60	44.52	39.20	42.12	44.80	38.70	38.50	39.10	39.60	37.6	40.31
Ca	Mg/l	0.46	0.46	0.45	1.01	0.52	0.61	1.64	1.81	1.45	10.54	2.82	2.46
Na	Mg/l	5.03	3.96	3.79	4.82	4.32	3.11	3.14	3.73	4.23	6.29	5.50	4072
Mg	Mg/l	1.71	1.07	0.92	2.39	0.76	1.98	3.12	3.29	3.09	4.15	3.41	3.12
K	Mg/l	0.12	0.14	0.18	0.16	0.20	0.13	0.12	0.17	0.16	0.18	0.15	0.17
SAR	-	4.83	4.53	4.58	3.70	5.40	2.73	2.04	2.34	2.81	2.32	3.21	2.83

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R.G = RafinGuza

B.S = Babansaura

G.G = Government Garden

F.M = Flour Mill

TABLE 2 VARIATION OF CHEMICAL PROPERTIES OF WATER SAMPLES AT VARIOUS LOCATION OF THE STUDY AREA

LOCATION							
Parameters (constituents)	**UNIT**	**R.G**	**B.S**	**G.G**	**F.M**	**SE**	**LOS**
PH	-	7.22 7.35	7.31 7.54	7.36 7.44	7.15 7.36	0.255	NS
Chloride	Mg/l	34.10 33.9	30.30 31.33	35.4 35.07	35.20 35.33	17.230	*
HCO_3	Mg/l	65.70 66.18	58.20 59.86	66.20 66.31	60.31 64.52	30.028	*
Boron	Mg/l	0.21 0.22	0.17 0.18	0.21 0.23	0.24 0.24	3.294	NS
NO_3(N)	Mg/l	23 35.67	21 23.0	15 20.67	32 31	17.400	*
NH_4(N)	Mg/l	0.85 0.85	0.79 0.83	0.90 0.88	0.90 0.86	13.872	*
SO4	Mg/l	44.60 44.8	42.1 42.02	38.5 38.770	37.6 39.17	10.640	*
Ca	Mg/l	0.46 0.46	0.52 0.71	1.81 1.63	2.82 5.27	9.358	*
Na	Mg/l	3.96 4.26	4.32 4.08	3.73 3.70	5.50 17.50	3.736	NS
Mg	Mg/l	1.07 1.23	0.76 1.71	3.29 3.17	3.41 3.56	4.125	*
K	Mg/l	0.14 0.15	0.20 0.16	0.17 0.15	0.15 0.167	3.919	NS
SAR	-	4.53 4.63	5.40 3.39	2.34 2.40	3.21 2.79	2.078	NS

NOTE:

NS (Not significant), * Significant at ≤ 5%

Meansfollowed by the same letter in same row are not significantly different from each other

R.G = RafinGuza

B.S = Babansaura

G.G = Government Garden

F.M = Flour Mill

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2.3 Calculation of some parameters:

The sodium absorption ration (SAR) was calculated from the values of sodium, calcium and magnesium from the following relationship (Michael 2008).

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

The values of the elements in mg/γ were converted to meg/ γ using the equations below:

$$Meql^{-1} = \frac{Meql^{-1}}{equ-wt} \quad \ldots\ldots\ldots\ldots \quad 2$$

$$\text{equ wt} = \frac{at.wt}{valency} \quad \ldots\ldots\ldots\ldots \quad 3$$

where:

equ. wt = equivalent weight at.

Wt = atomic weight

Na^+, Ca2+ and Mg^{2+} represent the concentration in milliequivalents per liter of the respective ions.

2.3 Statistical Analysis

The results of the laboratory analysis of water samples were subjected to statistical analysis using the statistical package for social science (SPSS version 17.0). the data were analyzed using Generalized Liner Model (GLM) at P<5% to obtain descriptive statistics by comparison of two means (T-test), and analysis of variance (ANOVA) to compare between the concentrations of each parameter at each location and its variations.

3.0 Results and Discussion

The results of water analysis is as presented in table 1. The sodium absorption ratio which is an irrigation water quality parameter varies from 2.34 – 5.40 $megl^{-1}$ with the higher value recorded at Rafinguza with the highest activities and lowest at Government garden that has minimal activities along the river

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catchment. The water is excellent for irrigation with little or no sodium hazards at all.

The result however indicates that the indicator lower in the month of January as opposed to April indicating less dilution giving rise to higher concentration.

Omolokun and Etsu (1976) in a related study reported the occurrence of tolerable levels of sodium in river Kaduna between the months of January and February with appreciable increasing values at the end of April.

3.1 Spatial Variation

The pH which is an indicator of acidity or alkalinity of water tends to be slightly alkaline as the mean values range from 7.15 – 7.36 as shown in table 1. Although the pH is within normal range, the increasing tendency should be monitored because high pH is associated with the presence of high HCO_3^- and CO_3^{-2} concentrations, known as alkalinity which increases the danger of soil dispersion by sodium ion.

Boron values vary from 0.17 – 0.24 and showed insignificant variations between the stations under study.

Toxicity problem is different from a salinity problem. To toxic ions of sodium and chloride can be absorbed directly into the plant through the leaves moistened during sprinkler irrigation. This occurs typically during periods of high temperature and low humidity.

3.2 Temporal Variation

Most of the parameters especially the pH, HCO_3, SO_4, Na were significantly higher in April as against samples taken in February but their variation were minimal thus posing no threat to its use for irrigation purpose.

4.0 Conclusion

A number of the parameters under consideration varied significantly from location to location but their values are within limits that can be used for dry season farming.

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Therefore, on a general note, river Kaduna may be considered suitable for irrigation as far as its effect on soil conditions are concern.

It must be noted however, that this study did not include microbiological and biochemical irrigations and these are aspects that require urgent research to determine if the water is biologically fit for use on crops that are eventually consumed by humans.

It is however recommended that a system of monitoring surface water quality should be put in place and stakeholders should also participate in addressing the issue of water pollution that are related to human activities and also indiscriminate discharge of effluent into the rivers. It is also recommended that water should be subjected to test occasionally to assess salt build up.

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