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DETERMINATION OF TOTAL HARDNESS AND SODIUM ADSORPTION RATIO FOR IRRIGATION AND OTHER AGRICULTURAL USES IN OLD NETIM FARM LAND AKAMKPA, CROSS RIVER STATE SOUTHERN NIGERIA.

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ABSTRACT

The study was carried out to determine the total hardness (TH) and sodium adsorption ratio (SAR) contents in water used for irrigation system in Netim community farm land, Akamkpa Local Government Area of Cross River State South-Eastern Nigeria. The major ions analyzed were Mg^{2+}, Ca^{2+} and Na^{+}. These major ions were used to determine the values of TH and SAR in the water to ascertain it's quality for irrigation system and other agricultural purposes. The study results showed that the ion (Na^{+}) is normal resulting to relatively a standard value of SAR content in the water. The total hardness was calculated by using the formula $2.497(Ca^{2+}) + 4.118(Mg^{2+})$. The total hardness of 133.70/L from the results indicates standard value considering WHO threshold (100-300) value for TH. The study revealed that sodium, magnesium and calcium in the soil have relatively average values of 37.2ml/L, 12.7ml/L and 32.6ml/L respectively within WHO recommended Standard of (>200ml/L). The analysis also show that the calculated value for SAR is 6.59, also within WHO threshold of (>9). Water temperature, $P^{H,}$ Biological Oxygen Disolve, Oxygen Disolve and Conductivity were also analyzed using probe method, these were all within WHO recommended standard for irrigation and other agricultural purposes.

Introduction

The need for good water quality for agricultural purposes has grown considerably over the years and the supply from water sources is grossly inadequate due to the hardness property and sodium adsorption ratio (SAR) contents in some surface water. Some people have therefore sort of other alternatives of water supply. This sorting to construction of boreholes (underground water) and the excessive use of surface water. Since streams and boreholes can be used for irrigation during agricultural purposes, especially for plants cultivation, there is need for the water to be assessed for quality and to know how extend a particular stream or borehole is good for agricultural uses. Though, the borehole is significantly protected from surface pollutants as the earth media is composed of different surface layers as natural filters yet, it could be very obvious that the metal ions causing hardness could be too high or low. Supply of water for irrigation should be as good as the quality permits. The construction, situations, operations and it's distribution system must be such as exclude any possible pollution of the water which may hinder the growth and production of crops, (WHO, 2011). Water provides energy in form of hydroelectricity in some countries. Country like Nigeria is nearly 97% dependent on hydro power for their electricity production and also for irrigation system. Even for thermal and nuclear power station. Substantial amount of good water is necessary to dissipate heat during industrial exothermic reactions. Industry cannot function without water and water is invariably the focal point for many types of reactions and recreations. (Lohair & Thanh 1978). The study of environmental water pollution in particular has therefore been of considerable importance not only to water analytical Agriculturist but also to Engineers, Hydrologist, Toxicologist, Chemist, Pathologist etc. Since most of these determinants pose danger threat to man's life including other living organisms and plants, it is very essential to analyze any water pose to use for irrigation and other forms of agricultural practices, either to increase the need parameters or to reduce to the required does to avoid endangering the crops production and render it aesthetically suitable for optimum yield thereby enhancing the economic growth of the area. Unlike oil and most other trategic resources, good quality water has no substitute in most of it's uses. It is essential for growing food crops and other agricultural produce, manufacturing goods, and safeguarding human health. Therefore, the development of groundwater or surface water constitutes a viable supplement to the earth concrete dam. Fresh water with low SAR and hardness between 100ml/L to 300ml/L is suitable for irrigation and other agricultural uses.

Materials and Methods

Descriptive research approach was adopted in this study. The data for this research study were obtained from samples collected from four (4) irrigation channels from different locations denoted as A, B, C and D as shown in table 1 for the purpose of this study and for easy characterization. The sampling points are given designations as ICHA, ICHB, ICHC and ICHD (meaning: irrigation channels corresponding to the sample location) as presented in table 2. The monitoring was carried out during the rainy season period where farmers carried out their cultivation and irrigation processes in the area.

Sampling Collection

The water samples were collected from their sources in sterile bottles, properly corked to avoid incoming air into the bottle containing the samples and transported to the laboratory within twelve hours from the time of collection. The sampling locations were chosen between distance of 50 meters apart within the irrigation farm lands in Old Netim community, Akamkpa. The Cross River State Water Board (CRSWB) Laboratory was used for these analyses.

Study Area Description

The study area is Old Netim farm lands in Akamkpa Local Government Area of Cross River State Southern Nigeria. Geographically, it is situated between latitude 5°21 0" North and 8°21 0" East. It has the elevation of about 102m (335 feet) and the community experienced a densely population of about 15,342 extrapolated from 2006 National Population Census.The area is in the South-Eastern Niger Delta region of Nigeria. Two seasons by fluctuation of precipitation predominate in the area are dry and wet seasons. From April to October is the wet season and November to March is the dry season. The area (Old Netim) where samples were collected is located in the Central part of Akamkpa, it is characterized by humid tropical climate (temperature range, humidity and precipitation). Annual rain fall in the area is approximately 1968-3143mm per annum and annual temperature range is 27°C - 33°C. The area also experienced a relative humidity of about 80%-90% (Ayoade, 2004)
Population of the study area (Akamkpa Local Government Area) is one of the oldest area in Cross River State. The are though, due to her large land is predominantly with farming system and other industrial activities. The area also witness serious population explosion due to the industrial and agricultural processes. These industrial and agricultural activities directly or indirectly deteriorate the quality of water resources in the area.

Selection of site for sampling

Old Netim is one of the major community in Akamkpa Local Government Area of Cross River State. Due to the geographical location of many of the communities, many streams in some of these communities do not survive the dry season and as such samples were not collected in these areas. Samples were only collected in the area that have the representative or average characteristics of other sources used for irrigation in the farm land. However, certain criteria were applied in selecting sample sites as follows:
I. Sample sites were selected such that the sample taken are representative of the different sources from which water enter the streams.
II. Sample sites were considered in such a way to account of the number of irrigations serve by each source.
III. Sample sites were of more interest considering the agricultural activities other than irrigation in the location.

TABLE 1: Showing sample locations including sources and designations in old Netim, Akamkpa Local Government Area of Nigeria

S/N	COMMUNITY	LOCATION	SOURCE	SAMPLE CODE
1	Asuagu	Point A	Stream	ICHA
2	Eyuma	Point B	Stream	ICHB
3	Itakom	Point C	Stream	ICHC
4	Blacky	Point D	Stream	ICHD

Sampling size
The maximum sampling size varies widely depending on the range of variation to be considered and the analytical methods to be employed. The volume required for the individual analysis are summarized in table 2 (WHO, 2017)
Sampling procedure:
Samples from Streams:
i. The sample cups and bottles were sterilized
ii. The water samples were filled into the bottles using the sample cups.
iii. The sample after collection are packed in a cooler containing ice bags.
iv. The samples were then taken to the laboratory within the shortest time.

Data Analysis

TABLE 3: Sample Volume Required for Individual Analysis

ANALYSIS	SAMPLE VOLUME
Sodium	100
Calcium	50
Magnesium	50

Calcium ion (Ca^{2+})ml/L

Calcium dissolves out of almost all rocks and is consequently detected in many water. Water associated with granite or siliceous sand will contain less than 10mg/L of calcium. Many water from limestone area may contain 30-100mg/L and those associated with gypsiferous shade main contain several hundred milligrams per liter. Calcium contributes to the total hardness of water. On heating, calcium salt precipitate to cause boiler scale. Some calcium carbonate is desirable for domestic water because it provides a coating in the pipes which protect them against corrosion.

EDTA Titrimetric Method: This method was used for this analysis. When EDTA was added to water containing calcium and magnesium ions, it reacts with the calcium before the magnesium. Calcium can be determined in the presence of magnesium by EDTA titration. The indicator used is the one that react with calcium only. Murexide indicator gives a colour change when all of the calcium has been used to form complexes by EDTA at a P^H of 12-13 (Balance,1990).

The following materials and reagents were used: Porcelain dishes 100ml capacity, Burette 50ml, pipette 25ml, Stirring rod, Graduated cylinder 100ml, Sodium hydroxide (NaOH) 1mole, Murexide indicator. The colour change from pink to purple at the end-poit.

Sodium ion (Na^+)

Method: Gravimetric/ Photometric

Procedure: The Analysis of sodium sometimes can be used as an indication of purity of water for example, in stream condensation, the sodium concentration can be used to indicate water carrying over for boiler system into the stream. Sodium determination will indicate the completeness of cation exchange. The sodium concentration of a typical water sample can be estimated by subtracting the sum of cation (Mg^{2+}, K^+, Ca^{2+}) so determined from the sum of anions (Cl-, SO_4^{2-}) in milli equivalent (mg/L) obtained by dividing their concentration in mg/L by their respective atomic weight. The corresponding difference of value obtained from subtraction was multiplied by the atomic weight of the sodium obtained.

Magnesium ion (Mg^{2+})

Titan yellow reagent was used for the determination of magnesium, unsatisfactory by many investigation, magnesium which amount up to 180mg/L has been determined spectrophotometrically using P-Nitrophenylazo-1-naphthol, this reagent form a colour complex with magnesium having absorption band at 405 and 480um (American Society for Testing and Materials, 2009). Magnesium ion was achieved by subtracting from the total hardness of the sample, the original value of calcium in mg/L of each water sample which was multiplied by the atomic weight calcium 20g prior to the subtraction.

Temperature

The temperature was determined by dipping the mercury in glass thermometer into the sample and the reading was taken and recorded.

P^H: meter PHS-25, E-201-E (Searchtech) was used. The meter was set on and adjusted to zero and then dipped into the water sample and the reading was taken and recorded.

Dissolved oxygen (DO)

Dissolved oxygen meter was used. The equipment was placed in such a way that it was not exposed directly to heat radiation from the sun. The switch was turned to the normal percentage saturation position, and the display allowed to show a stable value. The display was then adjusted by turning the small screw on the upper right corner until the display showed the r_o, the meter was then ready for measuring both saturated as well as part per millions (ppm) in mg/L. The probe was dipped into the water sample covering about 2/3 of its length. The switch was again turned to the ppm-mg/L position, the result was taken and recorded in mg/L at a stable value of the display.

Biological Oxygen Disolved (BOD)

The biological oxygen dissolved in sample was determined by dissolved oxygen meter. The probe was dipped into the water sample to cover the probe to about 2/3 of its length. The switch was turned to the ppm-mg/L position. The display was allowed to show a stable value and the result was taken and recorded in mg/L. The sample was incubated for 5 days at 25°C and the dissolved oxygen content remeasured.

Calculation Formula

The following formulas was used to obtained the values for SAR and BOD.

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

BOD = (a- b)

Where, a = initial dissolved oxygen in the sample and b = final dissolved oxygen in the sample.

DO = Oxygen Disolved

BOD = Biological Oxygen Disolved.

TABLE 3: The summary of the major ions of the area analyzed are shown below

S/N	Sample poit	Na^+mg/L	Ca^{2+}mg/L	Mg^{2+}mg/L	SAR	DO mg/L	BOD mg/L	Temp(°C)
1	ICHA	37.20	12.70	32.60	5.23	8.2	91	27
2	ICHB	37.21	12.69	32.60	7.82	8.6	98	27
3	ICHC	36.40	12.63	32.58	6.77	8.8	101	27
4	ICHD	37.50	13.24	33.10	6.54	8.7	95	27
5	Mean	37.08	12.82	32.72	6.59	8.6	96	27

Conclusion

The analyses indicate that the major ions contents is about (37.50 to 32.20) in the water, soft (total hardness <300mg/L) and fresh. On the basis of alkaline hazard, Na^+ is <100mg/L, the water are regarded excellent irrigation and also be used for most classes of livestock, poultry and fisheries cultivation. With the value of Ca^{2+} and Mg^{2+} all within WHO threshold for irrigation system. The mean values for all the parameters analyzed were within international standard for irrigation and other agricultural purposes. The quality evaluation scheme as shown in table 2 indicates that water bodies are generally good and within WHO Standard. The water results in terms of SAR shows degree of excellent quality for irrigation system and other agricultural uses.

Recommendations

The surface water is extremely good for irrigation system, this is because the Sodium Adsorption Ratio (SAR) is relatively low. The values for SAR in all the locations are within recommended standard. The lower the SAR the better the water for irrigation. Therefore, the surface water should be used for irrigation system and other agricultural purposes.

Unwanted materials be recycled more often instead of being dumped into water bodies, as this may lead to sewage and alteration in the value SAR. Finally, routine assessment of physicochemical Analysis of water be Carried out frequently on seasonal basis as mean of controlling the hygienic, safety streams and boreholes supply of water for irrigation and other agricultural uses.

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