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Impacts of Agricultural Activities on the Quality of Water in Ogane-Aji River, Anyigba, Kogi State, Nigeria.

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INTRODUCTION

As the world's population is expected to hit 10 billion by 2050 (Fess *et al.*, 2011), major concern is centered on how to feed the exponential growing population. Many effort has/is being made to see that by 2030, every human on earth gets adequate and sufficient food. To accomplish this goal, special attention is drawn to agriculture and agricultural practices that will enhance yield even with the declining available workforce (Fess *et al.*, 2011). From ancient times, agricultural practices and water bodies have always been intertwined. With water as one of the key factors that keeps agriculture alive. For thousands of years, agriculture was a natural process that did not involve any considerable or lasting damage on the land used. In fact, farmers were able to pass down their land for many generations, and it would still be fertile as ever (Agouridis *et al*., 2005; James *et al*., 2005). However, modern agricultural practices which encourages the use of inorganic fertilizers and other synthetic products (such as biocides) have resulted into agricultural pollution and, for the most part, these synthetics (which are usually applied in excess of the required quantity) either sinks into the soil and disrupts the soil's micro biota or is washed off along with run-off water into water bodies which inhibit the growth of aquatic flora and fauna (Agouridis *et al*., 2005; James *et al*., 2005; Mehaffey *et al*., 2005). There is a huge diversity and intensity to which agriculture is carried out, but all include the use of water. (Chen *et al.*, 2018).

Over the last two decades, Anyigba community has experienced an up surge in the total population as a result of the University situated there which attracts people from all over the country (Ifatimehin and Ufuah, 2006). This has necessitated an increase in agricultural practices to meet the nutritional demand of the booming population. In order to enrich the soil for quality harvest, fertilizers rich in phosphorous, potassium and nitrogen, and other synthetic chemicals are added to the soil. Therefore, application of nutrients contained in manures and artificial fertilizers often remain in the soil or are leached into the river. Excess enrichment of water because of nutrients, termed eutrophication, can give rise to toxic algal blooms which contaminates the water; disturb/harm aquatic life; and, make the water unfit for future use (Volk *et al.*, 2009). The objectives of this research are:

- To determine some physiochemical parameters such as; Dissolved Oxygen, Biological Oxygen Demand (BOD), Chemical Oxygen Demand, pH, Electrical Conductivity (EC), free Carbon dioxide, Sulfate, Phosphate, Potassium and Nitrate present in Ogane-Aji River, so as to ascertain the water quality for human consumption.

- To compare the water quality of Ogane-Aji River with international standard for drinking water

It is necessary to quantify the extent of pollution caused by agricultural activities on Ogane-Aji River, given that the river do not only serve as a source of irrigation water during dry seasons, but is also used for domestic purposes by many of the inhabitants of the community. This study, will serve as a reference material for the government and other relevant bodies in making policies for agronomic practices that will help conserve nature and other natural resources.

METHODOLOGY

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STUDY AREA

Ogane-Aji River is situated in Anyigba community Dekina Local Government Area of Kogi State (Onoja *et al.*, 2018). It falls within the southern Guinea Savannah and is located on latitude 8043‟ and 9015‟ south of the equator and longitude 6006‟ and 7045‟ west of the meridian (Onoja *et al.*, 2018).

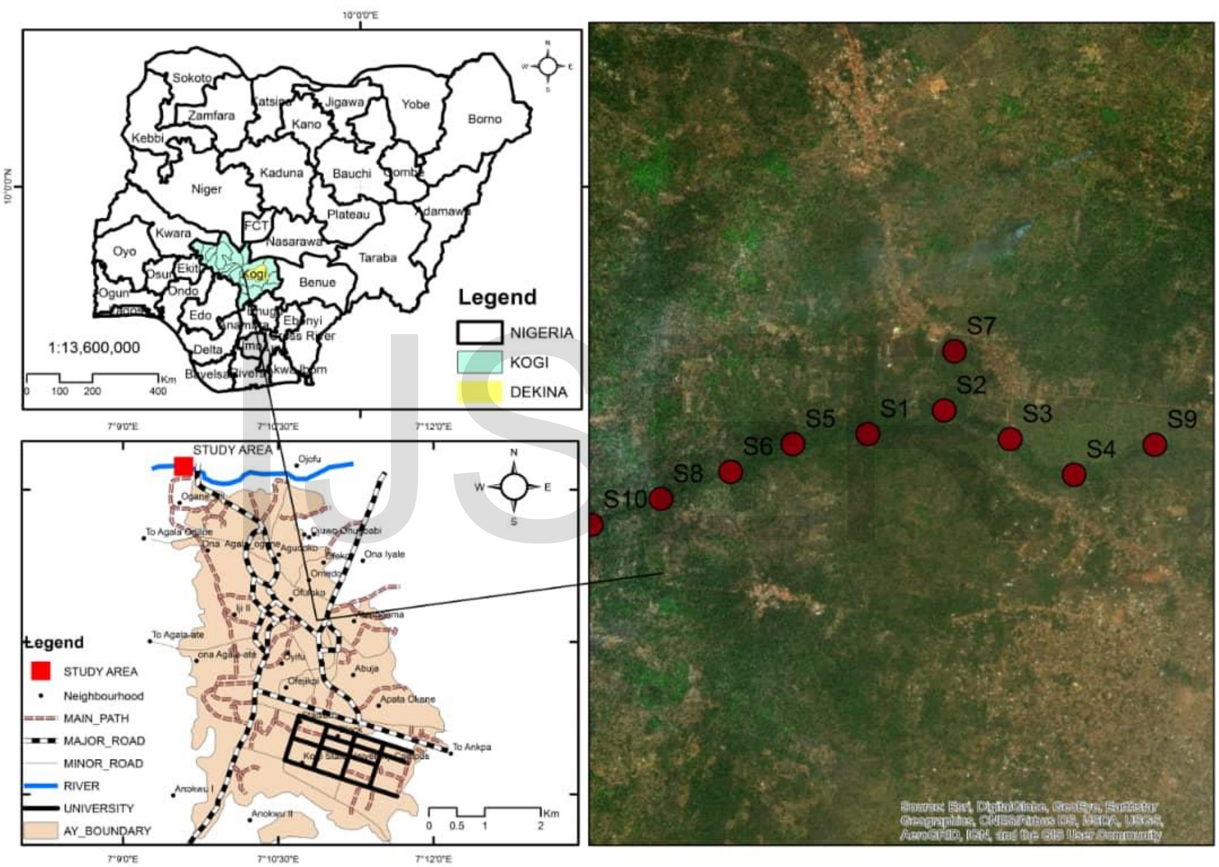

Figure 1: Map of Anyigba Showing the Study Area and the Sampling Points

SAMPLE SOURCE

Water samples were collected from Ogane-Aji River, Anyigba, Dekina Local Government Area, of Kogi State.

SAMPLE COLLECTION / SAMPLING

In the month of October, ten water samples (1 liter each) were collected from ten locations along the length of the Ogane-Aji River in Anyigba, Kogi State, where effluents from various agricultural activities were collected. The locations of each sampling points were determined using a GPS WAYPOINTD handheld global positioning system (GPS), while GIS (Version 10.1) was used to map and show the sample locations. The sampling began at the point source and covered a distance of about 70 meters between sample points. For easier identification, the sample containers were labeled as S1, S2, S3, S4, S5, S6, S7, S8, S9 and S10 respectively with their sampling points. Spot sampling techniques was used to do the sampling. The samples containers were thoroughly cleaned by rinsing with deionized water followed by repeated rinsing with sample water to avoid contamination in the bottle. The water samples were collected in sterilized containers as approved by APHA (2008).

SAMPLE PREPARATION

The water samples were filtered using Millipore membrane filters (Omnipore TM, Ireland) composed of mixed cellulose with 0.45 μm pores and then stored in polystyrene bottles and kept in refrigerator at 4^oC for further investigations.

ASSESSEMENT OF PHYSIOCHEMICAL PARAMETERS OF OGANE-AJI RIVER

All physico-chemical parameters analyzed for the river was carried out using standard analytical procedures

STATISTICAL ANALYSIS

All data were analyzed using descriptive statistics on Statistical Package for Social Sciences (SPSS) Version 20.

RESULTS:

The result from table 1 reveals that lowest value of EC was recorded on S9 with (14.82 µS cm⁻) while S1 had the highest value with (15.83 µS cm⁻) . For pH, lowest value of (5.58) was obtained in S1. In contrast, highest value of (5.90) was recorded in S6. Lowest value of TDS was recorded in S9 (7.43 mg/l) and highest value of (7.91 mg/l) was recorded in S1. HCO_3 obtained its minimum value of (0.08mg/l) in S5 while, the maximum value of (0.18 mg/l) was obtained in S8. For NO_3, the lowest value was (21.98 mg/l) in S2 while S8 had the highest value of (249.33 mg/l). K lowest value, (0.20 mg/l) was recorded at S10 while its highest value, (0.66 mg/l) was record in S6. Least value of (10.05 mg/l) for SO_4 was obtained in S10 in contrast to S6, with the highest value of (11.55 mg/l). lowest value for PO_4 was (0.00 mg/l) in S4 and its maximum value, (0.18 mg/l) was recorded in S10. For free CO_2, (10 mg/l) was the lowest value recorded in S4 and S10 respectively while (20.00 mg/l) in S2 was the highest value recorded. (24.00 mg/l) was the least value recorded at S4 while, (58.00 mg/l) recorded in S3 was the highest. Finally, BOD value of (0.30 mg/l) in S1 and value of (2.60 mg/l) recorded at S2 and S7 were the highest value respectively.

Table 2 reveals that all the parameters evaluated were within the WHO permissible limit, except for the Nitrate (100.79±74.40 mg/l) and Chemical Oxygen Demand (41.65±12.44mg/l) of the water samples that exceeded their permissible limit of 50-100 mg/L and 10 mg/l, respectively. The pH of the river (5.71) was slightly acidic compared to the WHO range of (6.5 – 8.5). These are as a result to the excessive application of fertilizers and other agrochemicals to boost the agricultural output of crops planted along the river banks (WWAP, 2013).

EC	15.83	15.29	15.49	15.20	15.22	15.11	15.08	15.10	14.85	14.82	15.20
pH	5.58	5.69	5.66	5.68	5.71	5.90	5.78	5.75	5.64	5.72	5.71

TDS	7.91	7.165	7.75	7.60	7.61	7.56	7.54	7.55	7.43	7.44	7.60
HCO_3	0.112	0.096	0.112	0.096	0.08	0.112	0.096	0.18	0.10	0.12	0.11
NO_3	27.2	21.98	29.46	40.8	86.13	167.73	138.26	249.33	136.00	111.06	100.80
K	0.305	0.244	0.244	0.244	0.305	0.661	0.305	0.305	0.244	0.204	0.31
SO_4	11.30	10.55	10.55	10.55	11.05	11.55	10.80	10.80	10.30	10.05	10.75
PO_4	0.08	0.09	0.13	0.00	0.13	0.04	0.09	0.07	0.07	0.18	0.88
Free CO_2	14.00	20.00	16.00	10.00	16.00	18.00	14.00	18.00	14.00	10.00	15.00
COD	52.50	52.50	58.00	34.00	40.00	52.00	24.00	26.00	48.00	30.00	41.65
BOD	0.30	2.60	1.30	0.90	0.20	0.70	2.60	1.10	1.10	1.00	1.18

Table 1: physiochemical parameters of the water samples of Ogane-Aji River

Table 2: Physiochemical parameters of Ogane-Aji River and WHO International standard for drinking.

Parameters	Range	Mean ± SD	WHO permissible limit
EC ($\mu S\ cm^{-1}$)	14.82 - 15.83	15.19±0.29	400
Ph	5.58 - 5.90	5.71±0.08	6.5-8.5
TDS (mg/l)	7.41-7.91	7.60±0.14	995.0
HCO_3 (mg/l)	0.08 - 0.18	0.11±0.02	125-350
NO_3 (mg/l)	21.98 - 249.33	100.79±74.40	50-100
K (mg/l)	0.24 - 0.66	0.34±0.13	12
SO_4 (mg/l)	10.05 - 11.55	10.75±0.45	250
PO_4 (mg/l)	0.00 - 0.18	0.08±0.05	0.1-1.0
Free CO_2 (mg/l)	10.00 - 20.00	15.00±3.29	-
COD (mg/l)	24.00 - 58.00	41.65±12.44	10
BOD (mg/l)	0.20 - 2.60	1.18±0.82	10

Means were expressed as mean ± S.D.

DISCUSSION

The observed electrical conductivity (14.98 - 15.83 µS cm^{-1}) was within the WHO permissible limits (400 µS cm^{-1}). The values of this current study are lower than the range of 28–68 µS cm^{-1} for Siluko river (Ekhator *et al*., 2011), Utor River (42.51–59.7 µS cm^{-1}) and Ogba River (40.8–50.6 µS cm^{-1}) reported by Ogbeibu and Anagboso (2004) and Anyanwu (2012), respectively. However, it was comparably similar to the range (14.50–155.23 µS cm^{-1}) gotten for the Eruvbi stream (Imoobe and Koye, 2011). High values of EC may be as a result of intense human activities that increase the ionization of most chemical compounds that enter the ecosystem.

The mean pH range (5.58 - 5.90) for the current study falls below the acceptable limit of 6.5–8.5 (WHO 2011), this indicates a slightly acidic condition of the Ogane-Aji River. Similar ranges were reported for River Siluko in Edo (5.70–7.20) by Ekhator *et al*., (2011) and Eruvbi River, Edo State (Imoobe and Koye 2011; Anyanwu 2012). The acidity of Nigerian rivers has been noted by multiple researchers (Ogbonna 2010; Anyanwu 2012; Imoobe and Koye 2011). WHO (2007) stated that low pH levels can enhance corrosive characteristics resulting in contamination of drinking water and adverse effect on its taste and appearance.

Solids in water are unpleasant as they reduce the quality of drinking water, obstruct photosynthetic processes and reduce the use of water for irrigation and industrial purposes (Ogbeibu and Anagboso, 2004). Total dissolved solids concentrations depend on the geologic material that water passes through in the saturated and unsaturated zone and the quality of the infiltrating water (Oram, 2014). A range of 7.41-7.91 mg /L recorded for TDS in the current study was within the stipulated limit of 500 mg/L by WHO (500). Lower ranges of total dissolved solids were reported for Siluko river (15.50–34.00 mg/L) by Ekhator *et al*., (2011) and other rivers (Utor River and Ogba River) in Edo State (Ogbeibu and Anagboso 2004; Anyanwu 2012).

Hydrogen bicarbonate ions (HCO_3) are present in natural waters and have been associated with the alkalinity and water hardness. The major sources of these ions in water include the dissolution of limestone, chalk, and other carbonate - rich rocks. The concentration of bicarbonate (0.08 - 0.18mg/L) and potassium (0.24 and 0.66mg/L) ions in this study ranged were both within their respective permissible limits of (350mg/L) and (12 mg/L).

In this study, nitrate ranged from 21.98 - 249.33 mg/L which was well above the recommended permissible limit (50 -100 mg/L) (WHO, 2011). Excessive use of chemicals and fertilizers in agriculture can increases the risk of surface and groundwater pollution, which has adverse effects on human health and the environment (Pisciotta, 2015). Nitrate above the recommended standard has been implicated in potentially serious blood disorders in infants less than 6 months of age, which is referred to as methaemoglobinaemia or blue baby syndrome and is characterized by reductions in the oxygen-carrying capacity of the blood (Adimalla, 2019). Serious health hazards can occur due to bioaccumulation of highly toxic nitrate within the intestinal tracts of infants, especially those who ingest polluted river water (Ololade and Ajayi 2009).

The mean concentrations of Sulphate were low and similar ranges have been reported in Utor River and Ogba River (Ogbeibu and Anagboso, 2004). Eruvbi River (Imoobe and Koye, 2011) and Siluku River (Ekhator *et al*., 2011; Anyanwu 2012). According to Beauchamp (2003), African Inland waters are mostly lacking in SO_4, due to their low concentration in the non-sedimentary rocks of drainage areas. High concentration of Sulphate in drinking water might lead to kidney and heart disorder and impaired health (Ojosipe, 2007).

Also, the phosphate concentration range (0.00 - 0.18 mg/L) is considerably similar to the values of (0.14–0.52 mg/L) reported previously for Siluko river (Ekhator *et al*., 2010), and Ogba River

(0.10–1.44 mg/L) by (Anyanwu, 2012). However, it was lower in comparison to the range (7.4 to 22.7 mg/L) reported for the Kaduna River (Mahre *et al.*, 2007).

Free CO_2 is an important component for photosynthetic plants or organisms and in the study area it ranged between 10.00 and 20.00 mg/L, this conform favorably with the report of Islam and Huda (2015) that reported a range of 13-25 mg/L Shitalakhya River, Bangladesh. According to Islam and Huda (2015), these levels are not suitable for living organisms.

Chemical Oxygen Demand is commonly used to ascertain the degree of organic compounds presents in water, which makes COD an indicator of organic pollution of surface water (Kumar *et al*., 2011). The value of the COD varied from 24.00 to 58.00 mg/L which exceeded the WHO permissible limit of 10 mg/L. All the observed values show that the water quality is being deteriorated by nearby agricultural activities, and other unhealthy practices such as laundry and bathing that takes place along the river bank. Islam and Azam (2015) also found very similar observation in case of water quality deterioration of Shitalakhya River.

Biochemical oxygen demand is mostly used to determine the pollution degree of wastewaters and the quality of the receiving surface waters. The observed mean for biochemical oxygen demand (0.20-2.60 mg/L) was within the WHO permissible limit (10 mg/L) for drinking water and aquatic life (Chapman 1996). According to Oram (2014), a water sample with a BOD of between 1 and 2 mg/L denote a very clean water, 3.0.0 mg/L denote a moderately clean water and >5 mg/L indicates pollution source nearby.

CONCLUSION

Water is an extremely important commodity, both to sustain life and for the global economy. However, the quality of global water has rapidly reduced for decades due to the impact of both natural and anthropogenic factors (Vadde *et al.*, 2018). This study, which assessed the water quality of Ogane-Aji River, has revealed that the nitrate (NO_3) content and chemical oxygen demand (COD) of Ogane-Aji River exceeded their respective permissible limits (WHO, 2011). This indicates the indiscriminate use of inorganic fertilizers and other agrochemicals to boost agricultural outputs or production along river bank, which are eventually washed off into the river and poses health risk to its consumers and end users (WWAP, 2013). Therefore, further research should be carried out to determine the heavy metal content of the river in order to quantify the full extent of the water quality.

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