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The physicochemical parameters of the water body within and around Savannah Sugar company Numan

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ABSTRACT

This study investigated the physicochemical parameters of the water body within and around Savannah Sugar company in Numan, Adamawa State. The rapid growth of industrial activities, including sugar production, often leads to the emission of pollutants that can have detrimental effects on the environment and human health. Sampling is conducted in selected locations within the vicinity of the Savannah Sugar Company, with measurements taken using established scientific protocols and state-of-the-art equipment. The physico-chemical analysis of the water sample revealed that Conductivity > Temp > Turbidity > pH > Do. These results highlight the urgent need for pollution control measures, public health interventions, and environmental management strategies. The outcomes of this study will assist policymakers, local authorities, and stakeholders in making informed decisions to protect the well-being of the affected communities and promote sustainable development efforts.

Keywords: Physicochemical, parameters, water, body and Savannah Sugar.

INTRODUCTION

Environmental pollution is posing significant public health risks worldwide, becoming a major concern in developing countries because of rapid economic activities and poor waste management. It is challenging to establish an association between environmental pollution and health effects because of the nature of pathways to exposure, limited data availability and the absence of a monitoring system. Furthermore, associations between environmental pollution and health are difficult due to the occurrence of multiple exposures, and the latency period of effect [1]. Heavy metals are hazardous contaminants in food and the environment and they are non-biodegradable having long biological half-lives [2]. The implications associated with metal (embracing metalloids) contamination are of great concern, particularly in agricultural production systems due to their increasing trends in human foods and the environment. Environmental contamination by heavy metals has become a worldwide problem during recent years due to the fact that heavy metals unlike some other pollutants are not biodegradable [3]. Consequently, they are not detoxified but are bio accumulated in the environment. Heavy metals are released into the environment through man's industrial, domestic and commercial activities, industrial effluents, pesticides and fungicides as well as manure from poultry farms. There is concern about the potential harmful effects of these metals because besides affecting the productivity of ecosystems, they could also impact on animal and human health. Heavy metal contamination of agricultural soils and crops surrounding the mining areas is a serious environmental problem in many counties, Nigeria inclusive [4]. Furthermore, there is risk of safety for mine workers and residents in the vicinity of mining environment subject to oral and nasal ingestion of the poisonous metals [5]. The level of heavy metal in soils and the forms in which they exist are influenced by pedogenetic processes.

Prolonged farming activities involving the use of fertilizers, herbicides and insecticides also contribute to soil pollution. Rapid industrialization has also brought about dangerous pollution of soil by heavy metals in many countries [6]. The pollution of soils with heavy metal is of global concern as a result of its potential impact on the environment and to human health. Vast portions of farmlands have been contaminated by metals as result of the activities of mining, smelting, fossil fuel burning, phosphate fertilizers and sewage sludge [7]. Based on high toxicity of heavy metals, their accumulation in farmland could lead to contamination of agricultural soil. Once soil is contaminated, it will not only affect the rapid growth of crops and quality yield of agricultural products but also pose a threat to human health via the food chain [8]. All over the world, especially in developing nations, there is a growing public concern over the potential accumulation of heavy metals in soil, water and plants owing to rapid industrial development [9].

Pollution of heavy metals in aquatic environment is a growing problem worldwide and currently it has reached an alarming rate. There are various sources of heavy metals; some originates from anthropogenic activities like draining of sewerage, dumping of wastes and recreational activities. Conversely, metals also occur in small amounts naturally and may enter into aquatic system through leaching of rocks, airborne dust, forest fires and vegetation. As heavy metals cannot be degraded, they are continuously being deposited and incorporated in water, thus causing heavy metal pollution in water bodies. The presence of heavy metals in the water may have a profound effect on the microalgae which constitute the main food source for bivalve mollusks in all their growth stages, zooplankton (rotifers, copepods, and brine shrimps) and for larval stages of some crustacean and fish species. Moreover, bioconcentration and magnification could lead to high toxicity of these metals in organisms, even when the exposure level is low. Under such conditions, the toxicity of a moderately toxic metal could be enhanced by synergism and fish population may decline. Apart from destabilizing the ecosystem, the accumulation of these toxic metals in aquatic food web is a threat to public health and thus their potential long-term impact on ecosystem integrity cannot be ignored [10].

Pollution of fresh water bodies, especially the rivers is no longer within safe limits for human consumption as well as aquatic fauna. Disposal of sewage wastes into a large volume of water could reduce the biological oxygen demand to such a great level that the entire oxygen may be removed. These may be derived from inputs of suspended solids to which toxic substances are absorbed; such as soil particles in surface water run-off from fields treated with pesticides [11].

On the other hand, these chemicals disrupt the ecological system balance due to pollution of water, air, soil and nutrients with the remains left behind in large areas, while the use of pesticides provides benefits for public health and hunger. In addition, some of them are toxic to the only specific living species because of their selective properties, while others are harmful to people, domestic animals and wild animals which are outside the target of the pesticides. In such cases they can cause acute and chronic poisoning [12].

Pesticides also play a very important role in the contamination of water resources. Since herbicides and nematicides are applied directly to the soil, they are considered to be the most important pesticides that pollute environmental waters. The ways for pesticides to interfere with the aquatic environment can be listed as; direct inputs from the agricultural industry, industrial effects, waste water effects, spraying of cattle and sheep, dust and flooding, and atmospheric transmission (wind effect, evaporation from application areas, erosion of pesticide applied lands in various ways) [13].

Pesticides, which can be dissolved in water or can be sediment in the case of exceeding the solubility criterion, pass through aquatic organisms in various ways through the food chain and cause bioaccumulation. Pesticides, which are transmitted to waters in different ways, are a threat with the adverse consequences of reaching people through water ecosystems and food chains. The fact that a person is a living creature that feeds on both plant and animal nutrients, and that it forms the last ring of the food chain, causes such compounds to appear in large measure in humans. Compostable compounds such as pesticides or heavy metals can enter the human body first with fish consumption [14].

Chemical and physical analyses of these samples can reveal the presence and concentration of pollutants such as heavy metals, pesticides, and organic compounds [15]. Additionally, ambient air can be monitored to identify pollutants and estimate the associated health risks. Air quality monitoring stations can measure the concentration of various pollutants in the air, such as particulate matter, ozone, and nitrogen dioxide. Health risk index can be calculated based on the level of exposure to the pollutants and the potential health effects associated with that level of exposure [16]. Overall, investigating pollution accumulation and estimating health risk index is an important step in identifying potential environmental and health hazards, and can help guide policy and decision-making to minimize exposure to pollutants and protect public health.

Aim of the Study

The aim of this research was to determine the physicochemical parameters of the water body within and around Savanna company

MATERIALS AND METHODS

Study Area Savannah Sugar

The study area, as shown in Figure 1, is an area located between latitudes 9⁰ 22' 00" N and 9⁰ 38' 00" N and longitudes 11⁰ 45' 00" E and 12⁰ 00' 00" E, covering the farm and factory of the Dangote Sugar Company (formerly Savannah Sugar Company). The Dangote Sugar Company being the main focus of the study is located north of the river Benue and about 20km North of Numan town in Adamawa state, Northeast Nigeria (Savannah Sugar Company Ltd., 2014). It lies at an elevation of 150 m above sea level. The company has a land mass of about 32,000 hectares spread, along Yola-Gombe highway. The out-grower farms of the Savannah Sugar Company are situated in five out-grower zones, respectively managed by estate mangers. Irrigation is done by the use of irrigation water from Kiri Dam (Figure 1), connected by a 30km distance canal to the sugar cane estate and commences two to three weeks after the rainfall cessation [17]. The climate of the area is semi-arid characterized by wide seasonal and diurnal temperature ranges. There are two main marked tropical seasons. The wet season, lasting from April-October and dry season lasts from November to March. The mean rainfall of about 905mm is recorded with peaks in August and September [18]. Between November and January, the Harmattan pushes the Inter-tropical Discontinuity (ITD) to its most southerly latitudinal position of 2-5°N. Throughout this period, most of Adamawa State is influenced comparatively by stable dry continental air mass from the northeast and hence rainfall is absent or very low. The average monthly temperature is 26.9⁰C, with minimum temperature of 18⁰C and a maximum of 40⁰C.

Sampling Area

Samples of soil, water and plants in this research work were collected in and around savannah sugar company, Numan, Adamawa State.The areas include Gyawana, Lafia in Lamorde LGA, Ngwabalang, Imburu Numan LGA, Boshikiri, in Guyuk LGA and Kiri, Kem Shelleng LGA Adamawa state. Soils samples were collected from the north, south, east and west directions, 1 km, 2 km, 3 km and 5 km radius also from 5 cm, 10 cm, 15 cm and 20 cm depth at each distance respectively from the milling plant, Simple random method was used in the sample collection. The soil sample was placed in a clean polythene bag for transport to the laboratory. Water samples were collected from wells, boreholes and the river. The water samples were placed in a clean polypropylene bottle for transport to the laboratory. Plants samples were collected from surrounding farms.

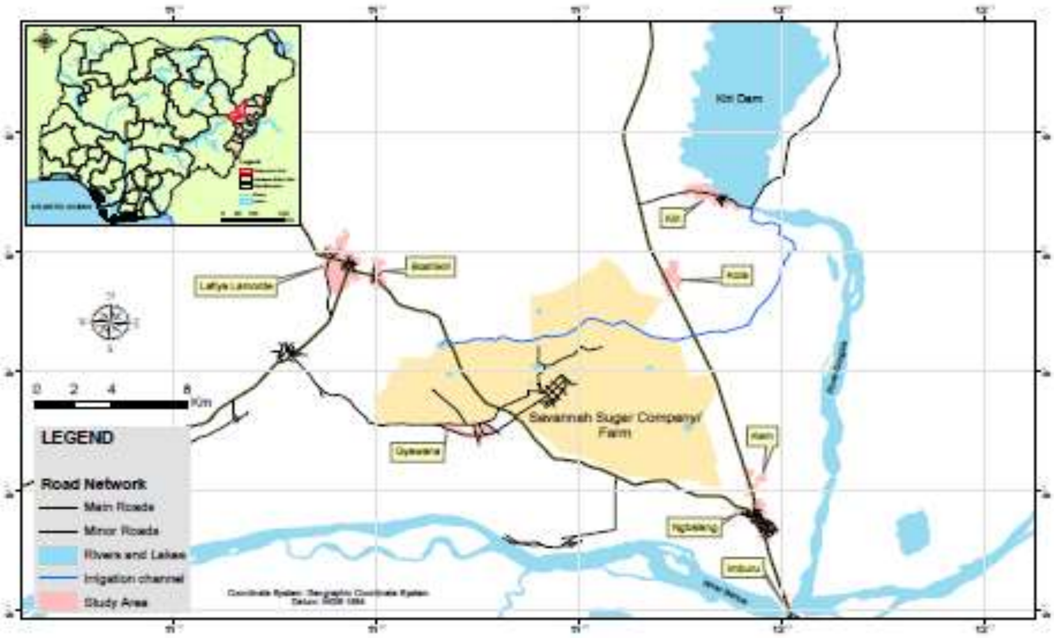

Figure A: Showing the map of study Savannah Sugar Company and other study areas.

Ground water samples Collection

Water samples to be analysed were collected from any source of water in the vicinity of the savannah sugar company. The samples were collected in a polypropylene bottle, which was pre-washed and rinsed with 10% HNO_3 (v/v).

Water Physicochemical Parameters Determination

pH

A Jenway 350 portable pH meter was used to determine the pH of the water. Buffer capsules of pH 4 and 9 manufactured by Fluka was used for the calibration. The pH meter will be standardized with the diluted buffer capsules before use. The probe of the pH meter will be dipped into the sample containers and be allowed to steady before taking the readings [19].

Temperature

A HANNA HI 145 thermometer was used to determine the temperature of the water samples.

Total dissolved Solids (TDS)

A HANNA HI 9835 conductivity meter, which also has a compartment for the determination of dissolved solids was used to determine the total dissolved solids in the water samples. TDS reading is automatically derived from the conductivity reading and no specific calibration was needed for TDS [20].

Conductivity

A HANNA HI 9835 conductivity meter was used to determine the conductivity of the water samples. The conductivity meter was calibrated with KCl solution. Selectable calibration points used to calibrate the equipment are 0.0, 0.084 mS/cm, 1.413 mS/cm, 5.00 mS/cm, 12.88 mS/cm and 80.0 mS/cm in the conductivity calibration range [21].

Turbidity

The HANNA HI 98703 turbid meter was used to determine the turbidity of the water samples. The equipment will be calibrated with four commercially prepared turbidity standards at 0, 15, 100 and 750 NTU while silicon oil was used to clean the cuvette before use [22].

Statistical Analysis

The obtained results were analysed using Microsoft Excel 2007 for descriptive statistics and SPSS 24 was used for ANOVA test of significant, Person's correlation analysis and Hierarchical cluster analysis.

RESULTS AND DISCUSSION

Physicochemical Analyses of the Water Sample

Physical parameters include temperature and color of water while chemical parameters include pH, dissolved oxygen contents, alkalinity, hardness and electrical conductivity. In this experiment only temperature, electrical conductivity, pH, dissolved oxygen and turbidity were measured in the sampling sites at Boshikiri, Gyawana, Imbru, Kiri, Lafiya, Ngwabalang, and Kem. Figures below shows the results for temperature, pH, electrical conductivity dissolved oxygen and turbidity of collected water samples. All parameters with the mean value of the data with standard error were calculated. The physicochemical parameters are very important because they have a significant effect on the water quality. It is obviously clear that water is one of most important elements responsible for life on earth. Unfortunately, human and industrial activities have degraded the quality of water. The physico-chemical parameters recorded different significantly (F-test, $P < 0.05$) as shown in table along the locations. The mean concentration of different physico-chemical parameter followed this order: Conductivity > Temp > Turbidity > pH > Do.

Temperature

The values of temperature were ranged from 29.1 to 34.0℃ respectively. Only the mean value of water temperature from Imbru dam was found within the permissible limits set by WHO, which was between 25 and 30 ℃. Water samples from other locations were found above the permissible limits. Water sample from Imbru dam has the lowest value with mean of 29.1 while water from Kiri dam has highest value with a mean of 34.0℃.

pH

The pH is a measure of acid-base equilibrium achieved by water dissolved compounds as well as extent of flocculation and coagulation process of chemicals. The pH of water samples from Boshikiri borehole and well were found to be 6.88 ±0.02 and 7.30 ±0.09 while that from Gyawana borehole and well were found to be 7.06±0.06 and 6.95±0.02, Imbru borehole and river were found to be 6.49±0.011 and 7.25±0.09, Kiri borehole and dam were found to be 7.33±0.01 and 7.53±0.01, Lafiya borehole and dam were found to be 6.17±0.06 and 7.17±0.08, Ngwabalang borehole and well were found to be 6.89±0.07 and 7.39±0.08 and Kem borehole and well were found to be 7.01±0.05 and 7.33±0.06.

The pH value was within the acceptable limit of 6.5-8.9, the pH affects chemical and biological processes and temperature affects the availability of oxygen concentration in the water. Borehole water from Imbru has the lowest value for pH with mean of 6.49, while water from sampling point of Kiri Dam has highest pH value with a mean of 7.53 as shown in Figure below.

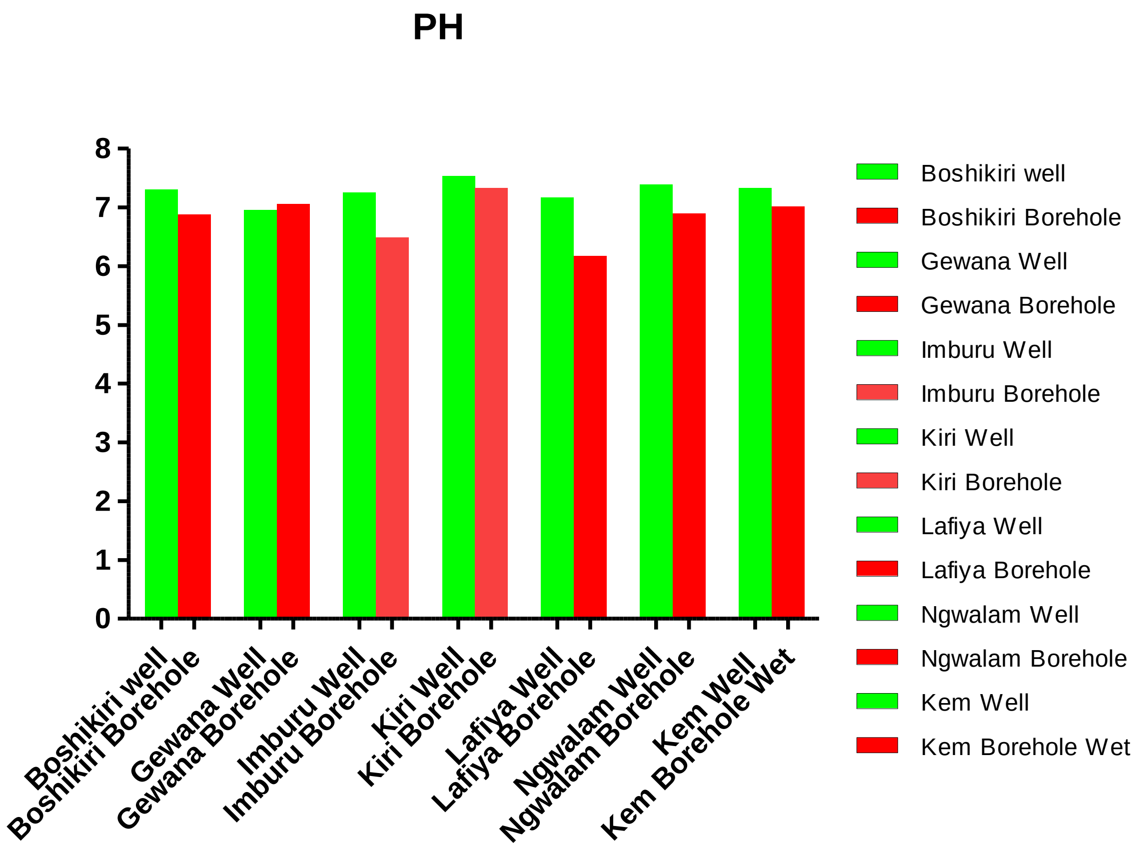

Figure 1: pH measurement of wells and boreholes water samples

Electrical Conductivity (EC)

Electrical conductivity gives an idea about the concentration of electrolytes in water and is the limiting factor. Electrical conductivity (EC) which is a measure of water's ability to conduct an electric current is related to the amount of dissolved minerals in water, but it does not give an indication of which element is present but higher value of EC is a good indicator of the presence of contaminants such as sodium, potassium, chloride or sulphate. The Electrical Conductivity (EC) were carried out in Boshikiri, Gyawana, Imbru, Kiri, Lafiya, Ngwabalang, and Kem sampling points. All the water samples collected from Boshikiri, Gyawana, Imbru, Kiri, Lafiya, Ngwabalang, and Kem. The values of electrical conductivity were found to be in the range of 90 µS/cm to 1351µS/cm. The Conductivity values of all samples were in agreement with conductivity range 0-1600 µS/cm of the guideline range for drinking water as indicated by WHO, and NAFDAC. It was evident from the Figure 2 there was no significant change in conductivity. Water from Gyawana well has the lowest value for Conductivity with mean of 90 µs/cm while water from sampling point from Kiri borehole has highest Conductivity value with a mean of 1351 µs/cm. In this study, the concentration of Conductivity is within the WHO acceptable limit of 0 – 16000 µs/cm.

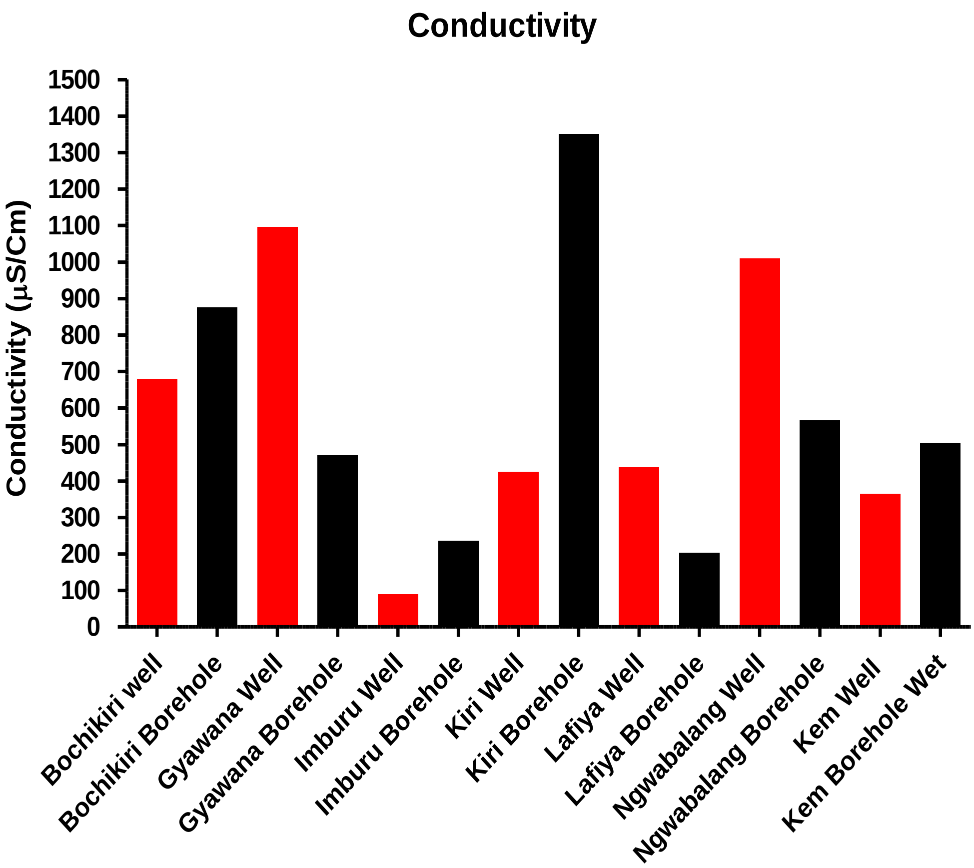

Figure 2: Conductivity measurement of wells and boreholes water samples

Dissolved Oxygen (DO)

The mean concentration of dissolved oxygen from ranged from 2.41-5.80 mg/L. The water sample from Kem bohole has the lowest value for dissolved oxygen with mean of 2.41mg/l while water sample from Kiri borehole has highest dissolved oxygen value with a mean of 5.80mg/l as shown in (Figure 3). All the values of dissolved oxygen in all water samples from different locations falls within the WHO and NAFDAC acceptable limit of (0-5 mg/L) except in dam and borehole water from Kiri and bohole water from Ngwabalang that exceed the permissible limit and this may be due to some agricultural activities taking place in the environment.

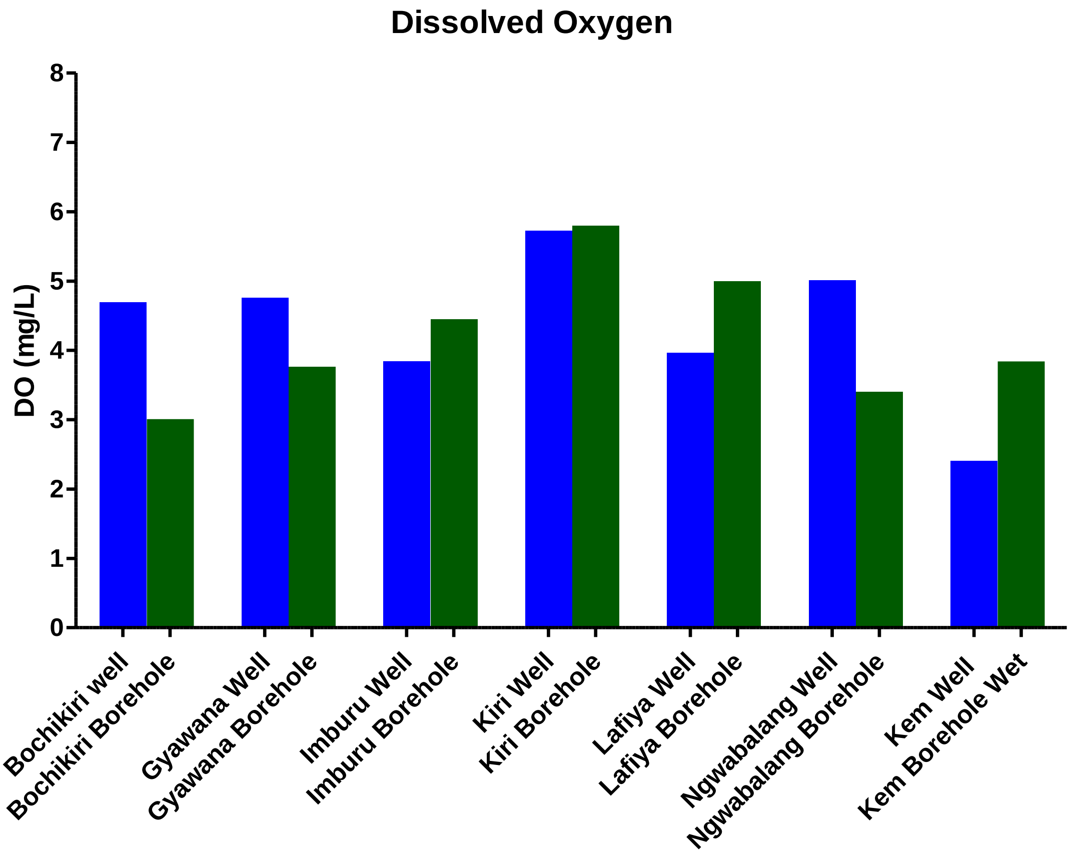

Figure 3: Dissolved oxygen measurement of wells and boreholes water samples

Turbidity

The mean concentration of turbidity of the 14 water samples from 7 different locations both wet ans dry sesson ranged from 3.90 NTU to 9.25 NTU. It was found that the Turbidity had lower mean value of 3.90 NTU in borehole from Lafiya while that of Ngwabalang borehole has the highest mean concentration value of 10.45NTU as shown in (Figure 4). The mean value of water turbidity was above W.H.O permissible limit.

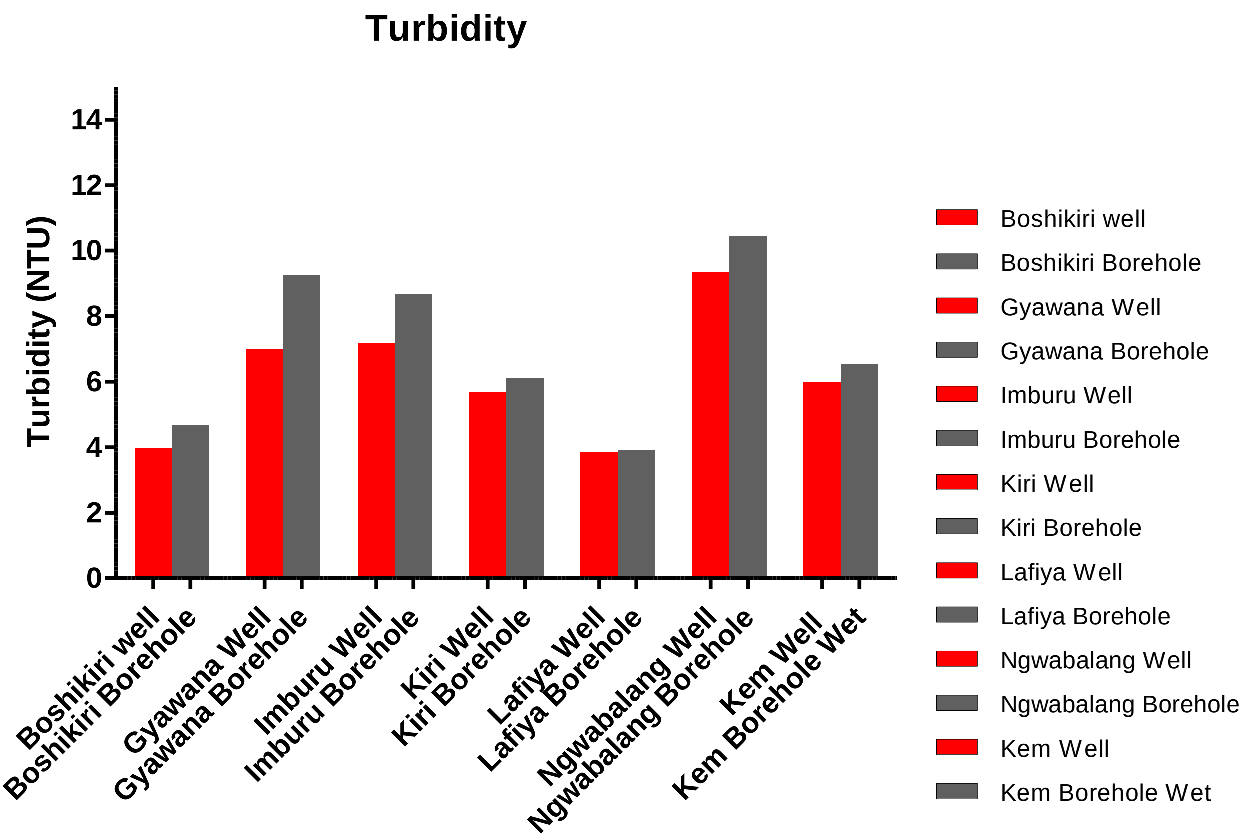

Figure 4: Turbidity measurement of wells and boreholes water samples

CONCLUSION AND RECOMMENDATIONS

Water samples were subjected for physicochemical parameters including Temperature, pH, electrical conductivity, dissolved oxygen and turbidity, the results were presented in the form of tables and figure charts. All parameters with the mean value of the data with standard error were calculated. The physicochemical parameters are very important because they have a significant effect on the water quality. The physico-chemical parameters recorded different significantly (F-test, $P < 0.05$) as shown in table along the locations. The mean concentration of different physico-chemical parameter followed this order: Conductivity > Temperature > Turbidity > pH > Dissolved Oxygen.

CONCLUSION

In conclusion, the physico-chemical parameters recorded different significantly (F-test, $P < 0.05$) as shown in the figures along the locations. The mean concentration of different physico-chemical parameter followed this order: Conductivity > Temperature > Turbidity > pH > Dissolved Oxygen.

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