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PHYSICOCHEMICAL CHARACTERIZATION OF IRRIGATION WATER NEAR A CEMENT FACTORY IN OBAJANA, AND NEARBY COMMUNITIES IN KOGI STATE OF NIGERIA.

Dr. Sunday Asher Adedeji[1] , Prof. Samuel E. Kakulu [2]

[1]*Chemistry Department, National Mathematical Centre, Abuja, Nigeria*

[2]*Chemistry Department, University of Abuja, Abuja, Nigeria*

[1]*sekakulu@yahoo.com,* [2]*sun05ade@gmail.com*

ABSTRACT

Water samples from the vicinity of a cement factory in Obajana and its environ in Kogi State of Nigeria, were analyzed for their physicochemical properties (temperatures, pH, electrical-conductivity, hardness, dissolved solids, nitrate, phosphate, sulphates and total alkalinity were analytically determined) in order to assess the impact of the cement industry on irrigation water. Samples were collected at thirty-two identified transects of stream water near the cement factory (in Obajana) and three communities within 40 km radius (Kabba, Osara and Lokoja) using standard analytical procedures during Dry and Rainy seasons. Some physicochemical parameters were determined using standard analytical techniques. Results indicated that the physicochemical parameter values varied across the study areas. The analysis showed that highest mean temperature of 28.18±2.6 ^oC was recorded in Lokoja while the lowest mean temperature of 25.04±2.13 ^oC was recorded in Osara. Water temperature recorded during the sampling period for the various sites did not differ much and the temperature values are within the WHO limit for drinking water, generally the pH of the study area ranged from 6.0 to 8.1, the Obajana water shows 7.8 to 8.1 pH which was alkaline, the total alkalinity of the stream water in Obajana was 322.5±71. mg/L followed by 305.06±74.1 mg/L from Lokoja, the highest mean electrical conductivity was 244.6±46.7µS/cm with a corresponding TDS of 178.5mg/L from Obajana, the mean concentration of the Carbonate content of Obajana with 3.8±0.6 mg/kg was observed to be higher than the three other locations under review. The Chloride content in this study revealed lowest during the raining season with 0.5±0.13 mg/kg in Osara and highest during the dry season with 21.71±0.21mg/l in Obajana. The results of the Sulphates demonstrates in Obajana with a value of 19.76±1.74mg/l being the highest during the dry season, and lowest been observed in Kabba during the raining season with a value of 2.4±0.8 mg/l. The phosphate and nitrate levels in the four sites in this studies are lower than the National Environmental Standards and Regulations Enforcement Agency (NESREA) regulatory limits of 3.5 and 40.0 mg/L respectively with detergents used for washing during sanitation being possible sources of phosphate and nitrate in the effluent from cement plant, this was reflected in the results obtained in Obajana. This suggested that most of the higher results obtained from Obajana compared with the other communities can be trace to the cement factory.

Keywords: *Pollution, Irrigation water, Physicochemical, Cement factory, community*

INTRODUCTION

River water plays an important role in the supply of water for fresh water to the public general water purposes, which is used for farming, laundry, recreation, and for washing and cooling in some industries. However, others consider rivers as a convenient means carrying wastes such as urban, domestic or industrial effluents away from their point of discharge. The degradation of river water due to the introduction of industrial effluents is now a serious concern to the environmentalists [1].

Agricultural farmers are more liable to water pollution, especially in industrialized countries. Local farmers in developing countries rely on river water for irrigation due to its cost effectiveness and availability, which is likely to be deteriorated as a result of industrial discharge result in declining crop production and increased food insecurity. This places immense pressure on the policy makers who seek to develop a sound strategy for sustainable resource development and control.[2].

Water pollution is the alteration of water quality to an extent that does not necessarily create public health hazards, but does adversely affect such water for domestic, agricultural farming, municipal or industrial use and the pollution could be by domestic, chemical wastes, bacteria or high temperature [3].

It was pointed out in [4] that industrial effluent consists of toxic and poisonous mixtures of dissolved solids and suspended solids in varying proportions. These unpleasant and dangerous substances consisting of inorganic and organic components are discharged into the environment, including rivers and streams.

The cement industry forms a part of the industries that are well known to contribute to environmental pollution. Exposure to cement dust for a short period may not cause serious problem, however prolonged exposure can cause serious irreversible damage to plants and animals [5].

thus causing suppression in plants. In animals it leads to various respiratory and blood-related diseases, like cancers, eye problems and genetic mutation [8] . The major pollutant from cement industries is particulates produced in the rotary kiln, and from crushing and grinding, blending, moving material to silos and packaging. Cleaning kiln inner surface to remove piled emission, generates effluents that are composed of soluble solids waste. Some of these soluble solids include salts of potassium and sodium hydroxide, chlorides and sulphates, suspended solids (calcium carbonate) in waste and processed water. These effluents which are discharged into water bodies, have great possibility of deteriorating water body quality [9].

The water bodies in which these effluents are discharged serve most times as sources of water for domestic, agricultural and industrial purposes. Hence, the assessment of the water quality of these water bodies are very important since the water demand for these purposes consequently have a close relationship with water availability and economic development of a nation[11], [12] . Furthermore, the use of water is sometimes restrained by its poor quality which makes it unhealthy for a particular use [13]. Successful management of water resources in Nigeria, and control of water based and water borne diseases require quality assessment of the water bodies. In view of this, [14] assessed the impact of effluent from Obajana Cement factory discharged into Onyi River in Kogi State, and reported the river as being slightly polluted. In 2008, [15].

The study on heavy metals in sediment of some inland waters adjacent to Benue Cement company, reported that the surface waters appears to have suffered adverse impact from the cement company and therefore not suitable for human consumption. A similar study by[16] on physicochemical characteristics of Ngo River around Dangote cement complex found the values of Temperature, pH, Total Dissolved solids (TDS), Nitrate (NO_3^-), Calcium (Ca^+), Phosphate (P) and Chemical Oxygen Demand (COD) to be in excess of WHO and National standards for irrigation water.

With the construction of Obajana cement factory which is exploiting the Obajana marble deposit through mining, there is every need to assess from time to time environmental impact of mining on the environment [19]. Quality of the environment is vital for sustainable development, especially in the face of rapid developmental programmes in developing countries. The rapid economic developments in Nigeria over the past few years have resulted in an increased demand for cement production, for instance in the year 2008, Obajana cement factory had the production capacity of about five million metric tons of cement per annum but by 2014, the production capacity had increased to about 13.25 million metric tons per annum. Since 2012, there has been a phenomenal rise in domestic production capacity, bringing the total domestic capacity to 27.6mtpa from 11.8mtpa in 2010 and of course the reverberating consequence of the environmental impact especially on water, air and soil will have also increased [20]. Environmental contaminants are widely distributed in air, water, soils and sediment and among environmental pollutants[21].

Water body contaminants can directly affect our health, first of all, the contaminants may enter ground water or surface water and contaminate our drinking water sources. Second, contaminants can also enter our food sources, such as crops and vegetables, and further enter into our bodies. Many of the contaminants do not easily degrade and will stay in the body for a longer period of time before excretion. The toxic effect on our health is long term [22].

The environmental concern in cement manufacture is primarily related to the emission of dust and gases, as 1 kg of cement manufacture generate about 0.07 kg of dust in the atmosphere [23]. The effect of mining on the environment is different, such as the quality of the ore, mining methods, land and many other factors. Extraction and processing of mineral resources will have a great influence on air, water, soil and biological resources [24].

Given the increasing demand for mineral resources, we have to do protective measures and engineering, through air, water and soil pollution control, which can minimized the problems in the area and away from it.

Meanwhile, it is important to note that the Dangote Cement industry in Obajana is one of the outstanding industries in Nigeria that holds the key to the development of the nation as a result of its rapid pursuit for cement to enable the country meet the development of strong physical infrastructural needs in terms of construction of good roads, bridges, hospitals, schools and to overcome the country’s housing needs. The current industry makes a great contribution to the socio-economic development by providing significant employment opportunities at non-skilled and skilled levels. Beyond that, the industry provides construction materials required for the other sectors of the economy to flourish. However, data regarding their environmental challenges are scarce [25].

The deposition of cement dust occurred at various distances around the cement factories and are influenced by wind, enhanced velocity size particles, and stack fumes[10] . Therefore this studies is to assess some physicochemical parameters of irrigation water in Obajana and those of the communities (Osara, Kabba, and Lokoja) about forty kilometers away to ascertain their suitability and comparing the parameters among the communities with some international standards for irrigation and portable waters and to assess the environmental impact of the Cement factory on the water bodies in the study areas. According to[26, 27] the assessment of the quality of these water bodies are very important since the water demand for these purposes consequently have a close relationship with water availability and economic development of a nation. Furthermore according to[28] the use of water is sometimes restrained by its poor quality which makes it unhealthy for a particular use. Successful management of water resources in Nigeria, and control of water borne diseases require quality assessment of the water bodies.

EXPERIMENTAL

3.1 Study Area/Sampling Site

Obajana, a town in Kogi State of Nigeria (Figure 1) is bounded by nearby towns such as Zariagi, Lokoja, Osara, Oshokoshoko and Kabba. Though the place was hitherto barely known, but with its present status as the home of the Dangote cement, it has since assumed international recognition [29]. In this study also to be considered are communities within the 40 km radius of Obajana, these includes Lokoja, Kabba and Osara.

Figure 1. Map of Nigeria Showing Kogi State

Kabba is 44.4 km away from Obajana through the Lokoja-Egbe-Ilorin road, the Coordinates of Kabba are 7°50′00″N 6°04′00″E with a total area of 330 km^2 (130 sq mi)[30]. Lokoja lies about 7.8023° North of the equator and 6.7333° East of the Meridian, Lokoja is about 40 km by satellite (45 km by road) away from

Obajana, while Osara is with geographical coordinates of 7° 41' 0" North, 6° 26' 0" East Osara is 44.6 km away by road to Obajana and 26.18 km by satellite. [31].

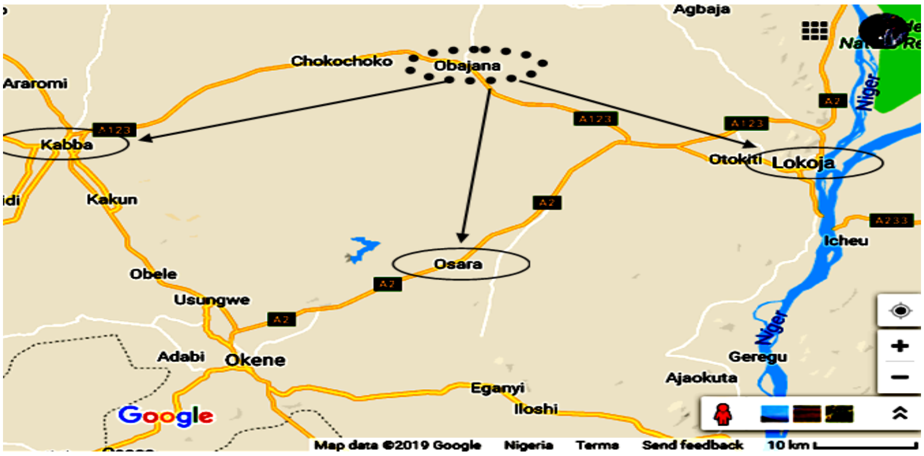

Figure 2. Google-map showing the four communities relative to the location of the Cement factory in Obajana. The sampling sites were categorized into four (see fig 3-6 below), based on the three communities within the 40 kilometer radius (figure 2) around Obajana the actual site of the cement factory. A total of 32 water samples were collected during the raining season; 8 water samples from each of the location, and these were repeated during the dry season for each of the locations.

Sample Collection

Stream-water samples were collected according to standard procedures by [32a] from different streams of the four locations and the Control (Obajana, Lokoja, Osara, Kabba and Control), and each of the location was tagged as Obj, Lkj, Osr, Kab and Ctr respectively. The coordinates for the sampling site are plotted using the goggle map as shown below.

site.

Figure 3 Geo-Map showing the Coordinate points for Obajana samples

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Figure 4 Geo-Map showing the Coordinate points for Osara samples

Figure 5 Geo-Map showing the Coordinate points for Lokoja samples

Figure 6 Geo-Map showing the Coordinate points for Kabba samples

MATERIALS AND METHODS

The temperatures were measured with a mercury glass thermometer at the stream site of each of the water stream locations according to [32b], The pH of samples was determined by electrometric method using a pH meter (HANNA, model HI 96107). being standardized with buffers of pH 4.0, and pH 9.2, the measurement of the conductivity was carried out using the standard procedure by [34], method described by [35] was used in the determination of hardness, the Trivedi and Goel [36] was adopted to determine the dissolved solids, [37] was adopted for the determine the nitrate, phosphate and sulphate according to [38] and finally the method described by US-EPA [39] was used in the total alkalinity determination.

RESULTS AND DISCUSSIONS

The results obtained were statistically represented in Tables 1 to 3 during the review.

Table 1. Dry Season Physicochemical Properties of Water Samples

Parameter	KAB	LKJ	OSR	OBJ	CTR
Temp. (^{O}C)	27.9±0.7	28.18±0.76	25.0±0.3	28.13±0.4	28.45±1.7
pH	6.8±0.2	7.3±0.3	7.2±0.8	8.04±0.16	6.8±0.3
EC (µS/cm)	142.7±41.3	117.3±60.6	166.7±71.9	244.6±46.7	69.68±16.5
TDS (mg/L)	178.5±5.1	107.00±14.6	120.9±49.9	276.89±115.3	37.00±8.13
Alkalinity (mg/L)	267.5±115.6	328.8±78.8	206.6±75.7	367.5±68.4	148.9±136.9
Hardness (mg/L)	58.6±27.3	116.9±23.9	23.29±4.5	138.9±65.75	8.6±1.8
Chloride (mg/L)	0.7±0.1	18.6±1.2	0.59±0.17	21.71±0.21	0.66±0.11
Phosphate (mg/L)	1.7±0.2	5.26±0.5	2.3±0.37	11.51±0.75	0.81±0.19
Nitrate (mg/L)	0.9±0.08	0.38±0.08	0.5±0.22	0.34±0.08	0.52±0.04
Sulphates (mg/L)	3.4±0.67	10.25±0.89	3.4±0.5	19.76±1.74	2.01±0.13

Table 2. Raining Season Physicochemical Properties of Water Samples

Parameters	KAB	LKJ	OSR	OBJ	CTR
Temp. (^{O}C)	27.3±0.9	27.05±0.9	26.04±0.3	28.13±0.4	27.17±1.3
pH	7.1±0.2	7.2±0.3	7.1±0.2	7.86±0.2	7.2±0.5
EC (µS/cm)	139.59±33.7	98.9±39.3	139.3±52.5	187.8±15.5	64.48±11.6
TDS (mg/L)	116.2±31.5	103.5±15.8	113.3±46.9	241.9±105.4	32.5±2.7
Alkalinity (mg/L)	197.5±94.7	277.5±73.6	180.1±60.0	281.2±69.4	116.7±100.6
Hardness (mg/L)	48.87±0.9	100.4±19.8	17.3±1.83	104.5±35.9	7.9±1.6

Chloride (mg/L)	0.59±0.11	16.24±0.8	0.5±0.13	19.5±0.2	0.59±0.07
Phosphate (mg/L)	2.13±2.42	4.8±0.5	1.8±0.4	14.12±0.4	0.66±0.18
Nitrate (mg/L)	0.6±0.1	0.31±0.07	0.41±0.1	0.2±0.06	0.5±0.07
Sulphates (mg/L)	2.6±0.6	2.4±0.8	2.8±0.6	17.5±2.3	1.58±0.39

Table 3. Mean Physicochemical Properties

Location	**KAB**	**LKJ**	**OSR**	**OBJ**	**CTR**
Temp. (^{O}C)	27.6±1.2	27.61±1.1	25.52±2.34	28.13±2.33	27.81±2.41
pH	6.9±0.34	7.2±0.2	7.1±0.3	7.9±0.21	7.0±0.21
EC (µS/cm)	141.145	108.1	153	216.2	67.08
TDS (mg/L)	147.35	105.25	117.1	259.395	34.75
Alkalinity (mg/L)	232.5±105.1	305.06±74.1	193.3±67.8	322.5±71.0	132.8±118.8
Hardness (mg/L)	33.7±14.12	108.7±21.9	20.29±3.15	121.68±50.81	8.28±1.72
Chloride (mg/L)	0.66±0.13	17.41±1.0	0.54±0.15	20.61±0.2	0.63±0.09
Phosphate (mg/L)	1.9±1/3	5.03±0.48	2.04±0.38	12.82±0.56	0.73±0.18
Nitrate (mg/L)	0.73±0.09	0.34±0.08	0.47±0.16	0.29±0.07	0.51±0.06
Sulphates (mg/L)	3±0.62	2.8±0.82	3.11±0.56	18.63±2.03	1.79±0.26

EC= Electrical Conductivity, TDS= Total Dissolved Solid, Temp= Temperature

KAB= Kabba, LKJ = Lokoja, OSR = Osara, OBJ= Obajana, CTR= Control

pH and Temperature Normal range for irrigation water was between 6.5 and 8.4

The pH for the studied area ranged from 6.7 to 8.0 pH as shown in Tables 1 to 3. The highest mean pH value of 8.0± 0.46 was observed in Obajana while the lowest mean value of 6.8±0.42 was observed in Kabba. Hydrogen ion concentration represented by pH is an index upon which irrigation water is quickly assessed for its suitability. Normally, the pH of irrigation water ranges from 6.5 to 8.4. The pH outside of the normal range might be suitable for irrigating, but has the potential to cause an imbalance of nutrients or contain poisonous ions[40]. The biggest hazard related to an abnormal pH in water is its effect on irrigation facilities. Exceptionally low pH in irrigation water can expedite the corrosion process of facilities, and irrigation water containing high levels of alkalinity can lower the efficiency of the trickle irrigation system [41].

The pH fell Within the WHO range for water, though the pH of the Obajana water stream is more alkaline with an average pH of 8.0 this value may be due to the presence of the cement raw materials from the factory and the Kabba water is slightly acidic while those of the , Lokoja and Osara are slightly normal. pH values lower than 6.5 are considered too acidic for human consumption and can cause health problems such as acidosis which could have adverse effects on the digestive and lymphatic systems of human[42].

The analysis showed that highest mean temperature of 28.18±2.6 ºC was recorded in Lokoja while the lowest mean temperature of 25.04±2.13 ºC was recorded in Osara. Water temperature recorded during the sampling period for the various sites did not differ much and the temperature values are within WHO [43] limit for drinking water. Temperature is a factor of great importance for aquatic ecosystem, as it affects the water organisms, as well as the physical and chemical characteristics of water, Fish are poikilothermic animals, that is, their body temperature is the same as, or 0.5 to 1°C above or below, the temperature of the water in which they live. The metabolic rate of fish is closely correlated to the water temperature [44].

CONDUCTIVITY AND DISSOLVED SOLIDS

Conductivity of the water samples (as shown on Tables 1 to 3) range from 64.48± to 244.6±46.7µS/cm while the TDS ranged from 32.5±2.7 mg/L obtained from the Control during the raining season to 276.89±115.3mg/l obtained from Obajana during the dry season. The highest conductivity recorded during the studies was 244.6±46.7 µS/cm with a corresponding TDS of 178.5±5.1mg/L from Obajana during the dry season followed by 166.7±71.9 µS/cm from Osara and a corresponding TDS of 120.9±49.9mg/L while the lowest was from the Control water with 69.68±11.86 µS/cm with a corresponding TDS 37.00±8.13mg/L. The mean Conductivity across the study area was 216.2 > 153.01 > 141.145 > 108.1 > 67.08 µS/cm with respect to the study area Obajana > Kabba > Osara > Lokoja > Control

Treated wastewater contains high salt content which can immensely affect crop growth; thus, there needs to be a standard for salinity [45]. Salinity is usually described in electric conductivity (EC). The effect that salinity gives to crop growth differs by crop type. Generally, if the EC of irrigation water is below 700 µS/cm, it does not affect crop growth; when above 3000 µS/cm, it can cause severe damage [45] . Israel and Italy aim for unrestricted irrigation and have EC standards for wastewater reuse of 1400 and 3000 µS/cm, respectively. Portugal has a fairly strict EC standard of 1000 µS/cm. In South Korea, the MOE sets the EC standard for direct wastewater reuse differently for food crops and processed food crops; the standards are 700 and 2000 µS/cm, respectively. Many countries apply the suspended solids standards for indirectly consumed crops, and South Korea can use the 15 mg/L standard, which is a standard for using lake water as agricultural irrigation [46].

TOTAL ALKALINITY

The lowest water alkalinity was recorded (116.7±100.6 mg/L) in Osara during the raining season and highest (367.5±68.4mg/L) in Obajana during the dry season, the range of the alkalinity in the studies was from 148.9±136.9mg/l in Control to 367.5±68.4mg/l in Obajana during the dry season and from 116.7±100.6mg/l in Control to 281.2±69.4mg/l also from Obajana water during the raining season as indicated in Tables 1 to 3.. The mean Alkalinity is in decreasing order of 322.5±71.0 > 305.06±74.1 > 232.5±105.1 > 193.3±67.8 > 132.8±118.8 mg/l in terms of location Obajana > Lokoja > Kabba > Osara > Control. An alkalinity test measures the level of bicarbonates, carbonates, and hydroxides in water and test results are generally expressed as "ppm of calcium carbonate ($CaCO_3$)". The desirable range for irrigation water is 0 to 100 ppm calcium carbonate. Levels between 30 and 60 ppm are considered optimum for most plants [47].

Following mixing of calcium carbonate, aluminum silicate, silica oxide and iron oxide as raw materials for cement production in a rotary kiln, water is required in the plant by factory workers for sanitary purpose. This might result in wastewater that is alkaline. The resulting effluent from the production has potential of imparting high alkalinity to the water bodies where total alkalinity of the stream water in Obajana was 322.5±71. mg/L followed by 305.06±74.1 mg/L from Lokoja . These levels of alkalinity were lower than 625 mg/L observed for cement effluent from Chttak industrial zone of Bangladesh but higher than the observed value by [48] for effluent water from Obajana water effluent.

TOTAL HARDNESS

The minimum and maximum values for total hardness obtained from this study were 58.619 mg/dm^3 (Kabba) and 138.9 mg/dm^3 (Obajana). Maximum hardness of 138.9±65.75 mg/dm^3 was recorded at Obajana stream during the dry season and minimum (7.9±1.6 mg/dm^3) in Osara stream, this was also reflected with the mean results of the hardness which was highest in Obajana (121.68±50.81 mg/dm^3) and lowest at the Osara water stream. The order of the mean hardness in the four location in decreasing order is 121.68±50.81 > 108.7±21.9 > 33.7±14.12 > 20.29±3.15 > 33.7±14.12 mg/L in terms of location Obajana > Lokoja > Kabba > Control > Osara.

In order to produce cement, limestone as a major raw material undergoes calcination process. The process entails the decomposition of limestone to calcium oxide which reacts with silicate to form cement and carbon(IV) oxide that is given off. In the presence of this gas as a by-product, a small quantity of limestone ($CaCO_3$) can readily dissolve in moisture to produce soluble calcium bicarbonate. The soluble calcium of this salt forms about 38% of total hardness of effluent from the Obajana cement plant [48]. The values of the hardness of water recorded for this study was higher compared to the values of 71 ± 32 mg/L ranging from 31 to 153 mg/L recorded by [48] for the hardness content in Onyi river in Obajana.

CHLORIDE AND SULPHATES

The Chloride content in this study revealed lowest during the raining season with 0.5±0.13 mg/kg in Osara and highest during the dry season with a 21.71±0.21mg/l in Obajana and the mean chloride content shows a range of 0.54±0.15mg/l in Osara to 21.71±0.21 mg/l obtained from Obajana. The results of the Sulphates demonstrates a level of sulphates in Obajana with a value of 19.76±1.74mg/l being the highest during the dry season, and lowest been observed in Kabba during the raining season with a value of 2.4±0.8 mg/l, very close sulphate levels were observed in Lokoja, Osara, and Kabba with sulphate levels approximately 3.0mg/l in each locations during the dry season and approximately 2.0 mg/l during the raining season in each of the corresponding three locations.

Nearly all water bodies contain chloride and sulphate, and their levels vary greatly depending on the underlying composition of the river bed. The concern for chloride level, of higher concentration is that it can corrode metal reinforcement such as bridge that is erected along the water way [49]. Sulphate has also been implicated as a corrosive agent in water bodies [50].

The observed mean concentration of chlorides ions in Obajana (20.60±1.0mg/l) in the water was higher when compared with the values obtained in a similar study in effluent water from Obajana with chloride value of 18.0±7.9mg/L while the sulphate from Obajana (19.76±1.74mg/l) was also higher than the 3.8±1.9mg/L of sulphates. The concentrations of chloride and sulphate in cement effluent at Obajana were much less compared with the corresponding concentrations of 3,458 and 2,455 mg/L reported for cement effluent discharged to

Surma River in Bangladesh [51]. High levels of chloride ions lead to increased concentrations in its uptake by plants and so results in toxicity problems in crops and consequent reduction in the yield. However, it is very important in photosynthesis[51].

PHOSPHATES AND NITRATES

The phosphate and nitrate levels in the four sites in this studies are lower than the National Environmental Standards and Regulations Enforcement Agency (NESREA) regulatory limits of 3.5 and 40.0 mg/L respectively. Detergents used for washing during sanitation are major sources of phosphate and nitrate in the effluent from cement plant [52]. This is reflected in the results obtained in Obajana compared to the other locations in the studies. In spite of water bodies requiring some nutrients such as phosphorus and nitrogen to be healthy, excessive levels of the nutrients can be harmful [53]. Phosphorus occurs in the form of phosphates with other elements. Different forms of phosphates which are complex in nature are found in the soil, water, plants, animals and humans. They exist in the soil as phosphates (PO_4^{3-}), monohydrogen phosphate (HPO_4^{2-}), and dihydrogen phosphate (H_2PO_4-), which are readily inter-converted to one another and the predominant species is determined by the pH of the solution or soil [54]. Excess phosphorus in soil can become a point source of pollution, because the excess not utilized by plants is wash away by runoffs into ponds, lakes and rivers. Though phosphorus promotes plant growth in soils, yet its excess in water promotes algal growth, which if persistently continues can lead to algae bloom. Algae bloom, leads to oxygen deficiency in water with the consequence of death of aquatic animals and odour. In soils with inadequate phosphorus content, plants will suffer, growth of crops will be stunted, leaves may change colour to purple and there will be a delayed time to flowering and growth of new shoots [55]. Nitrogen is required for proper plant growth, it is available to plants as either ammonium ($NH4^+$-N) or nitrate (NO_3^--N).

CONCLUSIONS

In this study, by comparison of the environmental situations in the vicinity of the cement factory and three other communities 40 km away from the factory coupled with guidelines from WHO, FAO USEPA and other International standards, we attempted to emphasize the impact of the cement industry on the quality of the water stream for portable and irrigation purposes from the physicochemical point of view. The physicochemical parameter in the stream water near the cement industry were higher than those from the communities about 40 km away, indicating that the cement factory might be responsible for making that difference.

It can be observed that the water stream in Obajana are higher in pH (8.5) this could be due to the presence of the CaO and the $Ca(OH)_2$ from the cement dust.

The pH of the water was within the WHO permissible limit for irrigation water but not suitable for drinking. It was deduced from the study that the impact of the influence of the Cement factory pollution on Obajana and Lokoja is higher as indicated by the results with closer values.

This obviously could be due to proximity to the Cement factory and maybe due to the more frequent pathway of trailers conveying the cements to other parts of the country through Lokoja.

The results obtained and the experience gained in this work were necessary to facilitate the identification of water contamination processes in communities close to cement factories, and serves as a basis for taking appropriate measures when farming, restoring and to protect the quality of water resources near a cement factory.

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