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ASSESSMENT OF THE PHYSICO-CHEMICAL WATER QUALITY COMPLIANCE OF WUPA WASTEWATER TREATMENT PLANT, FOR DOMESTIC USE IN FEDERAL CAPITAL TERRITORY, ABUJA, NIGERIA

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ABSTRACT

This study assessed the physiochemical Water Quality Compliance of Wupa Waste Water treatment Plant for Domestic use in Federal Capital Territory Abuja, Nigeria. The aim were achieve through the following objectives Determine the physiochemical properties of the water in WUPA waste water treatment. To determine the suitability of water

Introduction

Water is one of the world's most valuable resources which is of utmost requirement and critical for human development (WHO, 2012). The human right to water entitles everyone to sufficient, safe, acceptable and physically accessible and affordable water for industrial agricultural and domestic use (OHCHR, 2015; WHO, 2015). Concurrently, the end product of water for industrial, domestic and agricultural purpose is wastewater (James and Abiose, 2016). These have rendered the availability of safe and clean water under constant threat compounded with the resulting drought in arid and semi-arid regions, explosive population growth, and urban waste discharge. One of the most promising efforts to stem the global water crisis is industrial and municipal water reclamation and reuse (James and Abiose, 2016).

The Earth has been proliferated into Anthropocene period, where majority of the population lives in the city or near city. A new geological time dominated by urbanization and people. It has become increasingly impOrtant to understand the impacts of urbanization on ecosystem structure and functions, society, and culture (McDonald et al., 2011). Urbanization affects microclimate, surface water dynamics, groundwater recharge, stream geomorphology, biogeochemistry, and stream ecology (O' Driscoll et al., 2010). Consequently, water quantity, quality (i.e., sediment, nutrient dynamics, and other pollutants), and watershed functions are impacted (Sun and Lockaby, 2012). Still, observation shows that human activities are a major factor determining the quality of the surface and groundwater through atmospheric pollution, effluent discharges, use of agricultural chemicals, eroded soils and land use (Sillanpa et al., 2004).

The pollution of rivers, lakes and other water bodies in the surrounding area of big cities and densely populated areas, as well as the global concern over freshwater scarcity are serious problems in the environment and which have negative impact on public health (Giwa, 2012). The problem is that appropriate small. scale waste water technology management is not yet known by communities. Typically, water quality is determined by comparing the physical and chemical characteristics of a water sample with water quality guidelines or standards. Drinking water quality guidelines and standards are designed to enable the provision of clean and safe water for human consumption, thereby protecting human health. These are usually based on scientifically assessed acceptable levels of toxicity to either humans or aquatic organisms.

Materials and Methods

Study Area

Federal Capital Territory (FCT) is the home of Abuja, the capital of The territory was formed in 1976 from parts of former Nasarawa, Niger, and Kogi States and it is in the central region of Nigeria, bordered to the

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north by Kaduna State, to the east by Nasarawa State, to the south-west by Kogi State and to the west by Niger State. It lies between longitudes 60 20'E and 70 33'E of the Greenwich Meridian and with latitudes 80 30'N and 90 20'N of the equator. It occupies an area of about 8000km. The FCT is located in the centre of the country. Mabogunje (1977) describes the FCT as being in the middle belt of Nigeria with a size equivalent to 0.87% of Nigeria.

The FCT has six area councils namely, Kuje, Gwagwalada, Abaji, AMAC, Kwali and Bwari where the Lower Usuma Dam is located. The federal Capital Territory is central to Nigeria in administrative, geographical, and lying just above the hot and humid low lands of the Niger/Benue trough but below the drier parts of the country lying to the north. It lies north of the wide alluvial plains formed by the confluence of the Niger and the Benue rivers. The Jema'a platform, a continuation of the Jos plateau extends well into the middle of the territory. The city is located in a scenic valley of rolling grasslands.

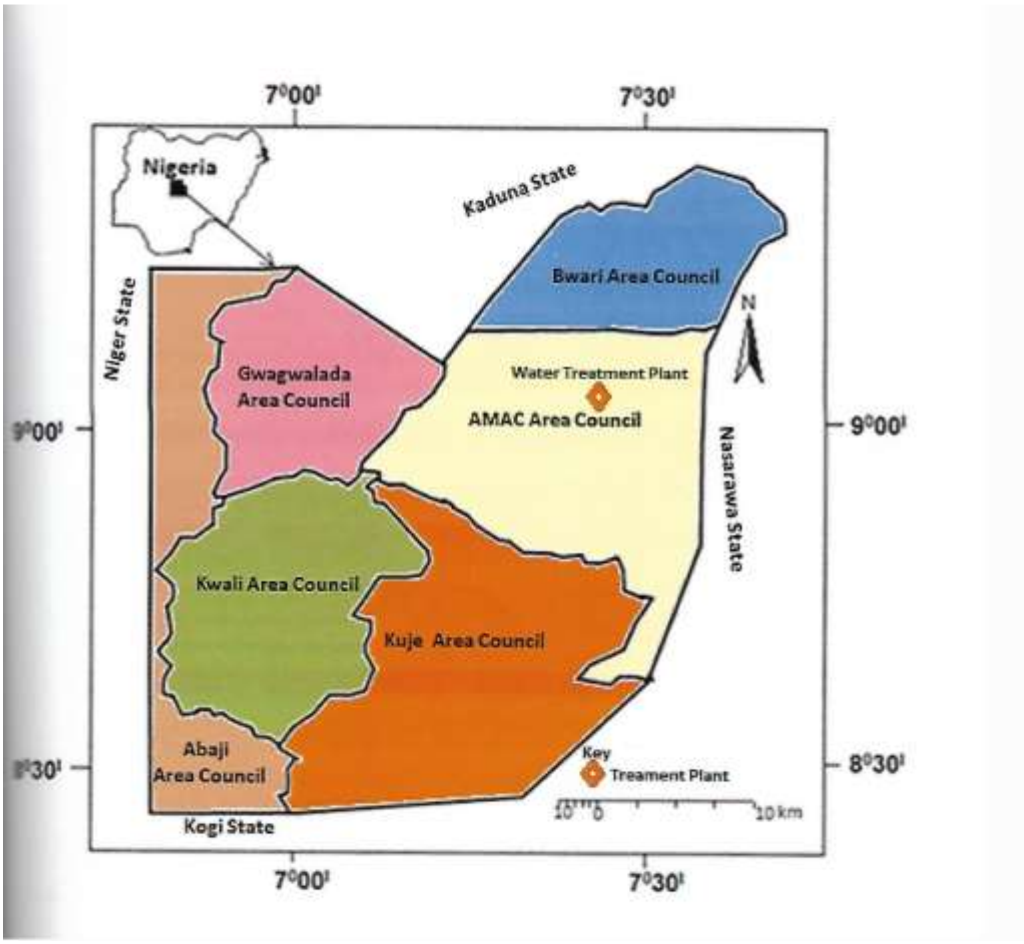

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Figure 1: Map of the Study Area:
Source: AEPB, 2019

Source of Data

The data for this study were collected from both primary and secondary sources.

Techniques and Procedures of Sample Collection

Water samples were collected at the Influent Point (IP) and Effluent Point (EP) of the wastewater treatment plant. The samples were collected at the peak hour of effluent discharge (12pm-3pm and 5-7 pm). As designated by Benethen (2003), the water samples were obtained using a sterile sample bottle of 250ml in a depth of 30cm. The samples were properly labelled, then stored in a cooler and to the laboratory for onward analysis.

Data Analysis

The collected water sample was analyzed in situ, to determine the physical state of the collected sample and to preserve the water prior to the final laboratory analysis.

In-Situ Analysis

The in-situ analysis was done with the use of Smar-TROLL Handheld Multiparameter Device, to determine the current physiochemical state of the samples.

The collected water samples were preserved by acidification, cooling and to conserve trace metals, absorption losses to container walls, and chemical element in the water, in other to avoid physiochemical changes in the collected water samples between time of collection and laboratory analysis.

Laboratory Analysis

The collected water samples from all points within- the sample frame were subjected to laboratory analysis, using recommended standard laboratory procedures.

Physiochemical Properties of Wupa Wastewater Treatment Plant

Table 4.1 shows the physical properties, and table 4.2 chemical properties of water as analyzed using simple descriptive statistics, which was sourced from the raw laboratory results.

Table 4.1: Physical properties of waste water at Wupa Treatment Plant (2019)

Descriptive Statistic s (D.S)			Temp (°C)		COND. (S/m)		TDS (		TSS (mg/l)	
	influ ent	efflu ent	influ ent	efflu ent	Influ ent	efflu ent	influ ent	ef flu	inffi ent	Efflu ent
x	7.42	7.47	26.4	26.3	213.9	229.4	112.2	121.1	138.2	16.9
S.D	o. 12	0.11	0.48	0.51	18.86	13.92	13.2	11.5	38.7	4.9
S.E	0.02	0.02	0.09	0.11	3.71	2.73	2.59	2.25	7.60	1.19
Min	7.14	7.12	25.3	25.7	170.5	215	90.3	105	87.5	10
Max	7.66	7.64	27.7	27.6	260	280	151	150	235.5	30

Source: Laboratory analysis, 2019

Table 4.2: Chemical properties of waste water at Wupa Treatment Plant (2019)

(D.S)	BOD (mg		DO (mgt)		COD (mgt		CL (mg/l		SO_4(mg/l)		Oil & Greas (mg/l)	
	In ñ.	E f fl	Intl.	Effl-	Infl.	Effl.				Effl.		Effl
x	65.8 37.3		4.73 6 81		200.7	39.48	35.1	23.9	40.6	23.3	36.1	13.2
S.D	33.4204		0.26		71.5	14.2	8.89	6.85	12.17,4		14.1	9.8
	6.5 3.94		022 005		14.1 278		1.74	1 .34	2.37	1. 46	2. 74	1.95
Min	40	3	3.9 6.23		30	7.10	17	11.8	23	11.8	3.8	3
Max	190 60		7.08 7 10		374.1 60		57	40	80	37	70	41

Table 4.3: Physio-chemical properties of water at River Wupa (2019)

i Stream		Temp		TDS	BOD	DO	COD			Oil & grease	
Upstream	7.7	27.3	225	125	50	6.79	110	27	35.0	40	104
Downstream	7.6	27.1	229	120	55	6.75	120	29	35.5	38.0	93

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Source: Laboratory analysis, 2019

Compared Results of the Influent and Effluent Water

The results; mean values for the effluent water as captured in both table 4.1 and 4.2 showed significant improvement over the mean values for the influent water for the main performance indication for water quality parameters of the treatment plant, such as the TSS, BOD, COD, CL., SO4 and oil/grease.

Table 4.4: Removal efficiencies of key parameters in Wupa wastewater treatment plant

PARAMETERS	rsTFLUENT	EFFLUENT	EFFICIENCY OF WUPAWWTP (°/o)
TSS (mg/l)	138.1	16.9	87.8
BOD (mg/l)	65.8	37.3	43.2
COD (mgA)	200.7	39.48	80.3
CL (mg/l)	35.1	23.9	32.8
S04 (mgfl)	40.6	23.3	42.4
Oil and Grease (mg/l)	36.1	13.2	65.8

Source: Laboratory analysis, 2019

Level of Compliance with FEPA and NESREÄ Permissible Limits

pH ofWastewater in Wupa Treatment Plant

The range of pH for the influent waste water was 7.14 to 7.66, effluent range was 7.12 to 7.64. The mean pH value for the influent water was 7.42 and that of effluent was 7.47, with standard deviation of 0.12 (influent) and 0.11 for the effluent wastewater. The standard error for the influent water was 0.02, and that effluent water was 0.02. The influent and effluent values of the standard deviation and the standard error of the mean, shows that there was little variation in the distribution. Comparing the results with the standard limit sewage water disposal into surñce water for FEPA (6-9) and NESREA (5.5-9), both the influent and effluent discharges all fell within the permissible limit (table 4.1).

A measure of the hydrogen ion concentration; pH of 7.0 indicates a neutral solution, pH values lower than 7.0 indicate acidity, pH values larger than 7.0 indicate alkalinity (USEPA, 2004). pH is extremely important in biological wastewater treatment, because the microorganisms remain sufficiently active only within a narrow range, generally between pH 6.5 and 8. Outside this range, pH can inhibit or completely stop biological activity. Nitrification reactions are especially pH-sensitive (Water Environment Federation, 2002b). Biological activity declines to near zero at a pH below 6.0 in un-acclimated systems. Water generally becomes more corrosive with decreasing pH; however, excessively alkaline water also may be corrosive. Results of the water analysis reveals that after treatment, the effluent discharge is safer for reuse in agriculture since the pH value fell within 6.5-8, Permissible pH for irrigation water (FAO, Bulletin 10; 1970), thus favourable for soil microbes. This was further proven in a research by a committee of consultants from the University of California in 1974. Generally, the ability of aquatic organisms to complete a life cycle greatly diminishes as pH becomes as high as 9.0 or as low as 5.0. Thus, if the treated wastewater (effluent) is been discharged into water bodies, no potential harms will be Impose on aquatic life.

Plate 1: Taking Temperature at the Laboratory

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Temperature

The range of temperature for the influent waste water was 25.3 °C to 27.7°C, effluent temperature range was 25.7°C to 27.6°C. The mean temperature value for the influent water was 26.4°C and that of effluent was 26.3°C as well, with standard deviation of 0.48 (influent) and 0.51 for the effluent wastewater. The standard error for the influent water temperature was 0.09, and that of the effluent water was 0.11. The result revealed that temperature slightly varies with distribution. Wastewater is typically somewhat warmer than unheated tap water and open alr water bodies, because it contains heated water from dwellings and other sources. As buried pipes convey wastewater through a long distances to and fro the plant, the influent and effluent temperature typically approaches the temperature of the ground (Metcalf & Eddy, 2003). However, the mean temperature values of both the influent and effluent samples (26.4°9, as well as the upstream and downstream water temperature of the receiving are in par with the set limit of FEPA and NESREA (<40°C). The outcome result of the analysis indicated that the temperature of the discharge water will have no effects on the feeding, reproduction, and metabolic activities of aquatic animals in the receiving stream. Many biological, physical, and chemical principles such as the solubility of compounds in sea water; distribution and abundance of organisms living in the watershed; rates of chemical reactions; water density; inversions and mixing; and current movements are temperature-dependent (WWAP, 2012).

Conductivitv

The range of the conductivity the influent waste water was 170.5 S/m to 260 S/m, while effluent waste water conductivity range was 215 S/m to 280 S/m. The mean conductivity for the influent water was 213.9 and that of the effluent water was 229.5, with standard deviation of 18.89 (influent) and 13.93 for the effluent wastewater. The standard error for the influent water conductivity was 3.71, and that of the effluent water was 2.73 (table 4.1). The conductivity value of the upstream sampled water from the receiving stream surface water is 225 S/m, while the downstream conductivity value as analyzed in the laboratory was 229 .

S/m (appendix A). The outcome of the standard deviation of both the influent and effluent water, showed that conductivity slightly varied with distribution.

Conductivity of water is a useful indicator of its salinity or total salt content (Singh et al., 2012). The mean conductivity values of the influent and effluent discharge water (213.9 and 229.5 S/m) collected from the Wupa wastewater treatment plant, as well as the samples collected from the upstream (225 S/m) and downstream (229 S/m) are all in accordance with the NESREA standard limits of 370 S/m-3,as indicated in table 3.1. This results is in par with the discovery of Siyanbola et al., (2011), in a study conducted in Lagos, Nigeria, on the physiochemical characteristics of industrial effluents discharge into municipal drains. Thus implies that the effluent discharge can be deployed into agricultural lands, without any effect on soil salinity. This result indicates an appropriate and quality treatment of the collected wastewater from the plant.

Total Dissolve Solid (TDS) of the Waste Water in Wupa Treatment Plant

The range of Total Dissolve Solid (TDS) for the influent waste water was 90.3mg/l to 151mg/1, effluent TDS range was 105mg/l to 150mg/l. The mean total dissolve solid value for the influent water was 112.2mg/l and that of effluent was 121.1mg/l, with standard deviation of 13.2 (influent) and 11.5 for the effluent wastewater. The standard enor for the influent water temperature was 2.59, and that of the effluent water was 2.25.

With a minimum and maximum value of the effluent water (105mg/1 and 150mg/l), the mean value of the effluent water samples is also in compliance with the FEPA standard limit and the NESREA standard limit of 2000mg/l.

As analyzed, water samples of the upstream and downstream collected from the receiving stream where effluent from the Wupa treatment plant is been discharge were 125mg/l and 120mg/l respectively. This values is also in compliances with the FEPA standard limit and the NESREA standard limit of 2000mg/l for the discharged of wastewater.

Total Dissolved Solids (TDS) comprise of inorganic salts (principally calcium, magnesium, sodium, bicarbonates, chlorides, and sulphates) and some small amounts of organic matter that are dissolved in water. IDS in potable water is generally less than 500 mg/L, a recognized threshold above which excessive hardness, unappetizing taste, scaling and corrosion may occur (UNEP, 2004). The range of TDS for potable water supplies can be from as low as 30 mg/L to as high as 1000mg/L in running surface water (Arizona Bureau of Reclamation and Sub Regional Operating Group, 2006). The palatability of drinking water has been rated, by panels of tasters, according to TDS level as follows: excellent, less than 300 mg/L; good, between 300 and 600 mg/L; fair, between 600 and 900 mg/L; poor, between 900 and 1200 mg/L; and unacceptable, greater than 1200 mg/L. High total dissolved solids may affect the aesthetic quality of the water, with washing clothes, staining, taste, or precipitation, while extremely low TDS concentrations in water may also be unacceptable because of its flat, insipid taste.

Conclusion

Based on the outcome of the analysis and summary of the research findings, it can be concluded that the examined water properties of the effluent wastewater discharge into the receiving stream, were all in compliance with the permissible limit as prescribed by FEPA and NESREA. Except for the BOD, DO as well as the concentration of oil and grease which was slightly above the recommended limit. Thus there is the need to put in more effort in the treatment of influent wastewater generated in the FCT before discharge into recelvmg streams. People using the water downstream of the river Wupa, must treat it or boil thoroughly and filter before drinking and putting to other domestic usage

Reference

Abba K. , Hauwa L.B. and Jimme MA. (2013). Assessment of Domestic Wastewater Disposal in Some Selected Wards Maiduguri Metropolis, Borno State, Nigeria. Journal of Geography and Geology; Vol. 5, No. 4; pp 83-85

ABU Committee on Protection of the Kubanni Dam Drainage Basin (2008). Report on Result of Measurement of the Remaiñing Storage in Kubanni Impounding Reservoir & Proposal for Upgrading the Environment in

Kubanni Drainage Basin, Presented to the Vice Chancellor, Ahmadu Bello University, Zaria. October 2008. PP 28-29

Adakayi P.E. (2000). Climate Change in DawanP.D. Geography of Federal Capital Territory. Asanlu Publication, Minna.

Adesogan, S. (2013). Sewage Technology in Nigeria: -A Pragmatic Approach. Science Journal ofEnvironmental Engineeñg Research, 10(7) 257-266.

Adewumi, J. R, Ilemobade, A. A. and van Zyl, J.E. (2010). Decision Support for the Planning of Integrated Wastewater Reuse Projects in South Africa. Water Science and Technology — Water Supply, 10 (2) 251—267.

Adewumi, JR , Ilemobade, AA. and van Zyl, J.E. (2013). Application of MultiCriteria Decision Support Tool for Assessmg the Feasibility of Implementing Treated Wastewater Reuse. International Journal of Decision Support System Technology (IJDSST) 5 (1) 1-24.

Aivaliotis, Mavridou, Lekkas and Stathopoulos (2001). In: The Lekkas (Ed.), 4th Conference on Environmental Science and Technology, pp. 713—721 Molyvos, Lesvos, Greece.

Ajibade, A.C., M. Woakes, M.A. Rahaman, (1989). Proterozoic Crustal Development in the Pan African Regime of Nigeria. Geology of Nigeria, Rock View.

AjibadeA.C. and Fitches, W.R (1988). The Nigerian Precambrian and Pan African Orogeny In: Precambrian Geology of Nigeria. A publication of Geological Survey ofNigeña

Akanmu, J.O., Eluwa, O. and Ekpo, 1. (2007). Chronicles of River Basin Development in Nigeria: Online: www.dsi.gov.tr|english/congress2007 /chapter1/09 pdf.

Alexander RB, Elliott AH, Shankar U, McBride GB (2002): Estimating the Sources and Transport of Nutrients in the Waikato River Basin, New
Zealand. Water ResourRes 38, 12

Almeida MC, Butler D. and Friedler E. (2000). At Source Domestic Wastewater Quality. Urban Water 1, 49—55.

AmadiU.MP. and TemeS.C (1987): The Engineering Characteristics of Soils around Abuja Nigerian Journal ofMining and Geology. Vol. 3

American Public Health Association (APHA) (2005). Standard Method for the Examination of Water Wastewater. Washington: American Public Health Association.

Arizona Bureau of Reclamation and Sub-Regional Operating Group. (2006). Central Arizona Salinity Study: Phase 11 Report. http://tinyurl. com/AZ- salinity.

Baba A., (2009). Measurement of Remaining Storage and Rate of Siltation of
Ahmadu Bello University Farm Lake at Zaria, First International Workshop of West Quaternary Research Scientists, City of Ibadan, Nigeria, October 26-30, 2009.

Balogun, (2001). The Federal Capital Territory of Nigeria. A Geography of its Development, University of Abuja.

Brown CD, Hart A, Lewis KA, Dubus IG (2003): P-EMA simulating the environmental fate of pesticides for a farm-level risk assessment system. Agronomie 23 (1) 67—74 crisis.pdf

Bruvold W. H, Ongerth H. J. (1996). Taste quality of mineralized water. Journal of the American Water Works Association. 61; 170.

Corcoran, E, C. Nellemann, E. Baker, R Bos, D. Osborn, H. Savelli (eds). (2010). Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-ArendaL www.grida.no ISBN: 978-82-7701-075-5

CPHEEO (2012). Manual on Sewerage and Sewage Treatment, Part A: Engineering Final Draft, Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, New Delhi.

De Kreuk M. K, Picioreanu C, Hosseini M. , Xavier J. B, van LoosdrechtMC.M. (2007). Kinetic model of a granular sludge SBR influences on nutrient removal. Biotech. Bioeng, 97(4), 801-815.

EPA (1998). Methods for Chemical Analysis Of Industrial Effluent. Environmental Protection Agency, USA.

Food and Agriculture Organization (FAO) Soil Bulletin 10 (Denis and Freitas; 1970)