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The Impact assessment of abattoir waste facility discharge on water in Osogbo, Nigeria

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Abstract: This study investigates the effects of indiscriminate disposal of abattoir waste into water bodies in the Aregbe area abattoir of Osogbo the capital city of Osun state, Nigeria. The samples for the study were gotten from the point source into the streams and wells of close proximity to the abattoir facility. The physio-chemical and bacteriological parameters of the water bodies were analyzed and compared to the World health organization limits for discharge and use. The observed physicochemical and bacteriological parameters were Color, Odor, Temperature, pH, Alkalinity, Turbidity, Total hardness, Appearance, Calcium Hardness, Chlorine ion, Magnesium ion, Dissolved Oxygen and Total Coliform bacteria using the standard procedure in the Standard Methods for the Examination of Water and Wastewater Part 1000. It was observed that the Color, Dissolved oxygen and Total coliform exceeded the limits set by the world health organization. The fairly poor performance of the water bodies is due to the carrying capacity which in coming years will be exceeded. The indicators of the given water quality parameters give rise to future studies on the state of the water bodies in Nigeria.

Subjects: Civil, Environmental and Geotechnical Engineering; Water Engineering; Environmental Health; Pollution

Keywords: abattoir waste; water quality; surface water; groundwater; water quality standards

1. Introduction

Water pollution has now become a global problem due to the ever-increasing population of the earth which constantly are in need of fresh water (Alfonso-Muniozguren et al., 2018; Gil-Pulido et al., 2018; Meng et al., 2018). Various regulations and discharge limits have been established for

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PUBLIC INTEREST STATEMENT

The quality of the water bodies and selected well close to the abattoir facility in Osun state, Nigeria was analyzed in compliance with the World Health Organization standard. The results show varying limits of the different parameters been tested within the allowable limits. The study gives an indication for further studies on the water quality of various rivers in Nigeria as they are possible sinks for all waste in the environment.

national and global standards. There has been an increasing study on the treatment of wastewater before discharge into the water bodies some of which were studied by (Akyol, Taner, Demirbas, & Kobya, 2013; Badejo, Omole, Ndambuki, & Kupolati, 2017; Emenike, Omole, Ngene, & Tenebe, 2017; Ogbiye, Omole, Ade-Balogun, Onakunle, & Elemile, 2018; Adebanji S. Ogbiye, Onakunle, & Omole, 2018). The recycling of wastewater is an increasingly popular option in water management to reduce pressure on water supplies due to the exponential growth in population (Zahedi et al., 2018). Water can be used for numerous purposes and there are no limits to its usage; in Nigeria, the environmental regulator is known as the National Environmental Standards and Regulations Enforcement Agency (NESREA) postulated some acts which form the guiding rules for water and wastewater use and discharge (FEPA, 1991).

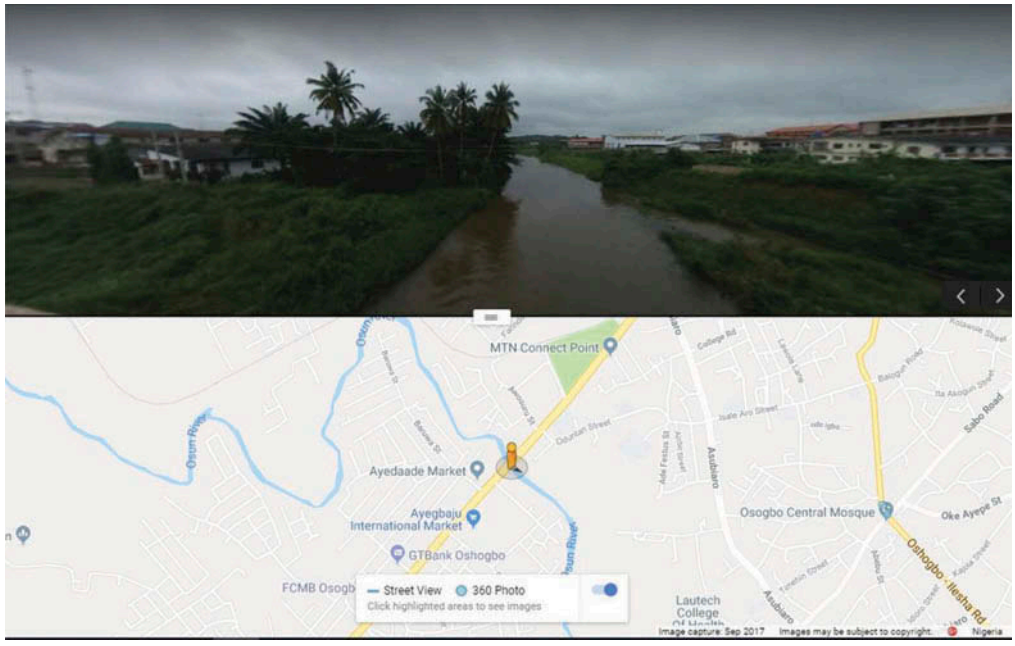
The meat industry which consist of various forms of processing which include abattoir, abattoir is one of the largest consumer of water (Angelakis, Snyder, Angelakis, & Snyder, 2015; Gerbens-Leenes & Mekonnen, 2013) with over 2000 Gm^3 of water required per year for the animal production (Mekonnen & Hoekstra, 2011). This high volume of water for the meat production yields considerably equal amount of wastewater to be discharged. The wastewater discharged vary in pollution content ranging from organic to inorganic pollutants. The need for regular surveillance, pre-treatment and treatment of water bodies is of utmost importance in this generation so as to maintain the sustainability of the environment (Khan, Gani, & Chakrapani, 2016; Nkansah, Donkoh, Akoto, & Ephraim, 2019; Tyagi et al., 2013). Abattoir sludge which originates from high strength wastewater (Eryuruk, Tezcan Un, & Bakır Ogutveren, 2018a) needs to be properly disposed of. This abattoir waste contains several compositional elements such as potential pathogens, biodegradable organic compounds and odor producing elements (Alfonso-Muniozguren et al., 2018; Eryuruk, Tezcan Un, & Bakır Ogutveren, 2018b; Eryuruk et al., 2018a; Ozdemir, Yetilmezsoy, Nuhoglu, Dede, & Turp, 2018).

One of the fastest growing population in the world is Nigeria, with a population of over One Hundred and Fifty million people. The wastewater disposal lifestyle of the Nigerian populace is of importance to understudy. The ever-growing population's way of discharge of wastewater (abattoir) is worthy of monitoring. In Nigeria, many abattoirs dispose their effluent directly into streams and rivers without any form of treatment and the slaughter meat is washed by the same water (Adelegan, 2004; Durotoye, Adeyemi, Omole, & Onakunle, 2018). According to the World Health Organization (WHO, 2011), more than 3.4 million people die each year from the waterborne disease most of whom are young children. It was estimated that about fifty per cent of the world's population in developing countries (such as Nigeria) is suffering from a water-related disease at any one time (Adelegan, 2004). In 2018, the world's poverty capital has moved from India to Nigeria ("World Poverty Clock," 2018), this, however, gives rise to the degradation in the use of water as a natural resource. This study investigates the effect of abattoir waste on the surface and underground water in Aregbe area of Osogbo (the capital city of the State of Osun, Nigeria). Different studies have focused on the various aspects of water resource management (Ali Khan & Tian, 2018; Eslami, Nowrouz, & Sheikholeslami, 2017), it is, therefore, worthy of note that abattoir waste disposal from the most populous African country and the world's poverty capital is of utmost importance in the global water cycle system.

2. Study area and methodology

This research was carried out in Osogbo, the capital city of Osun State in the Southwestern part of Nigeria. The study area is located on the extreme center of Osogbo and is traversed by a major river called Osun River (7.767,667, 4.539,501) as shown in Figure 1. The mean annual minimum and maximum temperatures are approximately 23°C and 31°C, respectively. The relative humidity of the study area is between 60% and 80% during the rainy season. The research was carried out within the township of Osogbo and samples were collected at abattoirs (Isale Osun slaughterhouse and Aregbesola/first bank area of Olaiya close). These having a distance of about 2 km to each other. The abattoir (cattle slaughterhouse) lots were visited in the suburban area of Aregbe and Isale Osun Area of Osogbo Osun State. Organic wastes in large quantity are generated on

Figure 1. Map of the Osun River from Google map 2019.



a daily basis on this site. Based on the inspection, the following was observed: solid waste and mixed dust from offloading of cattle from their transport trucks and lorries, straws, waste animals' parts and meats, wastewater from abattoirs, garbage from animals' fodder and human food wastes, as well as cattle dungs. These pollutants were at various stages moved down the slope into the drainage stream and percolates into the ground.

3. Materials and methods

The ground truthing in locating the sampling points of the abattoir facility and the water bodies were carried out by desk studies, the water samples were gotten and tested for various water quality parameters (in-situ and ex-situ). The water quality tests were conducted in the chemical research laboratory using the methods discussed below.

The wells and streams were sampled for two days at Aregbe area. The water samples were collected at the exact contact point of waste discharge (A) and 30 m downstream (B) for the stream water and 15 m apart for well in both locations as shown in Figures 2–5. All glass wares used in the collection of samples were sterilized in an autoclave at a temperature of 120°C for three hours before the samples of 100 ml and 2 liters of each of the well water was collected for bacteriological and physiochemical analyses, respectively, according to the procedure described in (APHA, AWWA, 1999, 2005, 2012).

Properties such as appearance, temperature, color, odor and taste were assessed. pH was determined using a pH meter and temperature was measured at the point of collection using a thermometer with a range of 10°C-50°C. Chemical constituents of the samples were determined using flame photometer, atomic absorption spectrophotometer, titration, gravimetric, evaporation to dryness and colorimetric (APHA, AWWA, 1999, 2005, 2012).

4. Result and discussion

The result of the Physiochemical analyses is presented in Table 1. The pH level of the samples when compared with WHO standard show that all the samples of water both in group A and B (as indicated in the methodology) are neither acidic nor alkaline except for the well-labeled A at

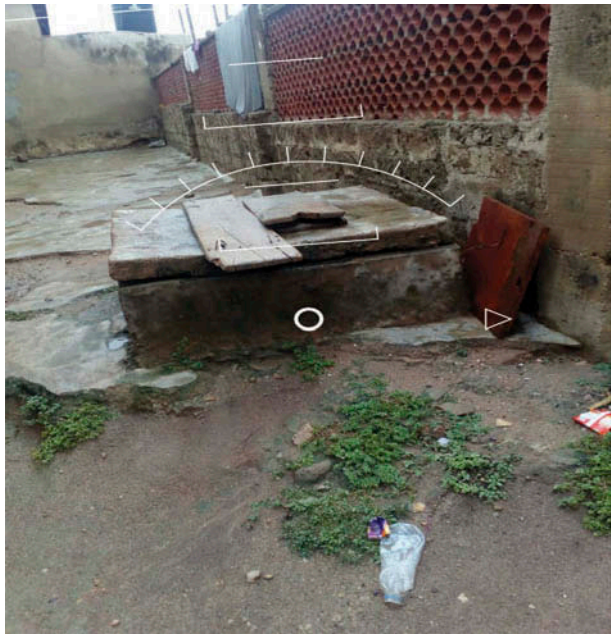


Figure 2. Sample location of Well A.

Figure 3. Sample location of Stream A.

Aregbe that is slightly acidic. Hence, the stream water needs no treatment for alkalinity or acidity but only for the well in Aregbe.

No odor was noticed from the entire well samples when and after collection but the stream samples are purely offensive because of direct contact of the abattoir effluent. Thus, the wells have an unobjectionable odor, which met the standard for (World Health Organisation [WHO], 2008). The well water samples are not clear and the stream water samples are brown in color which negate the basic point of water which is generally believed to be colorless. The well water samples are generally found to be colorless as they fall within the limit. The stream samples are all found to have color as a result of direct contact of blood and some other waste that may be

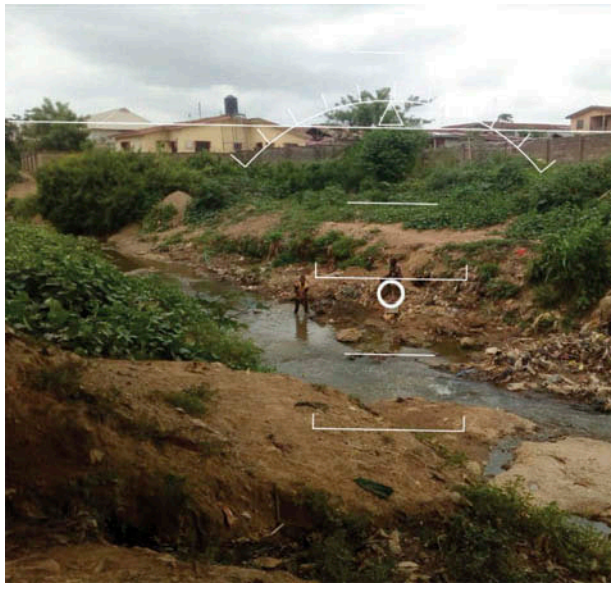


Figure 4. Sample location of Stream B.

Figure 5. Sample location of Well B.

responsible to exert color; thus, there is the need for treatment before discharge for use as they exceed the (WHO, 2011; World Health Organisation [WHO], 2008).

From Table 1, the chloride content of all the samples when compared with standard (World Health Organisation [WHO], 2008) showed that the samples are not salty beyond the recommended values. The chloride ion is 10.50 mg/l, 31.00 mg/l for well water in group A and B, respectively, 19.50 mg/l, 15.00 mg/l for stream in group A and B, respectively. This shows very little traces of chloride ion when compared to the WHO standards. The result shows that for well water, the iron content in group A and B is 0.16 mg/l and 0.08 mg/l, respectively, while the stream is 0.16 mg/l for group A and 0.8 mg/l for group B. all the wells sampled fell between the bearable range of the (World Health Organisation [WHO], 2008) which is 0.3 mg/l. The stream labeled B in Aregbe exceeds the required limit and hence needs to be treated before any domestic use as it is capable of deteriorating the teeth and stains when laundering. The maximum acceptable concentration for total alkalinity is 100 mg/l by every standard. However, the stream samples in

Table 1. Physico-chemical values and composition of the well and stream water used by butchers in abattoir at Aregbe area, Oshogbo, Nigeria

Water Sample	Well A	Well B	Stream A	Stream B	WHO LIMIT (World Health Organisation [WHO], 2008)
Temperature	27.80	26.20	27.60	27.80	>15°C
P^H	6.40	6.60	6.40	6.80	6.5–8.5
Odor & taste	Unobjectionable	Unobjectionable	Unobjectionable	unobjectionable	Unobjectionable
Color (NFU)	25.00	35.00	80.00	60.00	5–40
Appearance	Not clear	Not clear	Brown	Brown	
Total Hardness (mg/L)	164.00	204.00	208.00	190.00	
Calcium hardness (mg/L)	144.00	154.00	186.00	154.00	250
Chloride ion (mg/L)	10.50	31.00	19.50	15.00	250
Calcium (mg/L)	88.00	246.40	176.00	192.00	20
Magnesium Ions (mg/L)	135.00	27.00	46.00	50.00	150
Dissolved Oxygen (mg/L)	6.2	6.3	6.2	5.7	Not <2 & not >6
Iron (mg/L)	0.16	0.08	0.16	0.8	0.3

Aregbe exceeded the standard and hence, needs to be subjected to treatment under any condition. The permissible level for magnesium hardness is 250 mg/l, the stream samples at Aregbe falls within the range. While that of total hardness of water is usually due to the presence of multivalent metal ions, which comes from minerals dissolved in the water. Water hardness standard for drinking water is 100-500 mg/l. The generally accepted classification of hardness in drinking water in terms of calcium carbonate are as followed 0-7 mg/l as soft, 75 mg/l-150 mg/l as moderately hard and 150 mg/l and above as hard water. With this classification, the stream and the well in Aregbe are hard water.

Table 2 shows that samples collected from the wells and streams source have microorganism growth (bacterial contaminants). This not only makes the water unsafe for human consumption but it also makes it unfit for abattoir facility processes.

5. Conclusion

In Nigeria, nearly all abattoir facility disposes their waste on the land or stream with or without pretreatment, this, however, destroys the life in the aquatic environment and was observed in this study. Abattoir has been one of the major contributors to global water pollution and its negative impact was noticed in the current study using the World Health Organization standards for wastewater discharge and drinking water. Based on the well and stream water assessment of the abattoir waste effect, it was observed that there is the presence of e-Coli and other harmful organisms generated from animal wastes which pose a risk and health hazard for consumption and harmful to the environment at large. Therefore, the treatment of water for human use should be intensified before supply. The study has revealed that there was an adverse impact on the physiochemical and bacteriological parameters of effluent impacted stream by the discharge of abattoir wastes. However globally, abattoir facilities have been greatly influenced by government

Table 2. Bacteriological test on the water samples. Day 1 Aregbe

Sample No	Descriptive samples	Presumptive result of coliform organisms at 48hours of incubation at 37°c 50 ml 10 ml 1 ml	Most probable number of bacterial coliforms per 100 ml of the water sample.	WHO Standard (World Health Organisation [WHO], 2008)
A	Well	1 5 3	90	0/100 ml
B	Well	1 5 1	35	0/100 ml
A	Stream	1 5 5	180+	0/100 ml
B	Stream	1 4 3	30	0/100 ml
DAY 2 AREGBE				
A	Well	1 2 1	7	0/100 ml
B	Well	1 2 1	5	0/100 ml
A	Stream	1 4 4	40	0/100 ml
B	Stream	1 5 3	90	0/100 ml

regulations and policies in relation to health and sustainable development goals. Conversely, these regulations do not take its effect in Nigeria as poor waste disposal practice has become the order of the day.

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