Limnological Properties and Water Quality of Sombreiro River, Port Harcourt, Nigeria

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Abstract

The limnological characteristics and water quality of Sombreiro river was studied between March and May, 2021 with the water samples collected from the 3 stations analyzed in the laboratory following standard method of APHA. The results of the water parameters studied showed that the mean values were as follows: pH, 6.66±0.15, Temperature, 30.01±0.42^{0}C, Electrical conductivity (EC),120.1±39.4µs/cm, Dissolved Oxygen (DO), 5.40±0.18mg/l, Biological Oxygen Demand (BOD), 4.17±0.29mg/l) while the values for the nutrients, sulphate (SO4), Phosphate (PO4) and nitrate (NO3) were respectively,14.10±0.94mg/l, 0.46±0.07mg/l and 1.37±0.11mg/l. From the results only pH, DO and nitrate did not differ significantly spatially at probability level of P<0.05. The water variables were all within the permissible limits recommended by WHO, SON and EPA. Analysis of variance (ANOVA) showed no significant difference for all the variables studied across the stations. Sombreiro river is therefore not stressed but suitable for survival and growth of aquatic biota. Therefore, adequate measures should be taken to ensure that anthropogenic activities in the area are monitored to avoid discharge of harmful wastes into the area capable of causing contamination or pollution.

***Key words**: Limnological Properties, Water Quality, Sombreiro River, Port Harcourt*

INTRODUCTION

Water making up to 60-95% of the total weight of any functioning living cell (Tutor *et al.*,2015) and one of the most important substances upon which human life and indeed all life on earth depends (Al-Ridah *et al.*, 2020). Physicochemical variables help in assessing the functionality of a lake ecosystem on the basis of its productivity, nutrient balance and resource cycling which is essential in estimating ecological carrying capacity of the system and indicates the sources and number of pollutants in the form of nutrients and solids. The physical and chemical characteristics of water are important determinants of water quality and consequently its suitability for the distribution and production of fish and other aquatic animals (Swingle and Moss, 1969). Oyewo and Don Pedro (2003) reported that variability of water quality influences the toxicity levels of heavy metals on estuarine organisms as it affects the physical and chemical composition of the ecosystem.

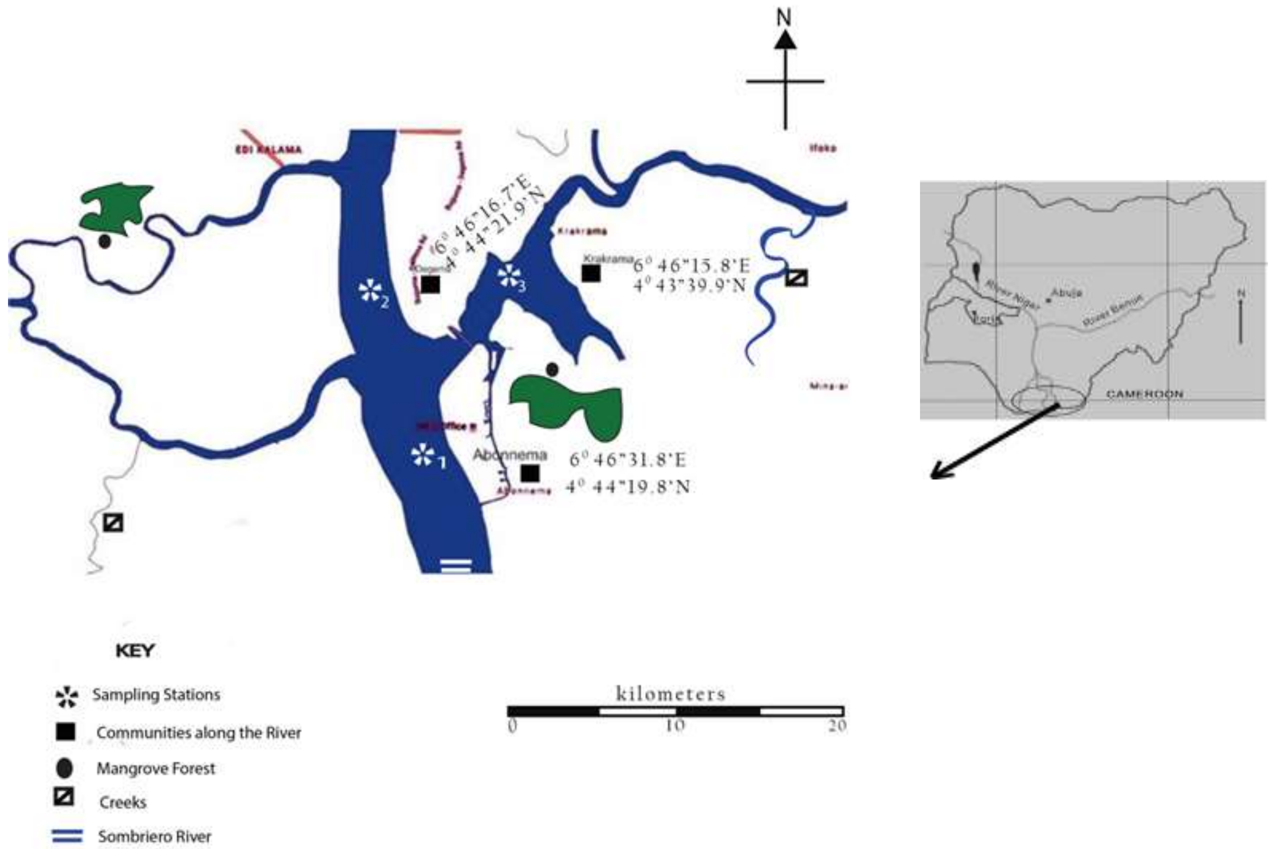
In Africa a large proportion of both rural and urban population live in the vicinity of inland or coastal waters showing that traditional human populations have tended to settle close to natural waters because they offer man's greatest hopes for food and material supplies. For instance, coastal waters provide fertile environment serving as important nursery grounds for many marine and freshwater organisms. The wetlands shelter and provide transit facilities for migrant birds, and the mangroves protect the coastline against erosion while inland waters serve as a ready source of portable water. They also act, in common with coastal waters as a place for transportation and recreation and a source of energy. Furthermore, inland and coastal waters are important ecosystem complexes for fisheries and aquaculture development (FAO,1991). Anthropogenic influences affect physicochemical parameters of water and are said to be known sources of water pollution which could be urban, industrial and agricultural activities (Irfan and Shakil, 2012). Arimoro and Oganah (2010), conducted a research study at Orogodo River, Southern Nigeria and opined that zooplankton distribution and abundance were affected by some physicochemical parameters or local environmental conditions such as temperature, depth, dissolved oxygen, alkalinity and conductivity which were said to account for 68% of variations in zooplankton.

The Sombriero River system is one of the most important river systems in the Niger Delta Basin, providing nursery and breeding grounds for a large variety of fish species and source of livelihoods for the inhabitants hence this research. Although this environment is threatened by pollution resulting from industrial activities, human anthropogenic activities and others as they discharge their effluents directly into the river irrespective of the major roles it plays to the community especially for their protein source and livelihood and for transportation. This study therefore intended to assess the variability and status of some physicochemical variables of this river.

MATERIALS AND METHODS

Study area and Sampling Locations

The study was carried out at the middle reaches of the Sombreiro River where three areas in the river were located as sample sites. The locations sampled were Abonnema (Latitude 4º42'55.56"N and Longitude 6º46'24.29"E), Degema (Latitude 4º45'27.63"N and Longitude 6º45'31.18"E) and Krakrama (Latitude 4º44'56.33"N and Longitude 6º46'42.57"E)(Fig.1). The Sombreiro River is located east of the Orashi River and originates from swamps in the Oguta-Ebocha zone. It has its source from the Niger River, runs downwards into the Southern tip of the Niger Delta basin and empties into the Atlantic Ocean.



Sampling Collection and Analysis

The water samples for limnological parameters were collected once a month for three (3) months between March and May from the three stations. All the kegs containers were kept in ice - chest box and transported to the laboratory for further analysis. Dissolved oxygen (DO), Conductivity, temperature and pH were measured in-situ using Water Quality Checker (Horiba U-10) while others were determined following the Standard method recommended by APHA (1998).

Statistical Analysis

One-way Analysis of Variance (ANOVA) was used to test for statistical difference in the means of the water parameters. The results were also computed statistically using software package for Windows, version 23 at 1% and 5% confidence levels ($P<0.05$). Pearson correlation test was also carried out to demonstrate correlation between the limnological parameters.

RESULTS AND DISCUSSION

Results of some of the physicochemical parameters studied are as presented in Tables 1-2 and Figures 2-5 with some selected national and international water quality standard guidelines.
pH ranged between 6.40 and 6.90 with the overall mean value of 6.66±0.15 without significant spatial variation (Table 1 & 2). pH value was highest (6.70±0.10) in April but lowest (6.60±0.27) in March (Figure 2). This observed pH range is acidic and within that considered permissible for

aquatic life. The pH range obtained in this study is comparable with the 6.20 and 7.90 reported by Otene and Iorchor (2013) Amadi-Ama, Bonny Estuary. pH is the standard measure of how acidic or alkaline solution could be and usually measured on a scale ranging between 0 and 14 with a solution with pH 7 neutral, less than 7 (<7) acidic, while 8-14 is alkaline or basic. According to (Kelly-Addy *et al.*,2004), the closer the pH get to 1 the more acidic it becomes while the closer it gets to 14, the more basic/alkaline it becomes. This pH range obtained in this study is in tandem with that reported by Ewulonu *et al*.,(2019) in a freshwater in Isiokpo which was attributed to influx of biodegradable materials and further biodegradation process leading to release of acidic gases as by-products into the water. However, this value is in total disagreement with the range of 8.0 to 8.3 which is said to be observed in most fresh water bodies as opined by Rheinheimer (1991).

Temperature ranged between 29.50^{0}C and 30.50^{0}C with the mean value of 30.01±0.42^{0}C (Table 1). Temperature was highest (30.27±0.25°c) in April but lowest (29.83±0.58°c) in March (Figure 3). This result is also in line with the finding of Davies and Otene (2009) who reported temperature range of 29.50+.02 and 30.25 + 0.03"c in Minichinda stream. The slight spatial and temporal variations (Figure 3) observed in this study could be attributed to change in climate conditions, degree of exposure to sunlight and surrounding vegetations. This range of temperature is in line with the range (29.30± 0.60 and 29.8±0.3^{0}C) reported by Akpan (2003) for Douglas and Stubbs creeks in Akwa Ibom State respectively. This is also in tandem with the range of 27.3-32.1^{0}C reported by Idariah *et al*.,(2010) for Amadi creek in Rivers State. Temperature has been considered to be an important physicochemical variable relatively easy to measure with thermometer (Lawson, 2011). The increase in water temperature accelerates chemical reactions, raises solubility of gases, amplifies taste and odour and elevates metabolic activity of organisms. Temperature has also been considered to be an important variable that directly affect the metabolic activities, growth, feeding, reproduction, distribution and migratory behaviours of organisms in the aquatic ecosystem (Suski *et al.*,2006, Crillet and Quetin, 2006).

Electrical conductivity (EC) ranged from 140.50 -1500µs/cm with the mean value of 120.1±39.4 (Table 1-2). Temporally, EC value was highest (131.0±3.61µs/cm) in February but lowest (98.0±71.46µs/cm) in March (Figure 4). The mean value of conductivity recorded in this study is in line with Kosa (2007) and Deekae (2009) in Luubara Creek. The significant difference between stations observed in this study may be attributed to difference in environmental factors owing to nutrient regenerating from bottom sediment, decomposition, heavy run-off and mineralization of microbes. This result also tallied with the mean reported by Ewa *et al*.,(2011) in Omoku creek but in disagreement with the value (19,839.8±14701.30 µs/cm) reported by Onyema *et al.*,(2009) in Badagry Creek. Ewa *et al*., (2011) opined that increased level of EC usually corresponds to a high value of TDS while Ohimain *et al*., (2008), Seiyaboh *et al*., (2013) and Rehman *et al*., (2016) reported that dredging and sand mining contribute to increase in EC values as observed in Stations 1 and 2

Dissolved oxygen with the mean value of 5.40±0.0.18 mg/l in this study (Table 1 and 2) is within the permissible limit recommended by WHO. DO value was highest (4.40±0.27mg/l) in March but lowest (3.97±0.25mg/l) in February (Figure 5) DO is an essential water parameter which is influenced by temperature (Manoral-online, 2012). Colder water contains more dissolved oxygen than warm water (AWQA, 2012). Organic load influences aerobic biodegradation, resulting to oxygen depletion (Alagoa and Aleleye-Wokoma, 2012). Ewa *et al.* (2011) recorded a high DO mean value of 39.90 mg/l for Omoku creek as compared to 4.47 mg/L by Olomukoro *et al.*, (2009) at Ekpan creek, 5.70 mg/L by Akpan (2003) at Okorotip creek and 5.04 mg/l by Davies (2009) at Woji-Okpoka creek were also reported. However, fish can move away from low DO areas. Water with low DO from 0.2 - 0.5 mg/L are considered hypoxic; waters with less than 0.5 mg/L are anoxic. The standard for sustaining aquatic life is stipulated at 5 mg/l a concentration below this value adversely affects aquatic biological life, while concentration below 2 mg/L may lead to death for most fishes (Chapman,1993). In comparison with the present findings, Das and Acharya (2003) reported low DO 3.8 and 2.1 mg/l in upstream and downstream within the rainy season, which decreased to 1.7 mg/l in upstream and 1.2 mg/l in downstream within summer in Kathajodi River at Cuttack City.

The range (3.70-4.60mg/l) and mean value (4.17mg/l) of BOD without significant difference spatially (Tables1 and 2) while monthly values are as in Figure 5. The higher BOD value observed in Station 2 than Stations 1 and 3 could be due to high level of anthropogenic activities in the Station. Akankali *et al*.,(2017) and Ling *et al*.,(2017) attributed high BOD in Etim Ekpo River in South-South Nigeria to discharge of organic and inorganic pollutants through runoffs from the surrounding farmlands, re-suspension and circulation of organic matters through dredging and sand mining activities. According to Moore and Moore (1976) waters with biological oxygen demand (BOD) levels less than 4mgl/l are considered clean while those with levels greater than 10mgl/l are considered as polluted as they contain large amounts of degradable organic materials. High biological oxygen demand levels reported by Davies and Otene (2009) in Minichinda Stream was said to be caused by the influx of enormous domestic and industrial effluents from the area.

Table 1: Overall Mean Values and Ranges of Physico-chemical parameters in the Study Area

Parameters	Mean	Minimum-	Maximum	WHO	SON	EPA
pH	6.66±0.15	6.40	6.90	6.5-7.5	6.5-8.5	6.5-8.5
Temp	30.01±0.42	29.50	30.5	25	Ambient	NS
EC	120.1±39.4	15.5	140.5	1500	1000	4.7-5.8
DO	5.40±0.18	5.10	5.60	15	NS	NS
BOD	4.17±0.29	3.70	4.60	10	NS	NS
SO_4	14.10±0.94	12.5	15.7	200	100	250
PO_4	0.46±0.07	0.39	0.60	0.5	0.01-0.03	NS

NO_3	1.37±0.11	1.26	1.60	10	10	10

WHO: World Health Organisation (2004). **SON:** Standards Organization of Nigeria (2007). **EPA:** Environmental Protection Agency (2002). **NS: Not Stated**

Table 2: Spatial Mean Value of Physico-chemical Parameters in the Study Area

Stations	pH	Temp(°C)	$EC(\mu s/cm)$	DO (mg/l)	BOD(mg/l)	SO_4(mg/l)	PO_4(mg/l)	NO_3(mg/l)
Station1	6.57 ± 0.06^{a}	29.83 ± 0.58^{a}	133.1 ± 6.54^{a}	5.37 ± 0.21^{a}	4.07 ± 0.47^{a}	13.38 ± 0.76^{b}	0.42 ± 0.05^{b}	1.33 ± 0.06^{a}
Station2	6.65 ± 0.22^{a}	30.37 ± 0.12^{a}	135.3 ± 2.25^{a}	5.36 ± 0.24^{a}	4.30 ± 0.24^{a}	14.80 ± 0.90^{a}	0.53 ± 0.58^{a}	1.42 ± 0.17^{a}
Station3	6.76 ± 0.12^{a}	29.83 ± 0.29^{a}	91.83 ± 66.11^{b}	5.493 ± 0.095^{a}	4.13 ± 0.06^{a}	14.13 ± 0.76^{a}	0.43 ± 0.06^{b}	1.35 ± 0.09^{a}

Means with similar superscript across the column is not significant at $P<0.05$

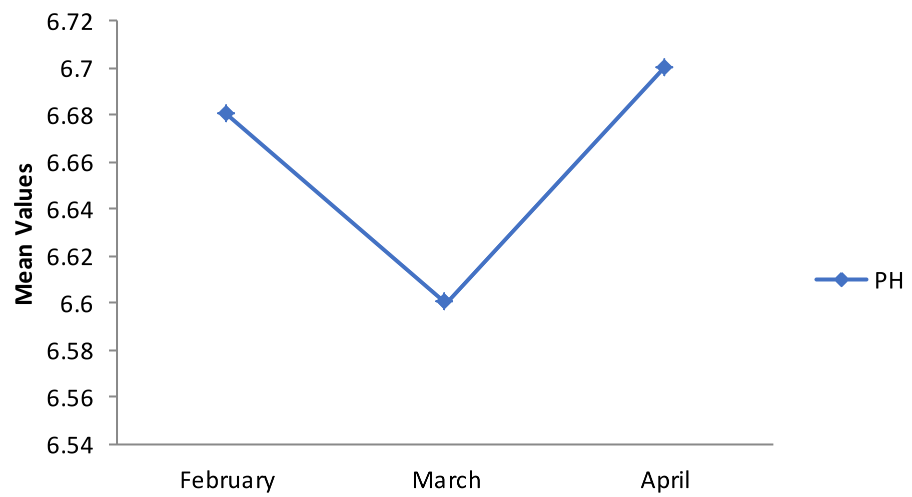


Fig. 2. Monthly Mean Values of Water pH in the Study Area

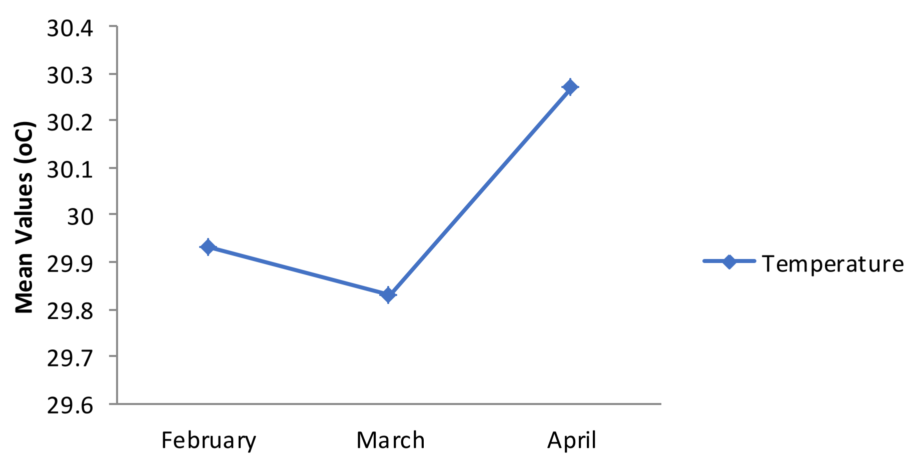


Fig. 3 Monthly mean values of Temperature in the Study Area.

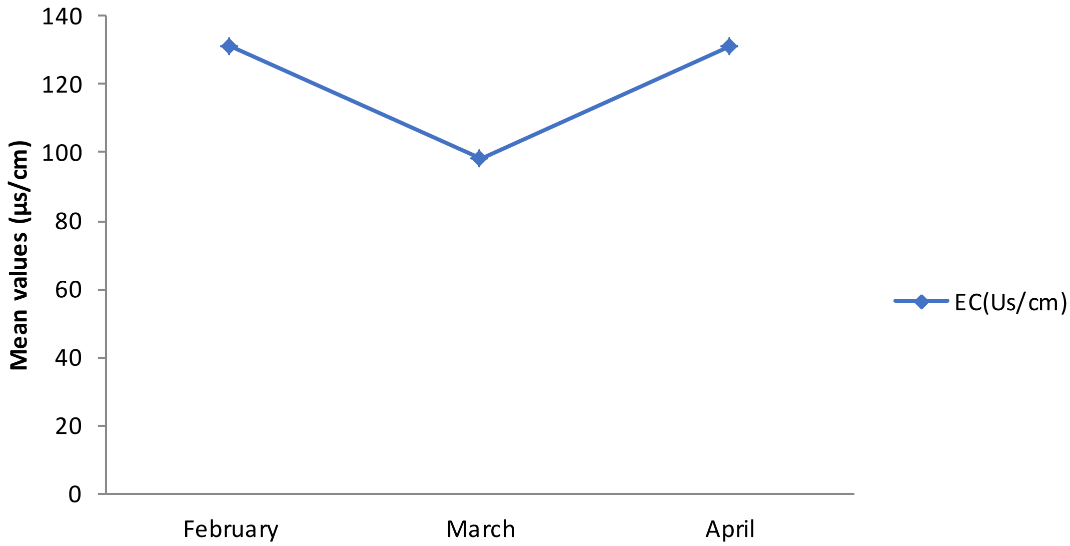


Fig. 4 Monthly Mean Values of Electrical Conductivity in the Area

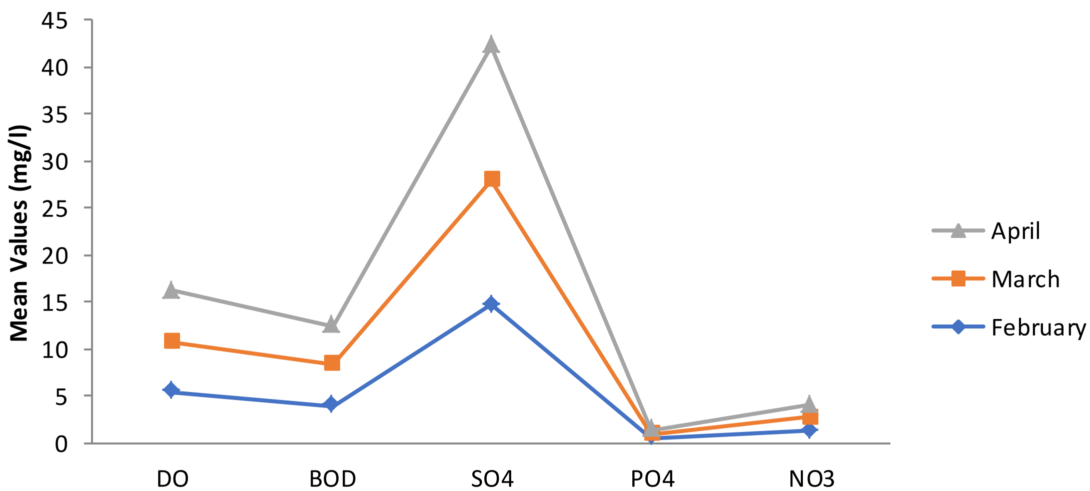


Fig.5: Mean Values of Some Water Parameters in the Study Area

The mean values of nutrients (PO_4, NO_3 and SO_4) observed in this study are all within the permissible limits that permit productivity in the aquatic ecosystem (Table 1-2 and Figure 5). Only phosphate and sulphate showed significant relationship spatially at probability level of $P \leq 0.05$. Spatial variation of $P0_4$ and SO_4 with the highest value in station 2 (Table 2) could be due to increased human feaces and high level of utilization of detergent by the teaming population in the area. Patra *et al.*,(2011) opined that plants and aquatic microbes usually reduce nitrate into nitrite but nitrite ion quickly oxidizes back into nitrate once it re-enters into the water. In general, nitrates are less toxic to people than ammonia or nitrite but at higher concentration it will become toxic especially to infants. When nitrate and phosphate concentrations continue to increase in water it causes contamination of water body as a result of eutrophication which significantly lead to reduction in water quality. Chapman (1996) reported that nitrate values above 5mg/l are indications of pollution resulting from organic sources. Organic and inorganic deposits or wastes (including fertilizer) with a high phosphate content might have been responsible for the higher phosphate values observed in Station 2 in this study. Mandal *et al*.,(2012) opined that the phosphate contamination comes from anthropogenic activities including runoffs laden with fertilizers and pesticides.

CONCLUSION AND RECOMMENDATION

The results of this study showed that Sombreiro river is not stressed or not under threat despite the numerous anthropogenic activities in the area and therefore considered suitable for production of fishes and other aquatic biota. Based on the current anthropogenic activities in the area adequate monitoring should be carried out to restrict uncontrolled and indiscriminate dumping of organic matter or wastes into the area which will in future pose environmental hazards.

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