# Assessment of the Impact of Municipal Sewage Disposal on the Water Quality in Obio/Akpor LGA, Rivers State

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***ABSTRACT***

*In the present study the impact of municipal sewage disposal on the quality of water bodies around Obio/Akpor Local Government Area of Rivers State and its environs was assessed. Samples were collected from five different stations along the Rumuolemini community in Obio/Akpor Local Government Area and other river outlets such as creeks along the Iwofe road axis. Samples were collected three times a week over a period of six months (June-November,) using standard analytical methods. Each sample was analyzed for Zn, Mn, Fe, Cu and Pb using AAS with hollow cathode lamp as light source. Microbial counts using the multiple tube fermentation (MPN index/100ml) technique showed significant ($p > 0.05$) differences for coliforms for the various stations. Highest proportions of indicator organisms occurred in station 1 with 25691.00$\pm$1.41 and 35602.5$\pm$3.54 for faecal and total coliforms, respectively, while total heterotrophic bacterial count had 6.10$\pm$0.14 in station 4. There were no significant differences ($p > 0.05$) for faecal coliforms at stations 3, 4 and 5 while total coliforms levels were significantly different. Heavy metal concentration determinations showed that Fe > Mn > Cu and Zn were detected in that descending order. High counts of faecal coliforms and iron content are indications of pollution resulting from discharge of wastewater along water ways within the community which are possibly responsible for an outbreak of infectious disease like typhoid fever, dysentery, salmonellosis, cholera and gastroenteritis and discoloration of water in communities around these locations. Such waste materials could be treated by phytoremediation and used for irrigation purposes than discharge raw sewage into rivers. In conclusion, proper treatment of wastewater is necessary before disposal to minimize or remove pollutants from the aquatic ecosystem. This shows that water bodies in such locations are no longer safe for both aquatic life and domestic purposes.*

***Keywords***: *sewage disposal, water quality, indicator microorganisms, heavy metals, pollution, diseases, Rumuolumeni*

## INTRODUCTION

Rivers State and its territory is bounded with waters and streams yet there is no potable water supply due to various industrial and anthropogenic activities within the urban centres of the State. Sources of drinking water could get contaminated by sewage in various ways such as from septic tanks, leaking sewer lines, sludge used for land application, and from partially treated wastewater. This could bring about anaerobic conditions which would adversely affect aquatic life (Spellman and Drinan, 2000), including fish stocks, and the suffering of the human diet. Also, it would cause appreciable health risks as water laden with untreated sewage is a potential source of water-borne disease-causing organisms. The effects can be far-reaching if such water is used to grow crops that are then eaten uncooked; in which case diseases can spread to whole communities.

It is well known that sewage and septic tank effluents are sources of the causative agents of gastrointestinal ailments such as diarrhea, dysentery, typhoid and cholera (Van and Pur, 1990; Bicki, 2001; Burabai *et al*., 2007; Ochuko and Thaddeus, 2013; Shafi *et al*., 2013; Ogbonna, 2014). In Nigeria, such ailments have been traced to the consumption of water polluted by untreated waste (UNEP, 2005; Ochuko and Thaddeus, 2013).

One of the major concerns in the Niger Delta is that the soils in the coastal plains are characterized by their hydraulically restrictive layers and seasonally high water table levels (Daniels and Weaver, 1987; Burabai *et al*., 2007).If there are leakages from septic tanks it becomes easy for water to seep into the land surface and run off into surface water or flow directly into the water table to cause contamination. Also, the seasonal high water table conditions help porous soil structures to allow raw sewage to empty into the groundwater table. This would make percolation impossible since the soil is saturated, leading to infiltration and ex-filtration process in the septic tank (Daniels and Weaver, 1987). Effluents arising from such indiscriminate disposal could adversely affect the quality of soil and water because such processes generate and release enormous waste containing nitrogenous compounds into the terrestrial and aquatic environments or habitats. Thus the accumulation of the waste materials may result in toxic and hazardous effect on both humans and other inhabitants of the environment (Stewart, 2005). Such impact or damage may diminish the local biodiversity and reduce the possibility for many species to find shelter and feeding grounds.

Organic pollutants such as domestic sewage, urban run-off, farm wastes and effluents from food processing industries, brewing industries, dairies, abattoirs, tanneries, textile and paper making factories have diverse adverse effects. These pollutants are biodegradable and are easily oxidized by making use of the dissolved oxygen in water. However, as dissolved oxygen drops, fish and other aquatic life are threatened or killed in extreme cases. The number of algae and bacteria is increased; macrophyte levels are also adversely affected due to light reduction rendering the bed of the river unstable for plants (Oribhor, 2016). This study was therefore undertaken to assess the impact of municipal sewage disposal in water bodies around Obio/Akpor Local Government Area of Rivers State and its environs. It is expected that the study would help to address potential short- and long-term water quality issues from the various activities associated with the municipal sewage disposal which had hitherto threatened the integrity of many rivers and coastlines in the area.

## Materials and Methods

The sampling was carried out between June and November 2014. The locations of the sampling sites were established using a Garmin 45 Geographical Positioning System (GPS) (Fig 1).

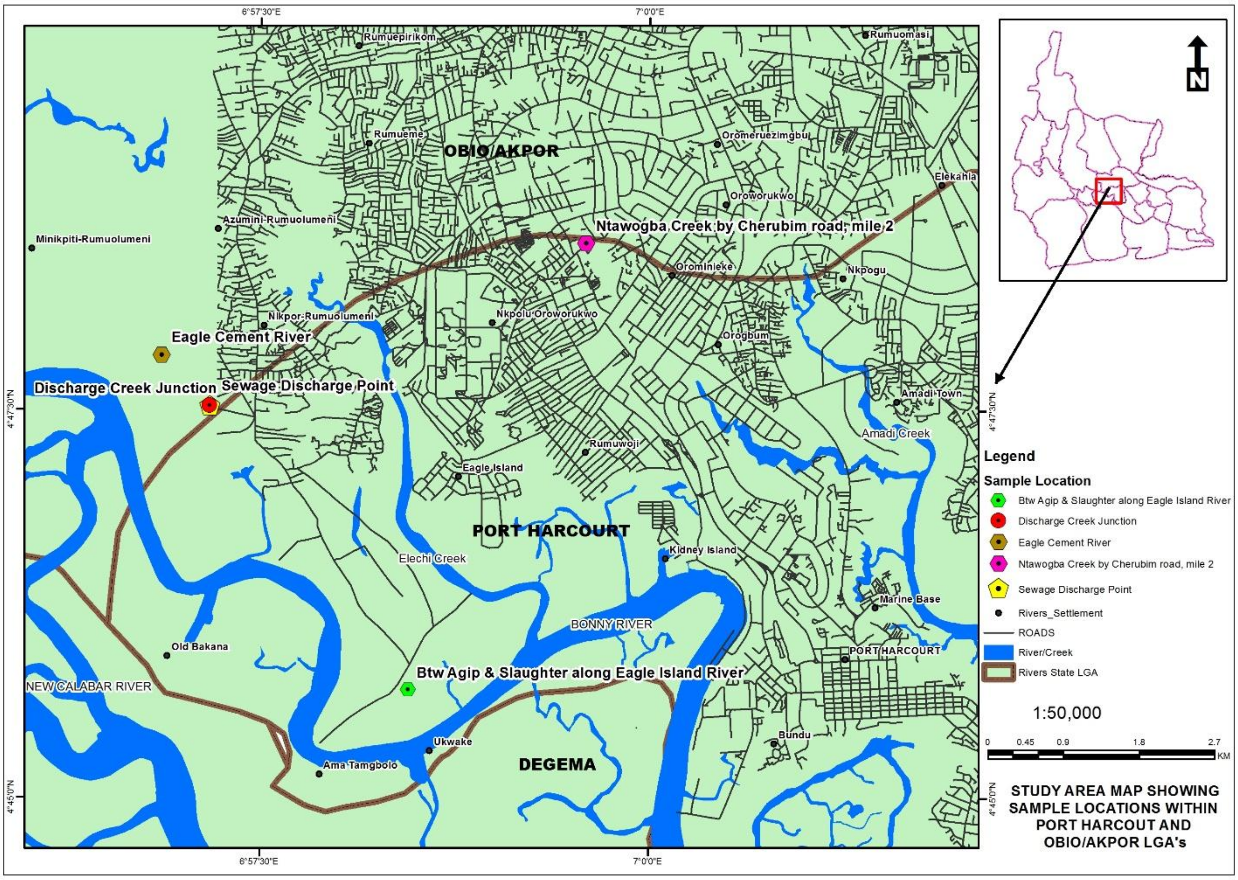


Fig 1. Map of Port Harcourt Metropolis showing sampling areas

Water samples were collected from the selected sites every month for six months from the Iwofe creek of Rumuolumini River. The samples were collected in a 1- litre plastic (1000 ml) bottles that had previously been carefully cleaned and rinsed thoroughly with distilled water (APHA, 1998).

Water samples for heavy metals were collected in a plastic bottle that had previously been soaked in concentrated nitric acid for 24 hours and rinsed with de-ionised water and brought to a pH of ≤ 2 with concentrated $H_2S0_4$ or $HNO_3$ and then stored in ice prior to laboratory analysis (Barley and Gardner, 1977). At the laboratory, the samples were stored in refrigerators at 4°C until analysis.

**Fig 2: Sewage discharge point at Iwofe**

**Fig 3: Aquatic Microphytes on the water body**

**Coliform count**

Water quality was determined by the standard multiple tube fermentation technique. Coliforms were tested for by inoculation of samples into tubes of lactose broth. The three-tube procedure using lactose broth (Collins and Lyne, 1976; Bakare *et al*., 2003) was used to the most probable number (MPN) of coliform bacilli (Collins and Lyne, 1976). Water samples (10 ml, 1 ml and 0.1 ml) were inoculated into tubes with 10 ml of lactose broth and incubated at 35 ± 0.5°C. Gas formation within 24 h of inoculation indicated positive presumptive test. Cultures showing no production of gas in 48h were considered negative. Samples from tubes showing gas were inoculated on to Eosine- methylene-blue agar; and one or more typical colonies were picked off into Brilliant Green Bile broth (Coyne and Howell, 1994) and studied microscopically for organisms with morphological and staining properties of coliform bacilli.

**Heavy metal analysis**

Fifty millilitres of water samples in duplicate were digested with 10 ml of concentrated nitric acid in a pyrex conical flask. The solution, after digestion was cooled, filtered through a Whatman filter paper No. 42 into a 100 ml volumetric flask and made up to 100 ml mark with de-ionised water. A blank was also prepared in the same manner and method using de-ionised water so as to check the accuracy of the method. Stock standards (100 mg/l) for the various metals were prepared using standard (BDH, Analar grade) and the concentrated 30% nitric acid. The filtrates were analysed for heavy metals using Atomic Absorption Spectrophotometer (Model Perkin-Elmer 31000) and the calibration curve obtained for five dilutions preparation from the standards. The numerous data generated were subjected to basic statistical approach. The descriptive statistics were calculated using Microsoft Excel XP for Windows. The statistical analysis was to determine whether the principal component or heavy metal variables fall into different groups with possible same source(s) of entry into aquatic ecosystem.

RESULTS

**Microbial counts**

The microbial counts from the surface water bodies where the raw sewage was discharged was found to be above the threshold level, however the counts varied from station to station where sampling was carried out (Table 1). Faecal coliforms occurred more in station 1 where the raw municipal sewage were discharged, with a mean count of 25691.00±1.41 MPN index/100 ml. Similarly, total coliforms had the highest proportion of 35602.00 ±3.54 MPN index/100 ml in station 1 while total heterotrophic bacterial counts were 6.10±0.14 x$10^7$ cfu/ml in station 4. This trend was also observed in stations 2 and 3 for faecal coliforms which had 19749.00±281.43 MPN index/100 ml and 29451.00 ± 1.41 MPN index/100ml for total coliforms respectively while station 5 had 4.9± 0.21x$10^7$cfu/ml for total heterotrophic bacterial count. The occurrence of these indicator organisms was highly variable with significant differences between the raw sewage delivery point and other sampling sites along the zones examined.

**Table 1: Microbial counts in surface water at study area**

| Stations | Faecal Coliforms (MPN Index/100ml) | Total Coliforms (MPN index/100ml) | Total Heterotrophic Bacteria ($10^7$ cu/ml) |
|---|---|---|---|
| **Station 1** | 25691.00±1.41$^c$ | 35602.5±3.54$^e$ | 3.45.±0.07$^a$ |
| **Station 2** | 19749.00±281.43$^b$ | 23665.00±134.35$^c$ | 3.20±0.00$^a$ |

| | | | |
|---|---|---|---|
| **Station 3** | 13190.00±707.11[a] | 29451.00±1.41[d] | 3.35±0.07[a] |
| **Station 4** | 13861.00±1.41[a] | 16405.00±7.07[b] | 6.10±0.14[c] |
| **Station 5** | 13210.00±14.14[a] | 14805.00±70.07[a] | 4.9±0.21[b] |

Means in the same column with the same letter are not significantly different at 5% level of significance according to LSD test.

**Key**: Station 1: Sewage discharge point; Station 2: Creek junction; Station 3: Eagle Cement River; Station 4: Eagle Island Creek located between the Agip and Slaughter; Station 5: Ntanwogba Creek by Cherubim Road, Mile 3

Furthermore, there was no significant difference ($p > 0.05$) in the occurrence of faecal coliforms between stations 3, 4 and 5 while there was a significant difference ($p > 0.05$) in the number of total coliforms between all stations sampled. Also, there was a 0.05 level of significance in the total heterotrophic bacterial counts from stations 4 and 5 while there was no difference in the counts for stations 1, 2 and 3.

**Heavy metal levels**

The mean concentrations of the heavy metals in the creek of Rumuolumini community are shown in Table 2. The values for iron content ranged from 0.31±0.002-13.14±0.014 ppm across the stations but were more in stations 1 and 2 with a total of 12.5±0.7 and 13.14±0.014 ppm respectively. Zinc, Copper and Manganese were detected from the samples. Lead was not detected in all the samples. The values for zinc were significantly different in trace amounts at 0.05 levels among the stations while managanese were not significantly different from stations 1, 2 and 3 but varied in concentrations in stations 4 and 5.

**Table 2: Heavy Metal Concentrations in surface water at the study areas**

| Stations | Zinc (ppm) | Copper (ppm) | Lead (ppm) | Iron (ppm) | Manganese (ppm) |
|---|---|---|---|---|---|
| **Station 1** | 0.41±0.003[e] | 0.16±0.01[d] | 0.00±0.00[a] | 12.5±0.7[c] | 0.35±0.07[b] |
| **Station 2** | 0.18±0.01[c] | 0.10±0.00[c] | 0.00±0.00[a] | 13.14±0.014[c] | 0.24±0.001[b] |
| **Station 3** | 0.34±0.01[d] | 0.08±0.00[b] | 0.00±0.00[a] | 0.41±0.001[a] | 0.32±0.005[b] |
| **Station 4** | 0.15±0.001[b] | 0.00±0.00[a] | 0.00±0.00[a] | 2.42±0.28[b] | 0.11±0.001[a] |
| **Station 5** | 0.05±0.01[a] | 0.00±0.00[a] | 0.00±0.00[a] | 0.31±0.002[a] | 0.08±0.00[a] |

Means in the same column with the same letter are not significantly different at 5% level of significance according to LSD test.

## DISCUSSION

### Microbial Counts

The water body in the vicinity where the municipal sewage wastes were discharged or used as dumpsites showed obvious deterioration in quality based on the number of faecal coliforms obtained. The MPN index observed for the water samples showed that the faecal coliform counts were above the permissible limit of WHO (2003, 2009), indicating gross pollution of the water body and its transition towards eutrophic state. According to Feng *et al* (2007), faecal coliforms are found in the intestinal canal of man and warm-blooded animals and are usually discharged alongside with faeces. The high counts of faecal coliforms are attributable to indiscriminate disposal of the municipal sewage along the banks of water bodies. Sometimes it may also be due to run-offs from urban solid waste disposal sites located around such vicinities which contain domestic animal and human faecal materials (Chapman, 1996; Agbolade *et al.*, 2009; 2010; Sharma *et al.*, 2010; Sadat *et al.*, 2011; Shafi *et al.*, 2013). Due to changes in agricultural methods, intensive farming operations utilize increased use of animal wastes as organic manure in most agricultural fields which also results in an increased pollution of rivers and streams especially through runoffs of leachates which drain into the water bodies (Gelt, 1998). This situation may cause contamination and transmission of diseases through water and food contaminated with human waste. Even though the people do not depend solely on these water bodies as their sources of water supply, the spate of water shortages could turn the tide as challenge. The high proliferation of heterotrophic bacteria in all the stations studied may have posed a challenge for competition amongst other groups of bacteria that could not survive for a long time. This might be as a result of increased microbial load washed into the river from the dumpsite by rain and the fact that more nutrients are brought in through leaching and run offs which eventually settle at the bottom of the river, leading to increased nutrient levels which encouraged rapid multiplication of bacteria (Adesemoye *et al*., 2006).

**Heavy metal concentrations**

The results of the mean concentrations of the heavy metals determined in the water body show that Fe, Zn, Mn and Cu were detected in various amounts with iron content exceeding tolerable limits (Table 2). Such amounts are a threat to river ecosystems due to increased turbidity resulting in accelerated sedimentation rates which changes the nature of water, thus affecting biological communities and physical habitats within the water body. The higher values of Fe and Zn could possibly be as a result of anthropogenic input vis-à-vis urbanization due to wastes from industrial and household materials, storm water runoff, precipitation carrying zinc from wear and tear of car tyres, corrosion of galvanized steel structures and leachates from refuse dumps carried into such surface water bodies. Such changes in sediment regime may also be caused by both land-based (such as catchments development, production-forest harvesting, road building) and water-based (bridge construction, eradication of noxious vegetation) activities (Nartey *et al*., 2012 Seiyaboh *et al.,* 2013) which therefore defaces the aesthetic effect of affected water bodies.

Manganese occurs in surface waters that are low in oxygen and often does so with iron. When oxidized in aerobic waters, the oxide builds up in distribution causing severe discoloration at concentrations above 50.0 μg/l (WHO, 2009). The menace of water hyacinth or macrophytes in the rivers and streams is to some extent, attributed to the unintended fertilization of aquatic ecosystems by run-off from the sewage discharges onto such water bodies. The presence of manganese may be due to discharges from industrial facilities or due to indiscriminate sewage disposal or leachate from waste dumpsites around such areas (USEPA, 2009). Because the communities where these activities are undergoing various industrial activities like the cement industry and platforms for oil lifting activities.

**CONCLUSION**

The present study was focused on the effect of municipal sewage disposal in some parts of Port Harcourt Metropolis. Monitoring these indicator organisms is an easy way to assess health risks due to bacterial contamination of surface waters. The presence of these physiologic groups in the samples is an indication of faecal contamination of the water bodies (Prescott *et al.,* 2005). This is possible since the sewage dumpsite is discharged within and around the water body. Through surface run-off, some of the faecal materials are carried to the nearby water body, leading to the presence of the coliform bacteria. Untreated faecal materials that contain faecal coliforms add excess organic material to the water. The decay of these materials depletes the water of oxygen which may result in killing of fishes and other aquatic life (Spellman and Drinan, 2000; Nartey *et al*., 2012). According to UNICEF (1999), if water is found to contain faecal indicator bacteria, it is considered unsafe for human consumption.

The result of this work has clearly shown that the water samples from different places of Obio/Akpor LGA has become grossly polluted and anything affecting this habitat (water body) also affects human food, health and general well-being. This could also affect the health of the people that are constantly exposed to it or use the water contaminated by sewage. This work is very useful for efficient pollution supervision and for drawing pollution control strategy for water and soils within Obio/ Akpor LGA in Rivers state. This study also calls for the management of waste generated that may pose health associated risks and hazards.

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