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EFFECT OF UNTREATED SEWAGE DUMP ON THE QUALITY OF GROUNDWATER IN IDDO COMMUNITY, LAGOS, NIGERIA

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ABSTRACT

This study was carried out to assess contamination of groundwater in Iddo as a result of many years of untreated sewage dump into the adjacent Lagos lagoon. Water samples were collected from five different sites in the lagoon at certain intervals. Similarly, water samples were collected from five boreholes and seven hand – dug wells sited in the immediate neighbourhood of the sewage dump sites. Sampling covered both the dry and wet seasons and tested for faecal coliform (FC) counts along with other parameters such as Biochemical Oxygen Demand (BOD) and salinity in order to determine their effects on the density of faecal coliforms. Analysis of parameters was subjected to standard procedures and data presented in simple statistics. Results for faecal coliform in boreholes ranged from 20-100 total plate count (TPC) /ml in dry season and 5-100 TPC/ml in wet season, while in well water, the values are >100 TPC/ml (dry season) and 30 TPC/ml – TNTC (too numerous to count) (wet season). In the lagoon water samples, faecal coliform counts are generally greater than 100 TPC/ml in dry season and varied between 100 TPC/ml and TNTC in wet season. BOD values of the lagoon varied from ND (not detected) to 2.8 mg/l (dry season) and 2.4-3.8 mg/l (wet season) with salinity values 3.27-3.45 % and 0.70-0.96 % in dry and wet season respectively. Coliform values were higher than World Health Organisation standard in drinking water. Results of analysis showed that both surface water and groundwater in Iddo community are heavily contaminated by the disposal of untreated sewage dumps.

Keywords: groundwater, contamination, sewage, lagoon, iddo, parameters,

INTRODUCTION

For decades, the Lagos lagoon by the Carter Bridge end of Iddo has served as a disposal site for raw sewage. Estimates of raw sewage input into the lagoon were put at about 26 million litres annually (Ekundayo, 1977). The figure has risen to almost double (50 million litres annually) within the last decade (Aina, 1992). At present, according to an unpublished report from the Lagos State Ministry of Environment, it is estimated that 128 million litres of raw sewage are being dumped into the lagoon annually. The reason for this dramatic increase resulted from rapid growth in the population due to increased urbanization and unplanned settlements. The recent population estimates of Lagos State is 9,013,534 million inhabitants. Poor sanitation facilities and unsafe drinking water constitute one of the major causes of death and disability in many developing countries resulting from the spread of water borne diseases (Orewole *et al.,* 2007). Olanrewaju (1990), observed that in Iddo community, those who do not have a toilet or latrine have to resort to indiscriminate defaecation directly into the lagoon or vacant plots and open drains. Consequently, with increase in population, there is an increased generation of wastes with total absence or inadequate waste disposal system. The environment in general bears the brunt; refuse left lying on the surface are washed via runoff into surface water and drains; liquid wastes (sewage) are also washed into surface water and infiltrate with rainwater into the soil resulting in the pollution of water resource. With an estimated 1360 million km^3 of water on the earth and only 4 million km^3 (0.3%) is available for human consumption (Wilson, 1990). Man's dependence on water consumption is therefore, largely on rivers, streams and groundwater for his needs, which remains a fundamental fact.

Groundwater refers to fresh water located in the pore space of soils and rocks. It is also said to be from rainfall that infilterates the soil and penetrates into the underlying strata (Wilson, 1990). Poor sanitation and indiscriminate dumping of refuse has continued to be a threat to the availability of good quality groundwater. However, the increased dependence on groundwater for daily water needs as a result of the total absence or erratic public water supply services by state controlled water corporation makes it imperative to study the effect of untreated sewage dump on the quality of groundwater. Water resources in Lagos for domestic, industrial and commercial is becoming scarce as a result of pollution of water bodies by wastewater which contains heavy metals and bacteria (Iwugo *et al.,* 2003).

The objective of this study, however, is to determine the effect of disposing untreated wastes into the Lagos lagoon and also, the effect of dumping sites on groundwater quality.

MATERIALS AND METHODS

Description of the Study Area

Iddo community is located along the bank of the Lagos lagoon (Fig. 1), which forms part of an intricate system of water ways made up of lagoons and creeks that are found along the coast of Nigeria beginning from the Republic of Benin to the Niger Delta Province. It is connected to the Atlantic Ocean off the Gulf of Guinea via the Lagos Harbour. Iddo community is located within the North East of Lagos in the Lagos Mainland Local Government Area. The lagoon is located between latitudes 6^o 22' - 6^o 38' N and longitudes 3^o 23' - 3^0 40' E. The bottom deposits range from coarse shelly sand around the mouth of the Lagos harbour through various grades of muddy sand to mud.

Water Sampling

Sampling were carried out during wet and dry season to capture seasonal pattern of groundwater quality in the area. Five boreholes, seven hand-dug wells and four sampling sites on the Lagos lagoon were identified for this study. A reconnaissance survey was first carried out during which the points were identified and randomly selected. The distance of each point from the pollution source was measured while the depth and

Figure 1: Map of Lagos Showing the Lagoon (Egwari and Aboaba, 2002)

method of construction of the wells and boreholes were recorded. The choice of groundwater sources and surface water was based on the fact that the natural inflow to sub – surface water (groundwater) is seepage from surface water (Lewis, 1980), therefore, establishing the source of contamination of the groundwater to be seepage from the already contaminated lagoon.

METHODOLOGY

Determination of Faecal coliform

Water samples for coliform analysis were collected with sterilized McCartney bottles. The samples were taken to laboratory immediately for analysis. Ethylene Myosin Blue (EMB) agar used as the nutrient medium. The solution of the agar was sterilized in autoclave to form a gel, which was pour into the disposable petri dishes. The agar was left to solidify before inoculating the water samples (0.1 ml) into the petri dish containing the EMB agar and incubated at 37^{o}C in Sanyo Gallenkamp incubator (INC 200 230T, ARTISAN SCIENTIFIC, UK) for 24 hours for coliform growth (Ademoroti, 1996). The blue metallic shining colonies produced were counted and expresses as col/ml. The sampling time of 0600GMT – 0800GMT was chosen to avoid error in results because of the usually rapid rate of multiplication of coliform bacteria under suitable thermal conditions.

Determination of Biochemical Oxygen Demand (BOD)

BOD is used to measure the concentration of biodegradable organic matter present in a sample of water. BOD_5 is a measure of the rate of uptake of oxygen by micro – organisms in a sample of water at a temperature of 20^{o}C over a given period of 5 days. BOD was measured by dilution method described by Ademoroti (1996). Dilution water was first prepared and saturated with sufficient oxygen by shaking for 20 minutes. The reagents (1 ml each) were added to the aerated distilled water. Water sample (25 ml) was measured into 250 ml BOD bottles in duplicate by the aid of large-tip volumetric pipette. The bottles were filled to the brim with dilution water according to required dilution and stoppers were inserted without leaving air bubbles. The initial DO on the undiluted sample was determined. The BOD bottles containing the samples were incubated for 5 days at 20^{o}C in a cooled incubator (GENLAB M75 SG, RHYS INTERNATIONAL, UK). After the five- day incubation, dissolved oxygen in the incubated samples were determined and BOD was calculated as follows by subtracting five day DO from the initial DO and result expressed in mg/l.

Salinity Determination

Sodium chloride concentration was used as an indicator for salinity. The Mohr's silver nitrate method was employed for chloride determination (Vogel, 1978). Water sample (100 ml) was measured into a conical flask on a white paper surface and potassium chromate solution (1 ml) was added. Titration was carried out against 0.025 M silver nitrate solution till a slightest reddish coloration appears which persists with constant shaking. Blank determination was carried out to allow for the presence of chloride in any of the reagents for the solubility of silver chromate and chloride was calculated and expressed in mg/l.

RESULTS AND DISCUSSION

Table 1 shows the values of faecal coliform (FC) obtained for different water samples in dry and wet seasons. The boreholes sampled had depths greater than 5m with distance from pollution site ranging from 8.0 – 70.0

m. During the dry season, two of the boreholes recorded faecal coliform greater than 100 TPC/ml while the others have values ranging from 20 – 30 TPC/ml.

The result during the wet season, however, showed only one borehole having FC greater than 100 TPC/ml while remaining four recorded significant drop in the bacteria count. This could be attributed to considerable dilution that resulted from increased water availability in the boreholes due to a rise in the water table.

A general outlook at the results of faecal coliform counts clearly indicated that the samples from boreholes recorded low bacterial counts, compared to samples from wells and surface water. The reason for this is not farfetched as depth plays a major role in the determination of water quality; hence, boreholes are known to have a higher level of purity compared with other water sources (Morgan, 1990). The presence of FC was also confirmed by Ethylene Myosin Blue (EMB) test, and only one borehole showed positive response to EMB during the dry season. High values of FC in all the water samples may be directly linked to contamination by untreated sewage (Bonde, 1977). This was in line with the study of Akoachere *et al.* (2008), who observed high values of faecal coliform in Daula lagoon in Cameroon. Similar research was conducted by Tatah and Ikenebomeh (1999) as very high faecal coliform counts was reported in Ikpoba River, Edo state of Nigeria due to high organic load of the river from sewage. Nwankwu (1992) also reported a range of FC, 3100-150, 000 cfu/100ml in Lagos lagoon at Iddo area and linked the high population of microbes to high organic matter from the dumpsites around the lagoon. The values of FC was far higher than WHO (1993) standard of 0 CFU/100ml, this indicated the pollution of both surface and ground water resources.

Faecal coliform is always an indication of faecal pollution. Sources may be from dump sites and direct disposal of wastes and sewages or runoff of animal droppings into the water bodies. The presence of FC in boreholes could be attributed to the mixing of lagoon water and groundwater beneath the earth crust. The coliforms could also have moved down the groundwater through infiltration (GAO, 1997). Health implications of FC may include cholera and other related water-borne illnesses while Contact recreation can also result in other miscellaneous infections of the skin, eye, ear, nose, and throat (Stelma and McCabe, 1992). Ajao (1990) has summarized the effect of domestic sewage being dumped on Lagos lagoon to include aesthetic nuisance of sludge accumulation, nauseating offensive odour, human hazards, and microbial contaminants among others.

The four (4) samples for the BOD test had distance from pollution source ranging from 5m to 100m. Dry season results ranged from 2.0 to 2.8 mg/l while at one location the BOD was not detected. During the wet season, slightly higher values were recorded for BOD; 2.4 to 3.8 mg/l (Table 2). BOD values decreased as distance from pollution source (lagoon shore) to sampling point increased. Comparing the BOD results with BOD standards (Kotandaraman and Ewing, 1969), (Table 3) all values fell within the class of porous source (which is not ideal for drinking water source). High values of 2.8 mg/l and 3.8 mg/l for dry and wet season respectively indicated that the population of microbes as well as amount of biodegradable material is more at the shore. The higher value during the wet season on the other hand was suspected to be due to a more conducive environment for the micro – organism in less saline water.

Samples for salinity test had distance from pollution source ranging from 5m to 100m. Dry season results ranged from 3.27 to 3.45%, however, wet season results ranged from 0.7 to 0.96% (Table 4). The results for salinity showed a higher percentage for dry season and this is not unconnected with the fact that there is considerable increase in the volume of water in the lagoon during the wet season, hence, reducing the salt concentration in the water. Comparing the result with Lewis (1980) (Table 5) salinity standard in drinking water, the results for dry season fell within the highly saline class while the result for wet season fell within the moderately saline class. The salinity nature of the lagoon according to Ajao and Fagade (1990) and Oyenekan (1979) has continued to influence the composition and distribution of sessile and benthic organisms.

Table 1: Results of water analysis

Source of water		Distance from pollution site (m)	Dry season		Wet season	
			EMB	TPC/ml	EMB	TPC/ml
Boreholes	Depth					
1	>5m	8	Negative	>100	NIL	50
2	>5m	20	NIL	20	NIL	10
3	>5m	40	Negative	40	Negative	>100
4	>5m	50	Positive	50	NIL	5
5	>5m	70	NIL	70	NIL	10
Wells	Depth					
1	4m	25	Negative	>100	Negative	30
2	4m	25	Positive	>100	Positive	TNTC
3	4m	40	Positive	>100	Positive	>100
4	3m	120	Positive	>100	Positive	TNTC
5	4m	35	Positive	>100	Positive	>100
6	4m	66	Positive	>100	Positive	>100
7	4m	75	Positive	>100	Positive	>100
Lagoon	Sampling sites					
1	1	30	Negative	>100	Positive	TNTC
2	2	60	Negative	>100	Positive	>100
3	3	120	Positive	>100	Positive	>100
4	4	5	Positive	>100	Positive	TNTC

EMB- Ethylene Myosin Blue, TPC-Total Plate Count, TNTC-Too Numerous To Count.

Table 2: Results of BOD analysis of the lagoon water

Sample No	Distance from pollution site (m)	Dry Season (mg/l)	Wet Season (mg/l)
1	5	2.8	3.8
2	30	N.D	3.6
3	60	2.4	3.0
4	100	2.0	2.4

Table 3: BOD Standard for Raw Water (Kotandaraman, and Ewing, 1969)

Average BOD value	Class
0.25 – 1.5	Excellent source
1.5 – 2.5	Good source
2.5 – 4.0	Porous source
Greater than 4.0	Rejectable source

Table 4: Concentration of Salinity (NaCl) of Lagoon water

Sample No	Distance from pollution site (m)	Dry Season (%)	Wet Season (%)
1	5	3.39	0.96
2	30	3.27	0.91
3	60	3.30	0.70
4	100	3.45	0.82

Table 5: Salinity Standard (Lewis, 1980)

Average Salinity value	Class
Less than 0.1 %	Fresh water
0.1 – 0.3 %	Slightly saline
0.3 – 1.0 %	Moderately saline
1.0 – 3.5 %	Highly saline

CONCLUSION

This study showed that the coastal groundwater of Iddo is heavily contaminated by the sewage – polluted surface water from the lagoon. Most of the houses still used pail – system to dispose off their faeces into the lagoon. It was also discovered that the pollution extends beyond 30m from the pollution source. This was due to high porosity and permeability of the sedimentary aquifer materials. Boreholes at depths greater than 5m and within 30m from source of pollution were not affected by faecal contamination though this does not preclude the presence of other bacteriological contaminants as shown by the EMB results of the boreholes samples. However, one example (one wet and dry season sampling) was insufficient to conclusively determine the degree and extent of the faecal pollution of the riparian aquifer. The information researched and obtained in this study has provided a basis for further investigation on the effect of sewage – polluted surface water on groundwater as well as its impact on the users of such contaminated water.

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