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Effect of Leachate on Nkisi River in Onitsha Metropolis

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EFFECT OF LEACHATE ON NKISI RIVER IN ONITSHA METROPOLIS

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Abstract: *This study investigates the effect of leachate on Nkisi River in Onitsha. Surface water is susceptible to contamination by leachate from dump sites and the use of such polluted water poses health risks to humans. In this study, leachate samples (sample C) were collected from a trench dug around the dump site which allows for the leachate to drain into. A reach was selected from the river which has a distance of 13.4meters. Water samples were also collected from both the downstream of the reach (sample A) which is being utilized by the nearby settlement and the upstream area (sample B) to serves as a control. Water quality index (WQI) and leachate pollution index (LPI) were calculated from physicochemical parameters such as pH, temperature, nitrate, total hardness, electrical conductivity, biochemical oxygen demand, total dissolved solids, total suspended solids and heavy metals. The results obtained for the WQI were found to be 396.34 for sample A and 445.21 for sample B while LPI for Sample C was found to be 19.998. In conclusion, there is an indication that water abstracted from Nkisi River is not suitable for domestic purposes. It is therefore recommended that dumpsite should be managed properly by ANSEPA and ANSWAMA in order to control leachate flow pattern, in the surroundings of Nkisi dumpsites.*

Keywords: *Leachate, water quality index, Nkisi River, dump site*

INTRODUCTION:

There is an increasing awareness to minimize the levels of wastes discharged into the environment. The United Nation Environmental Programme (UNEP) is drawing the attention of nations towards the consequences of waste management (Adewuyi and Opasina 2010). With ever increasing population, urbanization and industrialization, the environment is considerably polluted even in the developed countries. In Nigeria, the reliance on dumpsites is a common phenomenon in the disposal of waste materials (Aluko et al., 2002).

With the improved status of Onitsha as a major city or metropolis since the civil war, there has been an associated rise in living standards as well as a boost in the amount and nature of solid waste generated. In Onitsha metropolis, refuse are dumped indiscriminately along streets, roads, in open spaces, market places, frontages of residential buildings and drainage system as a result of garbage arising from numerous commercial activities. This condition is worsened by the rapid socio-economic activities of Onitsha which pulls visitors from different parts of Nigeria and some Africa countries for commercial purposes (Nwachukwu, 2008).

The city is experiencing various forms of waste management problems. The situation is worse after rainfall, as the drains are blocked with wastes thereby encouraging urban flooding. Wastes from these dumpsites are exposed to precipitation which dispersed them to nearby surface water. As a result of this act, surface water collection system (rivers, creeks, and lakes), has become vulnerable to pollution by leachate. In environmental context, leachate maybe defined as any liquid that has percolated through a solid waste dump site and drains out with it accumulated contaminants.

The Nkisi River is a river situated in Ontisha metropolis, and is seen as a major source of surface water by the inhabitants of settlement near it. Solid wastes generated from homes, business premises, institutions and also the Onitsha main market is been dumped along the banks of this river (Nkisi), thereby generating leachate of high toxicity into the river making it unfit for domestic purposes. Moreover, the organic contents of this leachate make it hampers the self recovery ability of the river. Aghogu (1991) observes that Onitsha has been made uninhabitable due to indiscriminate disposal of waste by industries, poor implementation or legislation on waste disposal, inconsistency in waste collection by Anambra State Waste Management Authority (ASWAMA) as well as, proper monitoring by Anambra State Environmental Protection Agency(ANSEPA), Therefore, this study aims at evaluating the effect of leachate on this river.

METHODS:

Study Area

The Nkisi River, with latitude $6^{o}10^{'}31^{''}$N and longitude $6^{o}47^{'}63^{''}$E is located within the Onitsha metropolis. It is a non seasonal stream but has its

peak flow during the rainy seasons and discharges itself into river Niger. The climate of the study area is that of tropical rainforest with distinct wet and dry seasons. The wet season is characterized by a period a prolonged period of rainfall which extends from April to October, while the dry season is characterized by a period of dry hot weather. This season extends from November to March including the harmathan period. The mean annual rainfall ranges from 2000mm (inland) to over 4000mm at the coast The vegetation comprises predominantly of red mangrove, (Rhizophora racemosa), plantain trees (Musa sp.), Oil palm trees (Elaeis guinensis) and Nipa palm (Nypa fruticans). This river is mostly used for domestic activities by the inhabitants of a settlement along the river. Construction sites and block industries also make use of the river water for construction purposes.

Figure 1: Map of Onitsha Showing Nkisi River

Sample Collection

Samples were collected from three different trenches dug around the dumpsite (situated at the Akpaho Area of Onitsha) inorder to get mean value. Samples were also collected from both downstream area of the river, (which is being utilized by the nearby settlement) and upstream area (which serves as control). The leachate effluents from the waste mass were collected by the trench dug around the dump site which allows for the leachate to drain into. Two containers of 1-litre plastic bottles, which has been washed, rinsed and conditioned, were used to collect the samples at the different locations, each of which will be for the physicochemical and biological tests. The samples were immediately transferred to ice chest and transported to the laboratory for analysis.

Laboratory Analysis

A comprehensive physio-chemical and microbial tests were conducted at the Spring Board laboratory situated in Udoka Housing Awka state capital and the micro Maeve Academic Laboratory located at Perm. Site, Awka respectively. The Parameters analysed includes; heavy-metals, TDS, TSS, nitrate, pH, electrical conductivity, total hardness, BOD, COD and total coliform. The analysis was carried out according to standard methods for APHA(1998).

Calculation of leachate pollution Index (LPI)

The LPI for each of the dumpsite leachate was calculated using equation by Kumar and Alappat, (2003a) and shown as:

$$LPI = \sum_{i=1}^{n} WiPi \quad (1)$$

Where,

LPI = the weighted additive leachate pollution index

Wi = the weight for the ith pollutant variable,

Note: Values for this study were obtained from (Naveen and Malik , 2016)

Pi = the sub index value of the ith leachate pollutant variable, n = 18 and ΣWi = 1.

However, when the data for all the pollutant variables included in LPI is not available, the LPI can be calculated using data set of the available pollutants by the equation

$$LPI = \sum_{i=1}^{n} WiPi / \sum Wi \quad (2)$$

In this study, m < 18 and ΣWi < 1

Calculation of water quaity index (WQI)

The WQI of the river sample was made using the weighted arithmetic index method (Olayiwola and Olubunmi ,2016)

$$WQI = \sum WiQ / \sum Wi \quad (3)$$

Where

Qi = quality rating scale of ith parameter

Wi = unit weight of ith parameter

The quality rating scale (Qi) for each parameter is calculated by using this expression:

$$Q_i = 100(Vi - Vo/Si - Vo) \quad (4)$$

Where,

Vi = value of the ith parameter from the laboratory analysis

Vo = the ideal value of this parameter in pure Water. Vo = 0 (except pH =7.0 and DO = 14.6 mg/l)

Si = recommended standard value of ith parameter

The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$W_i = K/s_i \qquad (5)$$

Where:

K = proportionality constant and can also be calculated by using the following equation:

$$K = 1 \Big/ \sum_{i=1}^{n} \frac{1}{S_i} \qquad (6)$$

Table1: Rating of water quality index (WQI)

WQI	Water Quality Status
0 – 25	Excellent water quality
26 – 50	Good water quality
51 – 75	Poor water quality
76 – 100	Very poor water quality
>100	Not suitable for drinking

Table2: Standard and ideal values used in the study

Parameters	Standard Value (Si)	Ideal Value (Vo)
pH	7.5	7
Temperature (^{0}c)	-	-
Elect. Conductivity (us/cm)	300	0
TDS (mg/l)	500	0
TSS (mg/l)	NA	-
Total Hardness (mg/l)	300	0
Iron (ppm)	0.3	0
Copper (ppm)	0.05	0
Nitrate (mg/l)	45	0
COD (mg/l)	250	0
BOD (mg/l)	30	14.6

RESULTS:

Table3: Water Quality Index for Sample A

Parameters	Mean Sample Result (Vi)	Unit Weight (Wi)	Quality rating (Qi)	Overall Rating (WiQi)
pH	6.81	0.219	38	8.322
Temp (^{0}c)	29	-	-	-
Elect.Conductivity (us/cm)	44.5	0.371	14.8	5.49
TDS (mg/l)	007	0.037	1.4	0.052
TSS (mg/l)	2.76	-	-	-
T.Hardness (mg/l)	33.7	0.0062	11.23	0.0696
Iron (ppm)	0.708	0.270	236	63.72
Copper (ppm)	0.336	0.162	672	108.86
Nitrate (mg/l)	6.77	0.0412	15.04	0.619
COD (mg/l)	365.3	0.622	146.12	90.89
BOD (mg/l)	244	0.3723	1489.6	554.58
Totalcoliform count(cfu/100ml)	30	-	-	-
$\sum$ WQI				832.603
$\sum$ Wi		2.100		
WQI		396.34		

Table4: Water Quality Index for Sample B

Parameters	Mean Sample Result (Vi)	Unit Weight (Wi)	Quality rating (Qi)	(WiQi)
pH	7.62	0.219	124	27.156
Temperature (^{0}c)	28	-	-	-
Elect.Conductivity (us/cm)	82	0.371	27.33	10.139
TDS (mg/l)	025	0.037	5	0.185
TSS (mg/l)	1.68	-	-	-
Total Hardness (mg/l)	34.2	0.0062	11.4	0.071
Iron (ppm)	0.625	0.270	208.3	56.24
Copper (ppm)	0.337	0.162	1.685	0.273
Nitrate (mg/l)	7.346	0.0412	16.32	0.672
COD (mg/l)	496	0.622	661.33	411.35
BOD (mg/l)	192	0.3723	1151.95	428.87
Total Coliform Count (cfu/ml)	98	-	-	-
$\sum$ WQI				934.956
$\sum Wi$		2.100		
WQI		445.21		

Table 5: Leachate Pollution Index for Sample C

Parameters	Mean Sample Result	Variable Weight (Wi)	Pollution Sub-index Value (Pi)	WiPi
pH	8.1	0.055	5	0.275
Temperature (^{0}c)	30	-	-	-
Elect. Conductivity (us/cm)	446.5	NA	NA	-
TDS (mg/l)	326	0.05	7	0.35
TSS (mg/l)	30	NA	NA	-
T. Hardness (mg/l)	52.8	NA	NA	-
Iron (ppm)	1.235	0.045	5	0.225
Lead (ppm)	11.6	0.063	5	0.315
Copper (ppm)	0.798	0.05	6	0.3
Nitrate (mg/l)	65	0.051	55	2.805
COD (mg/l)	944	0.062	9	0.558
BOD (mg/l)	358	0.061	7	0.427
Total Coliform Count (cfu/ml)	156	0.052	87	4.524
$\sum Wi$		0.489		
$\sum Wi\,Pi$				9.779
LPI		19.998		

The LPI was calculated on the basis of the available data as shown in Table 5. The 'P' values or sub-index values for all the leachate parameters were computed from the sub-index curves based on the concentration of the leachate pollutions obtained during the analysis. The 'P' values were obtained by locating the concentration of the leachate pollutant on the horizontal axis of the sub index value where it intersected the curve as shown in Appendix A. The 'P' values obtained for the parameters analyzed were multiplied with the respective weights assigned to each parameter

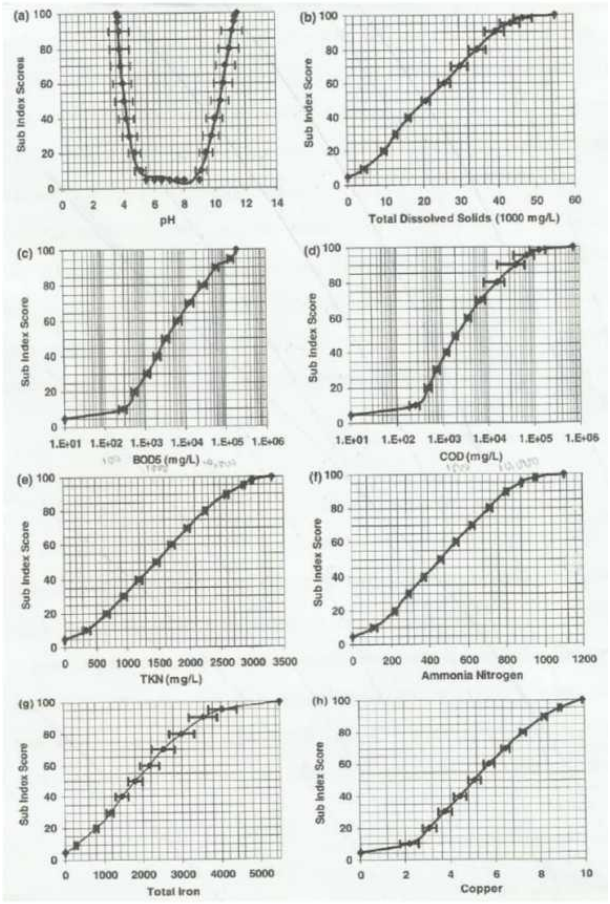

Figure 2: Averaged sub index curves of pollutant used in the study.

DISCUSSION & CONCLUSIONS:

Discussion:

In this study, the WQI is established from some physicochemical parameters such as pH, temperature, nitrate, total hardness, electrical conductivity, biochemical oxygen demand, total dissolved solids, total suspended solids and heavy-metals. From Tables 3 and 4, WQI were found to be 396.34 for sample A and 445.21 for sample B. The results indicate that these values are far too greater than 100, which means Nkisi river water is not suitable for drinking and even for domestic activities.

Table 5 shows that LPI for sample C was found to be 19.998. The LPI value of the leachate shall not exceed 7.38 which is a standards set for the disposal of treated leachate from Kumar and Alappat (2003) computation. This shows that the leachate generated from the dumpsite is highly contaminated.

Conclusion:

It can be understood that leachate from the dumpsite plays a major role in contamination of Nisi river, considering the high level of leachate pollution index (LPI) of the dumpsite (19.998). It is therefore recommended that immediate action be taken by relocating dumpsites far away from water bodies. This is to avoid the worse possible scenario of environmental pollution and threat to human health, most especially to the nearby settlement within the area.

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