Water Physico-chemistry and Metal Pollution Indices in Sediments along Selected Points of Ogun River in Abeokuta, Ogun State

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Introduction

Rivers are major source of freshwater (**Chinedu *et al.*, 2011**)

Increasing human population needs water (**Okechukwu *et al.*, 2012**)

Do Humans Use More Water than they Need?

- **YES.... Its simply Yes.... No If's or But's....**

Introduction (Contd)

- Ogun river stretches over 22.4 km (**Oketola *et al.*, 2013**)
- It receives effluent from various anthropogenic sources (**Dimowo, 2013**)
- This study aims at accessing the water physicochemical properties and calculating pollution indices of sediments at selected points

Material & Methods

Field Test

✓Sample collection

✓Water sample were pre treated for nitrate, Phosphate and heavy metals.

✓Some physicochemical analysis:

➢Temperature (Mercury thermometer)

➢pH, TDS and EC (Digital pocket multiparameter)

Laboratory Analysis

✓Nitrate and phosphate were determined using H83200multiparameter HANNA instrument(following the stated process)

✓DO and BOD analysed using Winkler's method. NB: BOD was done after samples were stored 5 days in the dark

✓The protocols of AOAC was used for Digesting metals.

✓Atomic Absorption Spectrophotometry was used to determine Cadmium, Lead, Chromium, Copper and Zinc)

2. Pollution index (PI) proposed by Tomlinson *et al* (1960):PI= $(C_{f1}+ C_{f2}+ C_{f3}+ C_{f4.....} + C_{fn})^{1/n}$

"n" is the number of metals and C_f is the contamination factor for each site. According to Mohiuddin *et al*. (2010), PLI = 0 indicates a perfect state of pollution; PLI = 1 points indicate only baseline levels of pollutants present and PLI >1 depicts progressive deterioration of sites

Pollution Indices

1. **Contamination factor (C_f)** described by Lacatusu (2000):Cm/Cb.

Cb (water)-WHO (2011)

Cb (Sediment)-ASV (Turekian and Wedepohl (1961)

The range for intervals of contamination is given as <0.1 very slight contamination; 0.10-0.25 slight contamination; 0.26-0.5 moderate contamination; 0.51-0.75 severe contamination and 0.76-1.00 very severe contamination.

Material & Methods

3. Geo-accumulation index (*I*geo) postulated by by Muller (1979) :log2(Cn/1.5Bn)

C*n* is the heavy metal concentration in the sediment.

B*n* is the background concentration of the element (that is ASV used as background concentration).

1.5 is the correcting factor due to lithogenic effect (Taylor, 1964).

The classes for Igeo are :

- Class 0 = Igeo<0 (practically uncontaminated)
- Class 1 = 0<Igeo<1 (uncontaminated to moderately contaminated)
- Class 2 = 1<Igeo<2 (moderately contaminated)
- Class 3 = 2<Igeo<3 (moderately to heavily contaminated)
- Class 4 = 3<Igeo<4 (heavily contaminated)
- Class 5 = 4<Igeo<5 (heavily to extremely contaminated)
- Class 6 = 5<Igeo>6 (extremely contaminated).

4. Ecological Risk Factor, given as Tr*Cf.

Toxic response factor (Tr) for the selected metals are:

Zinc (Zn = 1); Lead (Pb =5);

Copper (Cu =5); Chromium (Cr =2)

Cadmium (Cd =30)

C Er<40 (low potential ecological risk) C 40<Er<80 (moderate potential ecological risk) C 80<Er<160 (considerable potential ecological risk) C 160<Er<320 (high potential ecological risk) C Er>320 (very high ecological risk)

Data analysis

Statistical analysis was done using one- way analysis of variance (ANOVA) and expressed as mean ± standard deviation

Results and Discussion

Table 1: Mean physicochemical parameters at the selected sites along Ogun River.

Physicochemical Parameters	Sites				
	Iberekodo	**Arakanga**	**Ago-Ika**	**Enugada**	**Sokori**
T (^{0}C)	28.00±2.87^a	28.56±2.98^a	28.75±3.15^a	29.15±2.74^a	28.13±2.17^a
pH	7.49±0.72^a	7.60±0.61^a	7.58±0.68^a	7.58±0.69^a	7.42±0.02^a
TDS (mgL^{-1})	74.03±13.82^b	70.00±2.94^b	**85.23±22.53^b**	56.50±33.21^a	76.20±21.86^b
NO_3^- (mgL^{-1})	11.00±2.29^b	8.84±0.54^a	6.82±1.03^a	9.70±4.31^b	**12.81±3.56^b**
PO_4^- (mgL^{-1})	0.86±1.02^a	0.58±0.30^a	1.50±1.40^a	0.81±0.48^a	0.56±0.19^a
DO (mgL^{-1})	5.80±1.22^a	**7.71±1.22^a**	5.89±1.32^a	5.51±1.90^a	5.81±1.39^a
BOD (mgL^{-1})	4.71±1.14^a	4.11±1.13^a	3.32±1.10^a	3.37±1.71^a	3.32±1.31^a
EC(µmho/cm)	137.00±8.12^a	137.00±8.12^a	135.75±7.23^a	139.75±15.26^a	**168.25±42.57^a**

Mean values in the same row having the same superscript are not significantly different ($p>0.05$)

- T (^{0}C) and pH range is beneficial for aquatic life in terms of survivability, metabolic and physiological activities.

TDS: NB excessive TDS affects water ecology (low light penetration and quality)

NO_3^- increases when there is excessive wash down of decayed vegetable, animal matter and sewage (Farombi *et al.,* 2014)

Presence of photosynthesizing trees and cool air introduces more oxygen into the water

Results & Disc. contd

Table 2: Physicochemical parameters in water sample in comparison other regulatory bodies

Parameter	USEPA(1999)	WHO(2011)	NESREA(2011)	This Study
pH	6.50-8.50	6.50-9.50	6.50-9.00	7.42 - 7.60
Water temperature (ºC)	-	40	< 40	28.00-28.75
TDS(mg/L)	500	1000	2000	56.50-85.23
DO(mg/L)	-	≥ 4	≥ 6	5.51-7.71
BOD (mg/L)	-	6	6	3.32-4.71
Nitrate (mg/L)	-	50	40	6.82-12.81
Phosphate (mg/L)	**-**	**0.5**	**0.05**	**0.56-1.50**
EC(µmho/cm)		1000	500	135.75-168.25

Note: USEPA - United States Environmental Protection Agency, WHO - World Health Organization and NESREA - Nigeria Environmental Standards and Regulations Enforcement Agency.

Results & Disc. contd

Table 3: Heavy metal concentration in water samples (mg/L) with comparison WHO

	Sites					
Heavy metals (mg/L)	Iberekodo	Ago-ika	Enugada	Sokori	Arakanga	WHO 2011
Cd	**0.058±0.076[a]**	**0.04±0.050[a]**	**0.035±0.041[a]**	**0.06±0.071[a]**	**0.068±0.083[a]**	0.003
Pb	**0.10±0.02[a]**	**0.005±0.01[a]**	**0.13±0.18[a]**	**0.17±0.22[a]**	**0.16±0.24[a]**	0.01
Cr	**0.058±0.05[a]**	**0.098±0.10[a]**	**0.088±0.08[a]**	**0.085±0.05[a]**	**0.065±0.004[a]**	0.05
Cu	0.13±0.16[a]	0.18±0.21[a]	0.11±0.11[a]	0.18±0.20[a]	0.17±0.25[a]	2
Zn	0.09±0.08[a]	0.39±0.46[a]	0.67±0.79[a]	0.40±0.46[a]	0.08±0.08 [a]	5

Mean values in the same row having the same superscript are not significantly different ($p>0.05$)

- Presence of heavy metal at all sites
- All Non essential metals were higher than standards

Results & Disc. contd

Table 4: Contamination factor/pollution index for water samples at selected points of Ogun River

	Sites				
Heavy metal	Iberekodo	Ago-ika	Enugada	Sokori	Arakanga
Cd	19.3	13.3	11.7	20	22.7
Pb	10	0.5	13	17	16
Cr	1.16	1.96	1.76	1.7	1.3
Cu	0.07	0.09	0.06	0.09	0.09
Zn	0.02	0.08	0.13	0.08	0.02
Pollution Index	0.77	0.62	1.14	1.33	0.91

Cd had higher CF compared to other metal

All sites were slightly contaminated with Cr, Cu and Zn. Unlike Cd and Pb

Pollution Index:

- Values greater than 1 show progressive deterioration
- Values less than 1 show baseline level of pollutants.

Results & Disc. contd

Table 4: Heavy metal concentration in sediments at the selected points of Ogun River against regulatory bodies

Heavy Metal	Sites: Iberekodo	Ago-ika	Enugada	Sokori	Arakanga	WHO	USEPA	ASV	TRV
Cd	**13±18.29^{b}**	0.50±1.00^{a}	BDL	BDL	BDL	10	0.99	0.3	0.6
Pb	BDL	**114±129.1^{a}**	**83.5±29.77^{a}**	**144±104.86^{b}**	**79±14.47^{a}**	70	35.8	20	31
Cr	17±15.54^{a}	29±8.08^{ab}	41.5±16.68^{bc}	53.5±14.64^{c}	49.5±7^{bc}	NA	43.4	90	16
Cu	7.50±1.00^{a}	21.50±8.70^{a}	38±37.63^{a}	38.50±32.76^{a}	21±1.16^{a}	36	31.6	45	16
Zn	70±22.09^{a}	**510±374.99^{b}**	**275±67.50^{ab}**	**452.5±422.66^{ab}**	**109.50±8.06^{ab}**	200	121	95	110

Mean values in the same row having the same superscript are not significantly different ($p>0.05$)
TRV- Toxic Response Value

- Values in red were higher than the background value (ASV).
- Cd at the Ago-ika, Cu and Zn at Iberekodo had its concentration lower than TRV

Results & Disc. contd

Table 6: Contamination factor/ pollution index for sediments at the selected points of Ogun River

Heavy Metal	Iberekodo	Ago-ika	Enugada	Sokori	Arakanga
Cd	**43.3**	1.67	NC	NC	NC
Pb	NC	**5.7**	**4.18**	**7.2**	**3.95**
Cr	0.19	0.32	0.46	0.59	0.55
Cu	0.17	0.48	0.84	0.86	0.47
Zn	0.74	**5.37**	**2.89**	**4.76**	1.15
Pollution Index	1.00	1.51	1.36	1.77	1.03

NC-Not calculated

Cd at Iberekodo had highest CF

All sites were slightly contaminated with Cr, Cu and Zn. Unlike Cd and Pb

Pollution Index:

- Values greater than 1 show progressive deterioration
- Values less than 1 show baseline level of pollutants.

Results & Disc. contd

Table 7: Geo-accumulation index for sediments at selected points of Ogun River

Heavy Metal	Iberekodo	Ago-ika	Enugada	Sokori	Arakanga
Cd	**8.70**	0.33	NC	NC	NC
Pb	NC	**1.14**	0.84	**1.44**	0.79
Cr	0.04	0.06	0.09	0.12	0.11
Cu	0.03	0.10	0.17	0.17	0.09
Zn	0.15	**1.08**	0.58	0.96	0.23

- Sediments samples at Iberekodo were extremely contaminated with Cd
- Sediments samples at Ago-ika (Pb and Zn)and Sokori (Pb) were moderately contaminated.
- Other values less than 1 varied from uncontaminated to moderately contaminated

Results & Disc. contd

Table 8: Ecological risk factor for sediments at selected points of Ogun River

Heavy Metal	Iberekodo	Ago-ika	Enugada	Sokori	Arakanga
Cd	**1299.00**	**50.10**	NC	NC	NC
Pb	NC	28.50	20.88	36.00	19.75
Cr	0.38	0.64	0.92	1.19	1.10
Cu	0.84	2.39	4.20	4.28	2.34
Zn	0.74	5.37	2.89	4.76	1.15

- Calculated values of Cd at Iberekodo and Ago-ika pose a very high ecological risk to the environment , compared to the calculated values for other metals at the selected sites

Conclusion & Recommendation

- Anthropogenic activities might not have had much negative effects on water physicochemistry, however slight pollution was observed

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- Also, pollution indices show that aside Cd, the environment is less toxic for living organism seeking refuge in the environment

- It's strongly recommended that continuous monitoring should be observed to avoid severe pollution

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