Short Communication

Physicochemical characteristics of rainwater quality of Warri axis of Delta state in western Niger Delta region of Nigeria

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Physicochemical characteristics in rainwater samples collected at the peak of rainy seasons of August 2008 and 2009 from fifteen locations of Warri axis of Delta area in Western part of Niger Delta region of Nigeria were investigated for two consecutive years. The temperature ranged from 28.21- 29.38°C with mean value of 28.79 ± 0.27^{0}C - 29.68°C with mean value of 29.20 ± 0.22^{0}C for year one and two respectively. The pH of the rainwater was slightly acidic with pH values that ranged from 6.42 - 6.81 while the total suspended solid value was higher than World Health Organization (WHO) for the two years studied. In general, the data revealed that maxima and minima concentrations of the priority physicochemical rainwater quality parameters examined were within the recommended international standard of WHO 1996 except for pH and total suspended solid. However, the rainwater may still be suitable for domestic, recreational and industrial uses. Hence, similar findings like this would continue to guide us in protecting the quality of our water systems including rainwater. By and large, the results of this study would be useful for every interested group in need.

Key words: Rainwater, Niger Delta, WHO, mean value, physicochemical, maxima and minima.

INTRODUCTION

Rainwater is the purest form of naturally occurring water. It is considered therefore to be produced by a kind of natural distillation. However, it contains dissolved gases such as carbon dioxide, sulphur dioxide, nitrogen dioxide, ammonia, fine particulate materials or aerosols, etc from the atmosphere (Asthana and Asthana, 2003; Nsi, 2007). Rainfall constitutes one of the largest sources of water for Nigeria. The rainfall is mainly during the rainy season which varies from north to south. Hence, it runs from June to October and April to October in the north and south, respectively (Nsi, 2007).

A water resource such as rain, river, groundwater and sea is one of the major components of environmental resources that are under serious threat from over exploitation or pollution from anthropogenic activities (Efe, 2001). In Niger Delta region, the problem of water resource is getting good quality water (potable water) because of environmental pollution and degradation (Efe, 2002).

Chemical pollutions in rainwater and river water systems are derived through a combined effect of both industrial and municipal effluents, flaring of gases and runoffs from surrounding areas (Kaizer and Osakwe, 2010). Acid rain phenomenon is associated with rainwater because of the presence of certain oxides and particulate materials as mentioned above in the atmosphere. In that case, acid rain can be referred to as any rainfall that has an acidity level beyond what is expected in non-polluted rainfall (pH<5.5). However, excessive amounts of acid gases like SO_2, NO_2 and CO_2 that can dissolve in rainwater as it is falling from atmospheric cloud are responsible for acid rain (Narayanan, 2009).

Physicochemical characteristics of selected priority parameters in rainwater and bore hole water in Warri metropolis-western Niger Delta of Nigeria had been investigated. However, the deleterious levels of some physicochemical parameters were observed which stand as potential health hazards to the inhabitants of the area that use these water resources directly for domestic

Table 1. Range and mean values of physicochemical parameters of rainwater in Warri axis of delta state for year 2008.

Parameters	Range	Mean	[WHO limits (1996)]
Temperature (°C)	28.21 – 29.38	28.79 ± 0.27	May 5 - 50
pH	6.42 – 6.81	6.61 ± 0.09	7.0 – 9.2
DO (mg/l)	5.74 – 6.16	5.95 ± 0.10	5 – 8 May
TDS (mg/l)	16.35 – 28.27	22.31 ± 2.78	500 -1,500
TSS (mg/l)	14.28 – 23.33	18.75 ± 2.09	5
TOC (mg/l)	0.0003 – 0.0009	0.0006 ± 0.0001	-
Conductivity(S cm^{-1})	30.77 – 39.47	35.12 ± 2.03	400
Turbidity (NTU)	0.035 – 9.16	4.56 ± 2.14	5 – 25 May
Salinity (mg/l)	6.67 – 12.22	9.45 ± 1.29	200
PO_4 (mg/l)	0.124 – 0.42	0.27 ± 0.07	N/A
SO_4 (mg/l)	0.057 – 0.396	0.23 ± 0.08	200
NO_3 (mg/l)	0.075 – 0.31	0.19 ± 0.05	50
CO_3 (mg/l)	2.10 – 4.76	3.43 ± 0.62	100 -500
NO_2 (mg/l)	0.013 – 0.034	0.02 ± 0.005	2
Hardness (mg/l)	3.195 – 6.96	5.08 ± 0.88	100 -500

DO = Dissolved oxygen; TSS=Total suspended solid; TDS =Total dissolved solid; TOC =Total organic content; NA = Not available.

purpose without treatment (Efe et al., 2005). It is hoped that the research findings of this type would help greatly in assessing the status of rainwater quality within the inland oil producing area of Delta state.

However, the results obtained so far from this analysis indicate that the values of parameters determined were within the recommended international standard of World Health Organization (WHO) 1996 guideline for water quality except pH and total suspended solid that were slightly higher than WHO.

MATERIALS AND METHODS

Description of study area

The studied areas are located in Warri axis of Delta area of Delta state, Nigeria. The region lies within the longitudes 3°E-9°E and latitudes 4° 30′-5° 21′N of southern oil rich Niger Delta region. Delta area is known to be characterised by frequent precipitation with annual rainfall ranging from 3000 to 4500 mm. The high rainfall, humidity and river discharge during the rainy season combined with the low, flat terrain and poorly drained soils result in extensive flooding (Horsfall and Spiff, 2001). Warri being a great socio-economic city in the Delta area has drawn the attention of many researchers in recent decades for several reasons (Agada et al., 1992). The locations selected for the analysis are Koko, Oghara, Sapele, Jeddo, Egbokodo, Ubeji, Warri 1(NPA), Warri 2(jetty), Odeitsekiri, Ogbeijor, Aladja, Otujeremi, Effurun, Agbarho and Abraka. The people of these areas are mainly Urhobos, Itsekiri and Ijaws with other ethnic groups that also live within the city. A refinery is located in the area while the majority of other international and local oil/ gas companies operating in Nigeria have their operational base (Ekeh, 2005).

Plastic buckets that have been previously washed and leached with 10% HNO_3 and 1:1 HCl for 48 h were used to collect rainwater samples in an open place with a stand of about twenty feet above the ground. The collection of the rainwater samples were made from exactly fifteen (15) different locations in Delta area of Niger Delta. These samples were collected in August which is known to be the peak of rainy season of the year. The samples were preserved by keeping them in refrigerator prior to analysis for those parameters that were not determined *in-situ*. The temperature, pH, dissolved oxygen, total dissolved solid and conductivity were determined on the spot using various corresponding meters. The total suspended solid, total organic content, turbidity, salinity, phosphate, sulphate, nitrate, carbonate, nitrite and hardness were determined using either UV-Visible spectrophotometer or standard analytical procedures as earlier reported by APHA, 1995. The analyses were carried out in duplicates for each sample from those fifteen locations where the range and mean values were taken for each year of the two years studied.

RESULTS AND DISCUSSION

The range and mean values of some examined physico-chemical parameters of rainwater samples from Warri axis of Delta area in Western part of Niger Delta region for two consecutive years are presented in Tables 1 and 2. The temperature of the rainwater samples ranged between 28.21 – 29.38°C with mean value of 28.79 ± 0.27°C in first year while it ranged between 28.72 – 29.68°C with mean value of 29.20 ± 0.22°C in second year. Although, the temperature was found to vary with time of collection and with changes in the temperature of the surrounding, however, the temperature range and mean values of the second year were slightly higher than the first year. The pH of the rainwater samples were slightly acidic with pH values that ranged from 6.42 - 6.81°C and 6.51 – 6.78°C for first and second year respectively. This may be due to proximity of the area studied to a refinery where gases are flared and dissolution of these gases in rainwater will eventually enhance the acidity. The values of other parameters determined such as dissolved oxygen, total dissolved

Table 2. Range and mean values of physicochemical parameters of rainwater in Warri axis of delta state for year 2009.

Parameters	Range	Mean	[WHO limits(1996)]
Temperature (°C)	28.72 – 29.68	29.20 ± 0.22	May 5 - 50
pH	6.51 – 6.78	6.64 ± 0.62	7.0 – 9.2
DO (mg/l)	5.82 – 6.25	6.04 ± 0.10	5 – 8 May
TDS (mg/l)	19.37 – 33.38	26.37 ± 3.27	500 -1,500
TSS (mg/l)	15.52 – 30.55	23.03 ± 3.50	5
TOC (mg/l)	0.001 – 0.047	0.019 ± 0.01	-
Conductivity(cm^{-1})	36.96 – 50.07	43.51 ± 3.06	400
Turbidity (NTU)	1.27 – 9.07	5.17 ± 1.82	5 – 25 May
Salinity (mg/l)	8.85 – 12.38	10.61 ± 0.82	200
PO_4 (mg/l)	0.23 – 0.51	0.37 ± 0.065	N/A
SO_4 (mg/l)	0.09 – 0.37	0.23 ± 0.07	200
NO_3 (mg/l)	0.09 – 0.41	0.25 ± 0.07	50
CO_3 (mg/l)	2.49 – 4.82	3.65 ± 0.54	100 -500
NO_2 (mg/l)	0.008 – 0.027	0.017 ± 0.004	2
Hardness (mg/l	3.30 – 7.26	5.28 ± 0.92	100 -500

DO = Dissolved oxygen; TSS=Total suspended solid; TDS =Total dissolved solid; TOC =Total organic content; NA = Not available.

solid, total organic content, conductivity, turbidity, salinity, phosphate, sulphate; nitrate, carbonate, nitrite and hardness are within the recommended international standard of World Health Organization (WHO) 1996 guideline for water quality except total suspended solid. This may also be due to particulate matters produced during gas flaring that could contribute to total suspended solid present in rainwater. In general, the range and mean values of the second year is slightly higher than first year for all parameters. This is an indication that more of these physicochemical contents are introduced into the environment.

Conclusion

The high values of pH and total suspended solid than WHO could be as a result of closeness of the area to the refinery and petrochemical company where gases are indiscrimately flared into the environment. Hence, effort should be made by the appropriate authority to stop flaring of gases by the oil companies in due course.

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