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Assessment of Physicochemical Parameters in Nta-Wogba Stream in Port Harcourt, Rivers State, Nigeria

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Abstract Physicochemical parameters concentration reveals the physical and chemical states of a water body. Water samples were collected from Nta-Wogba stream in Port Harcourt metropolis and analyzed for physicochemical parameters. This was done in order to assess the portability of the stream water for use. Some physicochemical parameters such as pH, electrical conductivity (EC), salinity, phosphate, turbidity, sulphate, biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), dissolved oxygen (DO), chlorine, total dissolved solids (TDS) and total suspended solids (TSS) were analyzed in the month of August and November, using appropriate techniques. The mean values of the results were: pH (6.40±0.09), EC (1406.67±80.09 µS/cm), salinity (359.33±17.58 mg/L), Chlorides (219.03±10.11mg/L), nitrates (5.51±0.38mg/L), BOD (35.42±3.55mg/L), COD (48.00±1.63mg/L), DO (4.01±0.44mg/L), phosphate (0.90±0.03mg/L), Sulphate (158.50±2.50mg/L), turbidity (69.27±9.27 NTU), TDS (585.75±229.74mg/L) and TSS (37.78±4.61 mg/Lmg/L). The results obtained showed that pH, TDS, TSS phosphate, nitrate, COD and sulphate were within DPR and WHO permissible limits, while EC, turbidity, BOD_5 and DO were not within the permissible limits of DPR and WHO. Therefore, the water cannot serve useful purposes for portability and as such effort should be put in place to check indiscriminate discharge of waste into the stream.

Keywords Physicochemical Parameters, Nta-Wogba Stream, environment, water quality, water contamination

Introduction

Water, which is one of the basic and most relevant resources for the survival of man also stand out as the most threatened aspect in human existence. Water bodies receives a wide variety of wastes arising from industrial agricultural, domestic and natural sources [1]. Quality of water generally refers to the component of water, which is to be present at the optimum level for suitable growth of plants and animals. In natural aquatic system, various chemical parameters occur in low concentration [2]. The concentrations of chemicals in the environment increases as the population of people increases, increased expansion, development of industrial and industry based activities, utilization of natural resources, extension of irrigation and deficiency of or non-compliance to environmental laws and regulations [3-4].

Water dwelling plants and animals require a well-fitted environment to live and require sufficient nutrients for their development. The productivity or output of any aquatic environment is dependent majorly on the physicochemical properties of the water body [2] and maximum productivity is achieved when both the physical and chemical factors within the environment are working at optimum capacity [2]. In order to make important decision on the utility and control of water pollution, such decision will be based first of all on the nature of the water, which includes the physicochemical parameters [5]. Studies on the aspects of water quality are of utmost importance in the development of fresh water quality schemes [6]. Thus, water quality is an inevitable feature in ecosystem productivity [7].

The need for portable water is paramount in the survival and existence of life on the earth crust. Also, the accessibility of water of good quality is an essential ingredient or factor in the prevention of illnesses and to further enhance the quality of life of human beings [8]. Growth arising from industries and present expansion in city settlements have caused the establishment of different urban sectors, industrial sectors and concentrated growth and expansion of agriculture [9-10]. The establishment of these sectors arising from human quest for survival has caused severe situations in the need for portable water, this is because anthropogenic activities has influenced the content of discharges into the aquatic environment. One of the consequences of these human imposed on the river system activities is the reduction in the capacity of rivers to self-cleanse/auto purify, thus affecting the quality and interfering in feeding mode of aquatic plants and animals with a consequence on the food web [11].

Considering the importance of water to human, this study was therefore undertaken to examine the physicochemical properties of Nta-Wogba Stream found within Port Harcourt metropolis

Materials and Methods

Study Area

Nta-Wogba stream is located in Port Harcourt City, and cuts across Port Harcourt City and parts of Obio/Akpor Local Government Areas of the Rivers State, Nigeria. The upper course of the stream takes its course from the thick forest of Oha-mini, located within Mile IV (Oroazi) area of Port Harcourt and flows across several motorable roads and community settlements such as; Orazi, Rumueme and Port Harcourt city and empties into the Bonny estuary around the forces avenue in Old Government Residential Area, Port Harcourt. Water samples were collected at the different points designated in Table 1 in the months of June and October.

Table 1: Sampling sites showing the activities along Nta-Wogba stream and the coordinates

Sample sites	**Coordinates**		**Activities**
	North	**East**	
Sani Abacha Road	4°48’06”	6°59’45”	Domestic activities, mini industries
Olu Obansanjo Road	4° 48’ 57”	6°59’ 34”	Domestic and commercial activities Mechanic Workshops
Force Avenue (Old GRA)	4° 47’24”	7°0’30”	Domestics and Agricultural activities, cottage industries

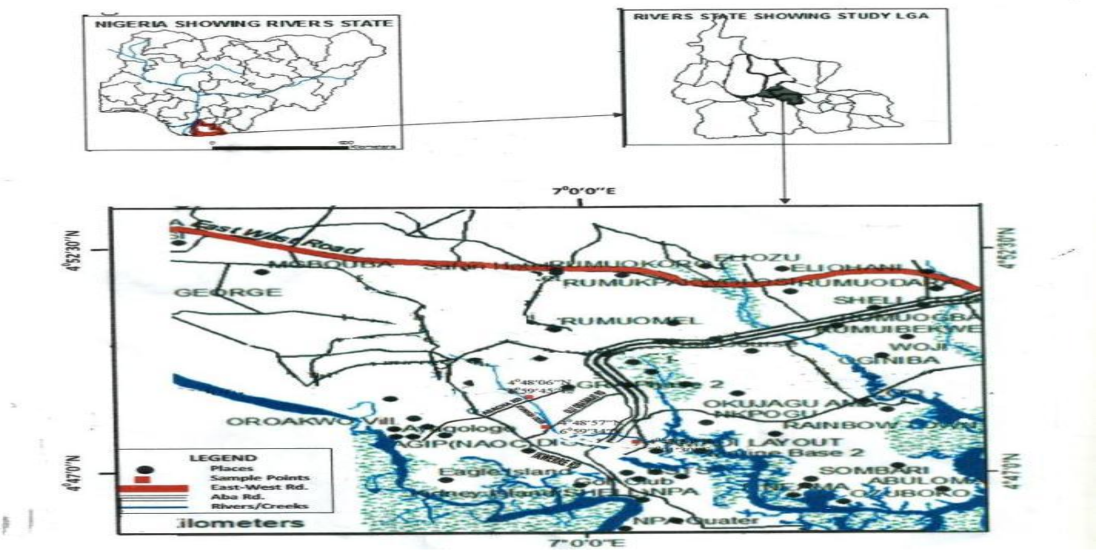

Figure 1: Map of Port Harcourt showing Nta-Wogba stream and the sampled points

Collection of Water samples

Water samples were collected from three locations as indicated in Table 1 above. The water samples were collected from a depth of 30cm into the water with glass bottles in the month of June and October. Before water sampling, the containers were rinsed with water from the stream at the different points of collection and thereafter filled to the brim and immediately corked. The obtained samples were placed in cold ice pack containers without allowing direct contact with sunlight. The samples were taken to the laboratory without further delay for preservation and analysis.

Sample Analysis

The samples were analyzed for different physicochemical parameters. pH, conductivity, salinity, turbidity, total dissolved solids and total suspended solids were examined on site (in-situ) with water checker hand held meter (Horiba product), while dissolved oxygen (DO) was examined with dissolved oxygen meter. Biochemical oxygen demand (BOD) of the water samples were determined on the fifth day after the samples were left in a dark cupboard for five days with the dissolved oxygen meter. The difference between the DO_1 and DO_5 is taken as BOD. Chemical oxygen demand (COD) was determined according to the method described by Ademoroti [12]. Chloride, phosphate, sulphate and nitrate were determined using colorimetric end point techniques.

Results and Discussion

The results obtained from the analysis of the Nta- Wogba stream is presented in Table 1 and 2 respectively, while the mean values for the two months is shown in Table 4. pH values varied from 6.32-6.53 with a mean value of 6.42 ± 0.11 in June. In October, the values of pH varied from 6.27 – 6.48 with an average value of 6.38 ± 0.11. The mean value of pH in the two months was 6.40±0.09. The observed pH values from the different stations along the stream except at the Olu-Obasanjo station were lower than the WHO value but within the range of DPR values. These values are lower than the values of Yusuf *et al*., [13] in Saba River Osun State, Nigeria and those of Olatayo [14], in waters from selected communities in Ilaje Local Government Area of Ondo State, Nigeria.

The pH of any water system is a dynamic symbol or feature of water value and quality, which reveal the degree of pollution of the water source. When the pH value is low, it typifies acidic waters and at such condition, has the capacity to dissolve poisonous elements and compounds like heavy metals, which produce toxic environments that are hostile to water dwelling plants and animals [15].

The conductivity of the water from the stream varied from 1300 – 1400 µS/cm in the stations with an average value of 1353±50.3µS/cm in June, while that of the month of October varied from 1375 – 1555 µS/cm, with a mean value of 1460± 90.42µS/cm. The mean value of conductivity within the period of analysis was 1406.67±80.09µS/cm. The observed values of conductivity in the stream within the months and their associated mean values were higher than the WHO limit for fresh water media. The observed conductivity values in the present work is higher than the values observed elsewhere in Nigerian rivers and streams [13-14, 16].

In freshwater media, the conductivity is expected to fall within the range of 50 to 1500 µS/cm, on the other hand when the water is extremely polluted with electrical carrying species or influence of sea water incursions, then higher values are likely to be expected [14]. These electrical conductivity carriers exist in the form of Ca ions, carbonates, nitrates, sulphates, and phosphates of metal elements. The high values observed in the stream in the present research may have arisen from numerous commercial activities carried on along the stream. These activities include sales of spare parts, mechanic workshop, sales of electrical materials and appliances, car wash, timber markets, presence of abattoir, and other anthropogenic activities. The values of conductivity can be applied as a useful tool to predict the hard and acido-basic condition of the water [17].

The salinity of the stream in the month of June varied from 330–360 mg/L, with a mean value of 345±15 mg/L. The variational change in stations values in October was 363-380 mg/L and a mean value of 373.7±9.29 mg/L. The mean value of salinity observed in the stations within the period was 359.33±17.58 mg/L. The observed values of salinity in the present work fall within the value for fresh water. The values were all far less than the expected range of 4-5%.

The salinity values observed in the Nta-Wogba Stream is lower than the values of Olatayo [14]. Salinity imposing ions in water are the sulphates, carbonates, bicarbonates and chlorides of Ca, Mg, K and Na. The factors that affect salinity of an aquatic environment are the drainage system into the water body, the soil geology, nature of precipitation and anthropoid activities close to the water that can possibly increase salinity enhancing ions or species into the water [18]. The salty nature of water has the capacity to prevent the growth of some plant species and also restrict the number of aquatic animal species. Factors that cause changes in the concentration of salinity carriers or species are rainfall, evaporation and precipitation.

The chloride concentrations of the Nta-Wogba stream in June varied from 200–221.2 mg/L, with an average mean of 211.7±10.78 mg/L. In October, the range of values was 220-230 mg/L, with and average value of 226.3±5.51 mg/L. The mean value of chlorides in the stream within the period was 219.03±10.11 mg/L. The values obtained within the period of examination were slightly lower than the WHO and DPR limits for drinking water.

The values of chloride observed in the Nta-Wogba Stream is higher than Manipur River System, India [19] and the ones observed Otamiri-oche River in Etche, Rivers State, Nigeria [1], but are lower than the values observed in New Calabar River at specific effluents discharge points [17]. Increased chloride concentrations in water has the capacity to dissolve and maintain heavy metals in solution, thus increasing the heavy metals potential of the water, turbidity, hardness and increased corrosivity of the water [17, 20].

Nitrates in the water samples from the stream in the month of June varied from 4.98 – 5.40 mg/L, with and average value of 5.24±0.23 mg/L. The variation of the nitrates among the stations in the month of October ranged from 5.35 - 6.10 mg/L, with a mean value of 5.78±0.39 mg/L. The observed mean within the period was 5.51±0.38 mg/L. The values observed within the period and stations were lower than the WHO and DPR set limits for nitrates.

The observed values of the present work were higher than those of other authors in a similar environment [1, 17], but lower than those of Qureshimatva *et al* [21], Chandlodia Lake, Ahmedabad, Gujarat, India and those of Odesiri-Eruteyan *et al* [22], in Ubeji River impacted with refinery effluent. Sources of nitrates in water can arise from sewage discharge from both home and industries and runoffs from agricultural lands, especially from fertilizer contaminated soils [23]. Increased concentrations of nitrates above the threshold value has the capacity to cause algal bloom, which results in eutrophication of lakes and slow flowing stream [24].

The values of biochemical oxygen demand (BOD_5) in the present work varied from 30.7–33.3 mg/L, with a mean value of 32±1.3 mg/L in the month of June, while the value range of 38 – 40 mg/L, with a mean value of 38.8±1.04 mg/L in October. The mean values for BOD_5within the period of analysis 35.42±3.55 mg/L. The BOD values observed in the present research is higher than the WHO and DPR values.

The observed values of BOD in the present work were higher than the values observed in water collected from Imabolo Stream, Kogi State, Nigeria [25], those of Kamal *et al* [2], in surface water from Mouri River, Khulna, Bangladesh and those of Tawati *et al* [26], in water from Maron River, Kepanjen, Malang, Indonesia. The significance of BOD is the fact that it is a measure of the rate of biodegradation of organic species in the medium and the strength of waste in the medium. BOD natural measures the amount of oxygen available to microbes to breakdown organic materials or constituents present in the water [17, 27-28]. It further reveals the extent of contamination or pollution of any water body. The values of BOD above 4 mg/L (as in this case) show a compromised water that is not suitable for consumption [4, 17, 28].

The values of chemical oxygen demand (COD) in the Nta-Wogba Stream varied from 46–50 mg/L, with an average value of 48±2 mg/L in the months of June and October. The COD values observed within the period was lower than the 250 mg/L value set by WHO and DPR. The observed values of COD in the examined stream were higher than the values of Edori and Nna [17], at effluents discharge points into the New Calabar River. It is also higher than those of Obeta *et al* [25], in Amabolo Stream, Kogi State, Nigeria and those of Natalia *et al* [29], in Kwacza River, Poland, but wer either lower, within the range or higher than the values observed from different streams and rivers in Abakaliki, Ebonyi State, Nigeria [30].

COD levels in aquatic media can be influenced or increased by the level of waste input into the medium. COD like BOD is also an expression of the level of carbon-based compounds pollution in water. The (COD), which measures the amount of oxidizable organic substance in water requires a quantity of O_2 that is required to be available. In this process, the amount of O_2 present in water that is utilized to accomplish the oxidation that is specified as COD [31]. The values observed for COD in the stream is expected because of the continuous input or discharge of contaminants of different types into the stream.

The dissolved oxygen (DO) quantity observed in the Nta-Wogba Stream in the month of June from the stations varied from 3.855 – 4.86 mg/L, with a mean value of 4.2±0.57 mg/L. In October, the values ranged from 3.5 - 4.25 mg/L, with a mean value of 3.87±0.33 mg/L. DO in the present work is lower than the WHO and DPR limits for domestic water use. The very low values of DO in the stream water represented a polluted water, not fit for both domestic and industrial uses. The depletion of oxygen in the stream water as typified in the result of DO is expected because the stream receives effluents from abattoir, sewages are in some case directly discharged into it, drainages from Ikwerre Road and other important commercial roads are discharged into it, market wastes from Miles 3 and 1 are not fully excluded from contamination sources and other industrial effluents discharged into the stream. DO is an important parameter for aquatic animals to thrive in any water environment [17]. With values as low as recorded in the present work, may not have the capacity to maintain aquatic animal life. This is because aquatic animal may require values of DO that may be up to 6.0 mg/L and above [4, 32].

The concentrations of phosphates in the stream in the month of June varied from 0.85-0.88 mg/L and a mean of 0.87±0.016 mg/L. In October, the observed values ranged from 0.90-0.95 mg/Land a mean value of 0.93±0.026 mg/L. The mean concentration within the months of analysis was 0.90±0.03 mg/L. The value of phosphates observed presently was lower than the WHO and DPR values for drinking water.

The phosphates values of the Nta-Wogba stream were higher than those of Omaka *et al* [30], in some streams and rivers in Ebonyi State, those of Natalia *et al* [29], in Kwacza River, Poland and those of Singh *et al* [19], in Manipur River System, India, but lower than the values observed in Mouri River, Bangladesh [2]. When nitrogen is present in any freshwater, together with phosphorus as phosphates, the growth and rate of increase of phytoplankton is highly regulated [33]. The low concentrations of phosphates in the present work is in agreement with the observation of Singh *et al* [19], whose observed that without anthropogenic influence , the values of phosphates usually occur between low to moderate concentrations in freshwater media. One major factor of phosphate increase in water is runoff from agricultural land burden with phosphate fertilizers and detergent bound wastewater. The second condition is predominant in the area, where different car wash and other detergent based washing is common.

The concentrations of sulphates in the Nta-Wogba Stream in June varied from 155–158 mg/L, with a mean value of 156.7±1.53 mg/L. In October, the values ranged from 158–163 mg/L, with a mean value of 160.3±2.52 mg/L. The mean value of the two months was 158.50±2.50 mg/L. All the values observed during the period of analysis were lower than the 200 mg/L limit set by WHO and DPR.

The concentrations of sulphates in the Nta-Wagba Stream is higher than the values of Uyigue [34], in Ekerekana Creek, Okrika, Rivers State, Nigeria, those of Kamal *et al* [2], in Mouri River, Bangladesh, those of Singh *et al* [19], in Manipur River System, India and those of Onyegeme-Okerenta *et al* [1], in Otamiri-oche River in Etche, RiversState, Nigeria, but were either lower, within the range or higher than the values observed in water from Imabolo Stream, Kogi State, Nigeria, natural sulphate present in a water system usually come from leaching of sulphur containing compounds and minerals such as gypsum [35]. Other possible sources (especially for this stream) are the use of detergent and soap by traders and merchants along the stream stretch. This corroborates the findings of Kamal *et al* [2], in a river contaminated with sulphates in Bagladesh.

The values of turbidity in June were in the range of 77.5- 80.6 NTU, with a mean value of 77.97±2.43 mg/L. The values obtained for the month of October were in the range of 55.5 - 65.4 mg/L and a mean value of 60.6 ±4.95 NTU. The mean of the two months was 69.27±9.27 NTU. The values of turbidity within the period and the stations were higher than the required limit of 5 NTU by the relevant agencies.

The turbidity values of the present work in Nta-Wogba were higher than the values of Singh *et al* [5], in an Indian river, those of Olatayo, [14] and those of Onyegeme-Okerenta *et al* [1], in different rivers from Nigeria. Turbidity, which describes the clearness and transparency of waster is a vital and active parameter that is applicable in control processes in water treatment procedures, with regard to coagulation and sedimentation of suspended particles and filtration. It introduces unwanted tastes and odours to water, hindersphotosynthetic processes promotes growth of algae [17, 36]. The high value of turbidity observed in the present work is due to the enormous wastes of different types and categories discharged into the stream. High turbidity has negative influence on fishes because it affects the sight due to reduction in light penetration and thus affect production [37].

Total dissolved solids (TDS) in the stations examined in the month of June varied from 650 – 700 mg/L and a mean value of 676.7 ± 25.17 mg/L. In October, the values were found within the range of 74.5 – 725 mg/L, with an observed mean of 494.8±211.4 mg/L. The mean value of the two months was rage 585.75±229.74 mg/L, which is lower than the 2000 mg/L and 1000 mg/L limit values for DPR and WHO respectively.

The TDS values observed in the present research were higher than the values observed in water from River Panjkora, Pakistan [38]. The values observed in Saba River, Osogbo, Nigeria [13] and those observed in water from River Jibam, Plateau State, Nigeria [39], were lower than the values of the present work. However, the values observed in the present work were either lower, within the range or higher than values observed by Asonye *et al* [40], in different Nigerian rivers.

The value of total suspended solids in the stream water in the stations ranged from 35-45mg/L, with a mean value of 40±5.0 mg/L in June, while October values ranged from 35.5-40.5 mg/L, with a mean value of 35.6±4.90 mg/L. The mean value of the two months was 37.78±4.61 mg/L, which was lower than the associated WHO and DPR limits.

Table 2: Physicochemical parameters of water samples from different stations in Nta-Wogba Stream in June

Physicochemical parameters	**Olu Obasanjo Road**	**Abacha Road**	**Forces Avenue**	**Mean ± SD**
pH	6.53	6.32	6.40	6.42 ± 0.11
Conductivity µS/cm	1400	1360	1300	1353 ± 50.3
Salinity (mg/L)	360	345	330	345 ± 15
Chlorides (mg/L)	221.2	214	200	211.7 ±10.78
Nitrates (mg/L)	5.4	4.98	5.34	5.24 ± 0.23
BOD_5 (mg/L)	30.7	32.0	33.3	32 ± 1.3
COD (mg/L)	46	48	50	48 ± 2
DO (mg/L)	3.85	3.89	4.86	4.2 ± 0.57
Phosphates (mg/L)	0.85	0.88	0.87	0.87 ± 0.016
Sulphates (mg/L)	157	155	158	156.7 ± 1.53
Turbidity (NTU)	75.8	80.6	77.5	77.97 ± 2.-43
TDS (mg/L)	700	680	650	676.7 ± 25.17
TSS (mg/L)	45	35	40	40 ± 5

Table 3: Physicochemical Parameters of water samples from different stations in Nta-Wogba Stream in October

Physicochemical Parameters	**Olu Obasanjo Road**	**Abacha Road**	**Force Avenue**	**Mean ± SD**
pH	6.48	6.40	6.27	6.38 ± 0.11
Conductivity µS/cm	1555	1375	1450	1460 ± 90.42
Salinity (mg/L)	380	363	378	373.7± 9.29
Chlorides (mg/L)	230	220	229	226.3 ± 5.51
Nitrates (mg/L)	6.10	5.90	5.35	5.78 ± 0.39
BOD_5 (mg/L)	38	38.5	40	38.8 ± 1.04
COD (mg/L)	46	50	48	48 ± 2
DO (mg/L	3.5	4.25	3.70	3.87 ± 0.33
Phosphates (mg/L)	0.90	0.93	0.95	0.93 ± 0.026
Sulphates (mg/L)	160	163	158	160.3 ± 2.52
Turbidity (NTU)	55.5	60.8	65.4	60.6 ± 4.95
TDS (mg/L)	74.5	685	725	494.8 ±211.4
TSS (mg/L)	40.5	35.5	30.7	35.6 ± 4.90

Table 4: Mean Values (Mean ± SD) of Physicochemical parameters in Nta-Wogba Stream compared to DPR and WHO Standards

Physicochemical parameters	June Mean Values	October Mean Values	Mean ± SD	DPR	WHO
pH	6.42 ± 0.11	6.38 ± 0.11	6.40±0.09	6-9	6.5 - 8.5
Conductivity µS/cm	1353 ± 50.3	1460 ± 90.42	1406.67±80.09	-	1000
Salinity (mg/L)	345 ± 15	373.7± 9.29	359.33±17.58	-	-
Chloride (mg/L)	211.7 ±10.78	226.3 ± 5.51	219.03±10.11	250	250
Nitrates (mg/L)	5.24 ± 0.23	5.78 ± 0.39	5.51±0.38	20	10-50
BOD_5)mg/L)	32 ± 1.30	38.8 ± 1.04	35.42±3.55	10	4
COD (mg/L)	48 ± 2.00	48 ± 2.00	48.00±1.63	250	250
DO (mg/L	4.2 ± 0.57	3.87 ± 0.33	4.01±0.44	20	10 20
Phosphates (mg/L)	0.87 ± 0.016	0.93 ± 0.026	0.90±0.03	5.0	5.0
Sulphate (mg/L)	156.7 ± 1.53	160.3 ± 2.52	158.50±2.50	-	200
Turbidity (NTU)	77.97 ± 2.-43	60.6 ± 4.95	69.27±9.27	5	5
TDS (mg/L)	676.7 ± 25.17	494.8 ±211.4	585.75±229.74	2000	1000
TSS (mg/L)	40 ± 50	35.6 ± 4.90	37.78±4.61	100	100

The TSS values observed in water from Nta-Wogba Steam were higher than those of Odesiri-Eruteyan *et al* [22], in Ubeji Creek, Delta State, Nigeria and also those of Tawati *et al* [26], in Maron River, Indonesia, but lower than the values observed by Uyigue [34], in Ekerekana River, Okrika, Rivers State, Nigeria.

Increased TSS increases turbidity of water and is affected mostly in the rainy seasons when runoffs from adjoining agricultural exposed lands are drained into water bodies and also from direct waste discharged into the water body. The prevalence of the second reason in the area may be one of the factors responsible for the high values observed [17]. This observation is in agreement with the observation of Uyigue [34], in the Ekerekana water body, where there is indiscriminate discharge of refinery effluents, open dumping and faecal deposits from industries and the locals as well.

Conclusion

The fitness of surface water from Nta-Wogba stream was examined using some water quality parameters. The results showed that pH, salinity, chloride, nitrates, COD, phosphate, sulphates, TDS and TSS were higher than the limits set by DPR and WHO, while conductivity, BOD5, DO and turbidity were higher than the established limits by the regulatory agencies. Therefore, the water is not suitable for both human and industrial consumption. As a result, efforts by relevant government agencies be put in place to checkmate the input sources of pollutants and contaminants. Also, adequate waste management facilities be put in place within the area covered to avoid continuous pollution of the water.

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