Global Scientific JOURNALS

GSJ: Volume 9, Issue 3, March 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

ON PHYSICO-CHEMICAL DYNAMICS OF MAJIDUN RIVER, LAGOS STATE, NIGERIA

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ABSTRACT

Majidun River is used for artisanal fishing, transportation and domestic activities in Ikorodu, Lagos State. At the lower course, the river receives eluate from solid wastes dumped at the shore; this coupled with sand mining could impact adversely on the biota and their environment. There is dearth of information on their limnology. The aim of this study was to investigate the physico-chemical characteristics of Majidun River in order to provide information for effective management.

Monthly sampling was carried out from three randomly selected sites on Majidun River (from September 2019 to August, 2020. Water temperature was measured *in situ*. Conductivity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), pH and alkalinity were determined from collected surface water according to APHA methods. Data were analysed using descriptive statistics, and ANOVA.

Mean temperature, conductivity, DO, BOD, pH and alkalinity were 27.6 °C ± 3.3°C,116.3 ± 2.0 μScm^{-1},6.3±1.2 mg/L,3.0±0.8 mg/L,7.3± 0.1 and 12.0 ±2.9 mg/L respectively for the river, Water temperature, pH, conductivity, BOD, DO and alkalinity values fell within WHO limits for aquatic life.

The findings suggest that the river is impacted by anthropogenic activities. There is need for enforcement of management policies against dumping of wastes into the river. The river could be used for aqua cultural practices, but not for drinking.

Keywords: Physico-chemical characteristics, Anthropogenic wastes, Majidun River and Reservoir.

INRODUCTION

Rivers are longitudinal reactions that store, transform and transfer organic matter and nutrients to adjacent flood plains, groundwater, lakes and coasts and to the atmosphere (Battin *et al.*, 2009, Benstead and Leigh, 2012).

These water bodies are often used for the disposal of industrial and anthropogenic effluents on the wrong assumption that aquatic ecosystems have self-purifying ability (Fakayode, 2005; Adeogun *et al*., 2011). The explosion in population density, urbanization and industrialization had profound impact on human life and aquatic environment in terms of quantity and quality (Herschy, 1999). More so seasonal and climatic changes affect the quality and physico-chemistry of surface water. The increased demand for water as a consequence of population growth, agricultural and industrial development had been accompanied by research oriented towards the definition of criteria and guide for water quality (W.H.O, 1966).

The objectives of this study are to:

1. determine the extent to which Majidun River had been over stressed by human activities over the years.
2. assessment of some physico-chemical parameters in Majidun River.

Justification

Majidun River is used for artisanal fishing, sand-mining, transportation and domestic purposes. It is a dump site for domestic and industrial wastes. The condition is worsened by the proliferation of urban and industrial establishments along the shores of the river. Despite the increasing anthropogenic influences occasioned by the rapid development of Majidun town and its environs in recent times, there is dearth of information regarding its limnology. It is also an opportunity to study the limnology of Majidun River as part of the important baseline information which can be utilized as a platform for impacts assessment, planning, and implementation of policies for monitoring and effective development.

Materials and Methods

Study Area

Majidun River is located in Ikorodu Local Government Area, Lagos State. It lies within longitude 3.22° and 3.29°E, and latitude 6.39° and 6.41°N of Nigeria coastline (Fig. 3.1 and 3.2). It has a catchment area of 2.9 km^2 with its major source from River Owuru in Ogun State and flows into Lagos Lagoon at Ipakodo where it receives tidal waters from the Lagoon (Fig. 3.3) Majidun River is characterized by a humid tropical climate with an annual average Relative Humidity of 80% and atmospheric temperature ranges between 26°C and 29°C (Olaniyan, 1975). The river has a width range of about 100-150 m. The water depth increase sharply towards the mid-channel zone to a range of 15m and 25m, probably due to the sand mining activities in the area. The annual rainfall is 4021mm with a peak in July-August; least rainfall occurs between December and February (Hastenrath, 1985). The southwest trade winds, bearing rains from the Atlantic Ocean is predominant.

Vegetation

The vegetation is characterized by floating higher plants such as duckweed (*Lemna* spp.) water lettuce (*Pistia*) and water hyacinth (*Eichhornia crassipes*). Rooted trees with dense undergrowth of shrubs such as *Rhizophora racemosa, Avicennia germinans, Mariscus alteriforlus* and *Paspalum orbiquilare* are also typical of its flora in Majidun River.

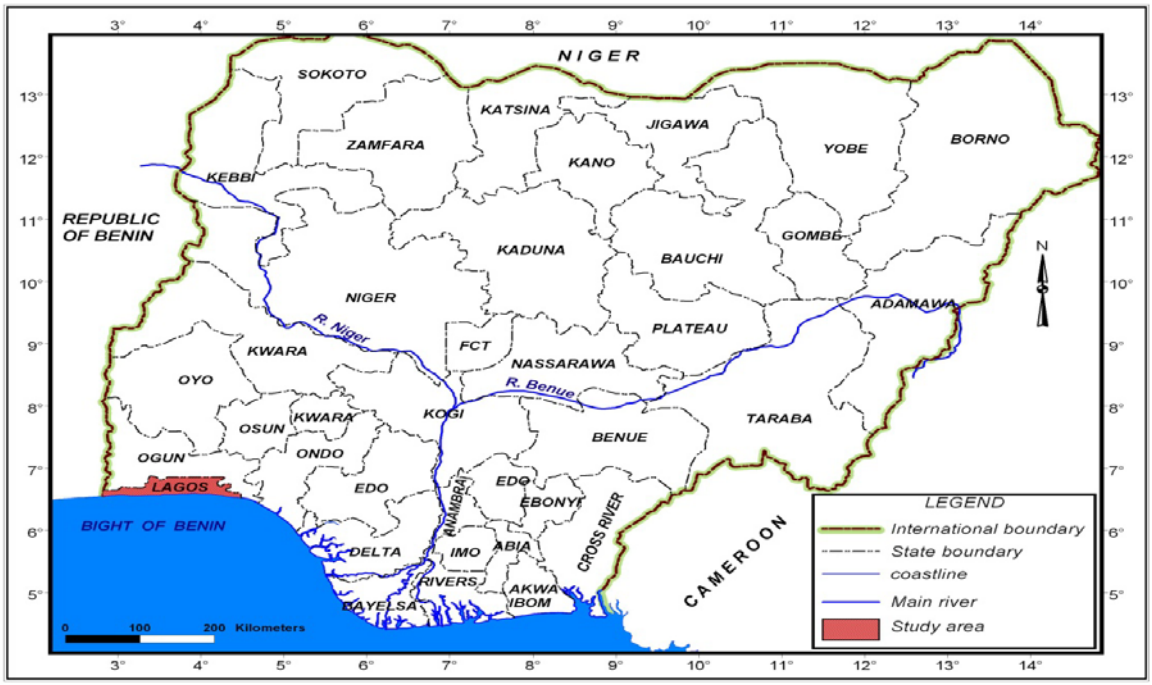

Fig 3.1: Map of Nigeria showing Lagos State ( )

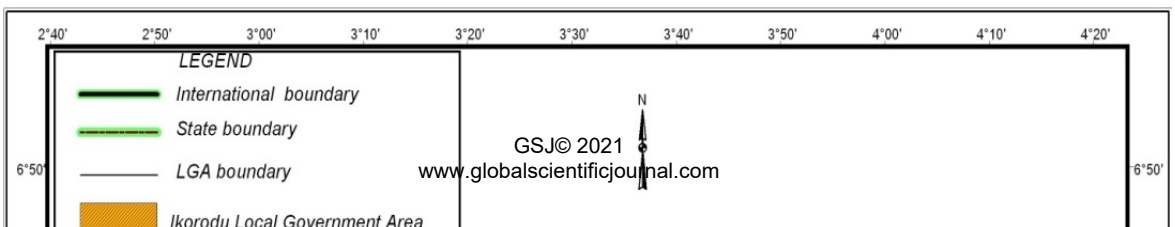

Fig 3.2: Map of Lagos State showing Ikorodu Local Government Area ( )

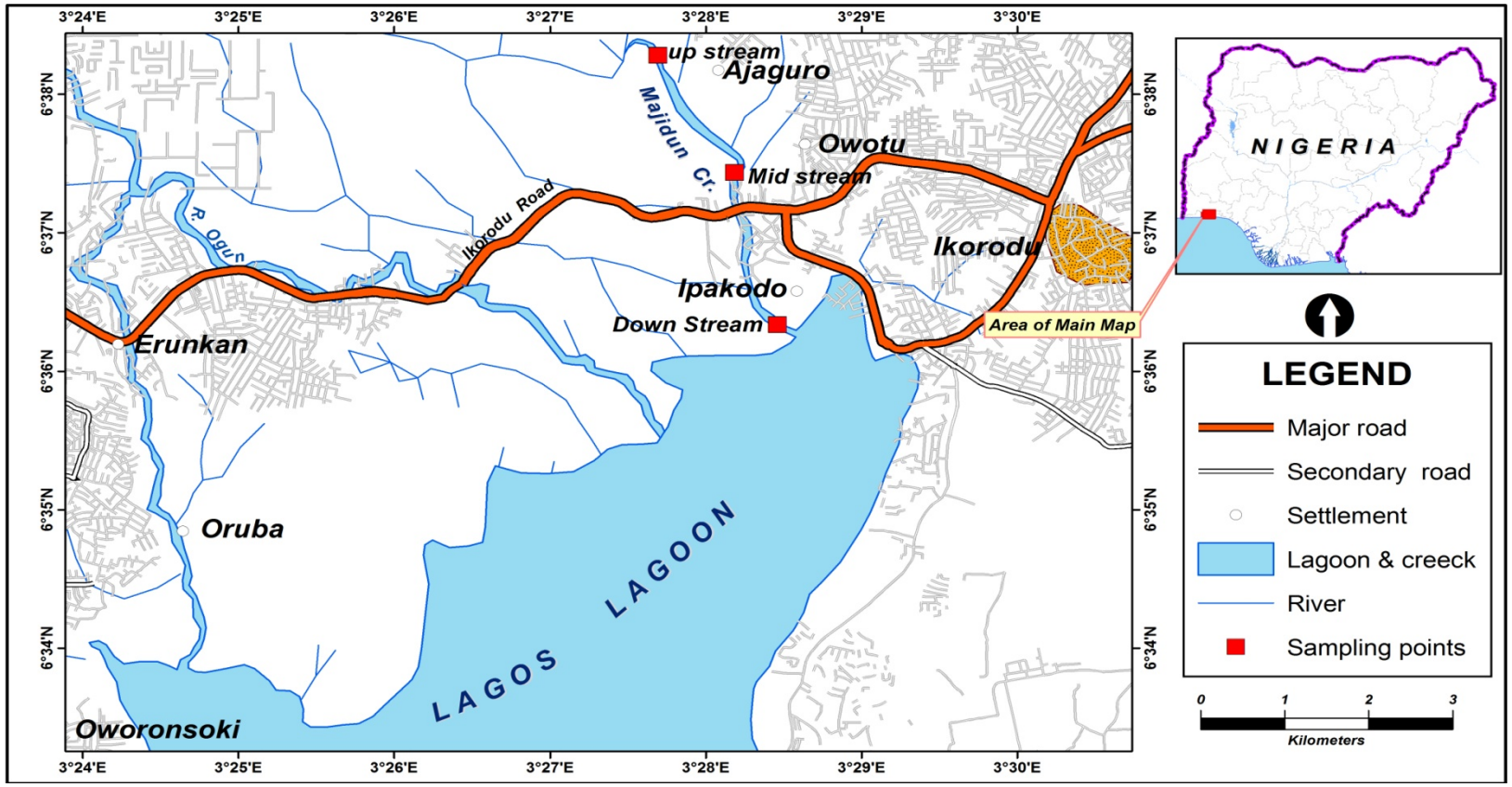

Fig 3.3: Map of Ikorodu Local Government showing Majidun River and Sampling Stations

Sampling stations

Three sampling stations (1-3) were established and studied (Fig3.3) represent the Upstream Station the Midstream Station and the downstream station. Upstream station to Midstream stations were about 1500m, From Midstream station to downstream station were about 1000m (Fig3.3).

Sampling techniques

Samples were collected from September, 2019 – August, 2020 to cover the main seasons (the rainy and dry season) of the year. Each station was sampled within 08.00-18.00 hours throughout to reduce the impact of diurnal variation to the minimum. Samples were collected from the water surface for physicochemical parameters from each sampling station.

Physico-chemical parameters.

Water samples for physicochemical parameters were collected from the surface column about 0.5m below the water surface of the reservoir from all the sampling sites with two replicates for each site. All the containers used in sampling were washed with non-phosphate detergent and subsequently rinsed with tap water and distilled water before use to prevent contamination of the samples taken. The containers were carefully labeled on the field.

Temperature

The temperature of the air and surface water at each site was measured with Mercury in glass thermometer graduated in degree Celsius (^{0}C). The thermometer was allowed to stabilize for 5minutes respectively in atmosphere to read air-temperature and then in surface water to read water temperature.

Dissolved Oxygen

Water samples for dissolved oxygen were collected in 250 ml glass specimen bottles. The bottles were filled with water and stoppered under water, making sure that no air bubble was trapped into it. The bottles were carefully opened again and 1ml each of Winkler's solution A and B (Manganous sulphate and alkaline iodide) were introduced into it using a pipette. The bottles were inclined and stoppard carefully to avoid the inclusion of air bubbles. The contents of the bottles were then thoroughly agitated by rotating and inverting the bottles several times for about 10seconds. The bottles were then transported to the laboratory. In the laboratory determination of dissolved oxygen concentrations in the water samples were carried out using the iodometric titration methods described by Golterman *et al* (1978).The unit of measurement is mg/l.

Biochemical oxygen demands (BOD)

Water samples for Biochemical oxygen demand were collected in 250ml glass specimen black bottles. The bottles were filled with water and stoppered under water, making sure that no air bubble was trapped into it. The samples were collected in black bottles which were incubated for 5 days at 20^0C. The sample was then fixed with Winkler solutions (A and B) at the end of the fifth day. The bottles were inclined and stoppard carefully to avoid the inclusion of air bubbles. The contents of the bottles were then thoroughly agitated by rotating and inverting the bottles several times for about 10seconds. The bottles were then transported to the laboratory for determination of Biochemical oxygen demand concentrations in the water samples which were carried out using the Winkler's iodometric titration methods described by Golterman *et al*,.(1978).The unit of measurement is mg/l.

Hydrogen ion concentrations (pH)

In the laboratory the pH values of water samples were determined using a pH meter (510pH meter).The glass electrode of the meter was immersed in the water samples collected and the pH value read off (APHA,1995).

Transparency

Transparency was determined *in situ* by using secchi- disc. The calibrated secchi-disc was suspended into the river at various stations, the length at which the disc could be seen was noted and the length at which the disc could not be seen was equally noted the average of these two lengths was determined and results expressed in meter.

Conductivity

In the laboratory the conductivity of the water samples were determined using Jenway conductivity meter 4071.The electrodes of the meter was immersed in water samples collected and the conductivity read off (APHA, (1995) in µs/cm.

Alkalinity

In the laboratory, 100ml of the water sample was introduced into a conical flask and titrated against 0.05N H_2SO_4 (tetraoxosulphate (vi) acid) from a burette using a mixed indicator solution. The mixed indicator solution was prepared as follows; 0.02% of Methyl red was dissolved in 95% alcohol and 0.1% of bromocresol green was added and the mixture was made up to 100ml as described by Golterman, *et al.*, (1978). The colour changed from yellow to pink which was the end-point. This procedure was repeated twice and the average was taken. The total alkalinity ($CaCO_3$ mgl^{-1}) was then calculated by the titrant value read from the burette multiplied by 50.

Chlorides

In the laboratory, 0.1N $HgNO_3$ (Mercuric nitrate) was titrated against 100ml of the water sample in conical flask, using 1ml of potassium chlorate indicator solution. The colour changed from pink to brick red colour which was the end-point. The chloride value was then calculated by the titrant value read from the burette.

Total Dissolved Solids (TDS)

In the laboratory, 100ml of the sample was filtered using Whatman T_{50} filtered paper the filterate was heated in crucible for evaporation process of sample to constant weight at 105 ± 2^{0C} in the crucible. This was cooled in desiccators and re-weighed for determination of TDS according to APHA, (1995).The unit of measurement was in mg/l.

Statistical analysis

1. Descriptive statistics of mean and standard deviations were used to summarise the data for all sampling sites and seasons in Majidun River.
2. Variations across the sampling sites, including range and seasons were carried out using descriptive statistics.

RESULTS

Physico-chemical parameters of Majidun River

The results of the physico-chemical parameters of Majidun River are presented in Table 4.1. The seasonal variations (Mean±S.E) of physico-chemical parameters for Majidun River from September, 2019 to August, 2020 are presented in Table 4.2.

Air temperature

Air temperature ranged between 23.9 and 32.8^{o}C). Downstream recorded the highest (28.6±0.68 ^{o}C) while, Lowest mean air temperature was recorded upstream (27.2±0.37^{o}C) and midstream (27.7±0.58^{o}C) respectively. The mean air temperature in rainy (28.1±0.91^{o}C) and dry (29.1±3.29^{o}C) seasons (Table4.2)

Water temperature

Water temperature of Majidun River ranged between 25.6 and 31.17^{o}C Downstream station recorded the highest (28.6 ± 0.54^{o}C) while, lowest mean water temperature was recorded upstream (27.5±0.46^{o}C) and midstream (28.0±0.51^{o}C) (Table 4.1). The mean water temperature in rainy (28.6±1.65^{o}C) and dry (28.7±2.25^{o}C) seasons (Table4.2).

Transparency

Transparency ranged between 0.3m and 1.39m. The lowest mean transparency was recorded upstream (0.46 ± 0.03m) while, downstream recorded the highest (0.55± 0.08m) (Table 4.1). The mean transparency in rainy (0.60±3.86m) and dry (0.50±1.22m) seasons (Table 4.2).

pH

pH in Majidun River ranged between 5.9 and 7.5. The lowest mean pH was recorded downstream (6.60 ±0.11) while, upstream recorded the highest (6.82± 0.14) (Table 4.1). The mean pH in the rainy (6.67± 0.52) and dry (6.53 ± 0.20) seasons (Table 4.2)

Total Dissolved Solids

Total dissolved solid ranged between 42 and 60mg/L). The lowest mean total dissolved solid was recorded upstream (16.8±34.8mg/L) while, downstream recorded the highest (19.7±37.8mg/L) (Table 4.1). The mean value for the rainy (27.1±1.40mg/L) and for dry (12.4±0.69 mg/L) seasons (Table 4.2)

Conductivity

Conductivity ranged between 82 and 438µs/cm. The lowest mean conductivity was recorded downstream (422.3±6.3µs/cm) while, midstream station recorded the highest (438±6.µs/cm) (Table 4.1). The mean value for the rainy (450.0±1.62µs/cm) and dry (302.0±1.88µs/cm) seasons (Table 4.2).

Total Alkalinity

Total Alkalinity ranged between 20.6 and 55.3 mg/L The lowest mean total alkalinity was recorded upstream (33.3± 2.44mg/L) while, downstream recorded the highest (36.1±2.72 mg/L) (Table 4.1). The mean total alkalinity in the rainy (34.2 ±1.05mg/L) and the dry (38.0± 8.69 mg/L) seasons (Table 4.2).

Dissolved oxygen

Dissolved oxygen of Majidun River ranged between 2.3 and 46.8 mg/L The lowest mean dissolved oxygen was recorded upstream (3.53±0.32mg/L), while, downstream station recorded the highest (4.45± 0.32mg/L) (Table 4.1). The mean dissolved oxygen in the rainy (4.41± 1.17 mg/L) and dry (4.50± 1.16 mg/L) seasons (Table 4.2).

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand ranged between0.63 and 3.93mg/L The lowest mean biochemical oxygen demand was recorded upstream (2.62±0.32mg/L) while, downstream station recorded

the highest (3.35 ±0.51mg/L) (Table 4.1) The mean biochemical oxygen demand in the rainy (2.80± 1.24 mg/L) and dry (4.40 ± 1.68 mg/L) seasons (Table 4.2).

Chloride ion

Chloride ion in Majidun River ranged between 22.0 and 65.0 mg/L. The lowest mean chloride ion was recorded upstream (19.5±65.9mg/L) while, downstream station recorded the highest (21.4±69.1mg/L) (Table 4.1). The mean value for rainy (19.9± 2.42) and the dry (23.0± 2.57) seasons (Table4.2)

Table 4. 1. Physico-chemical parameters (Mean±S.Eand Range) of Majidun River from September, 2019 to August, 2020.

S/N	Parameters	Upstream Mean ±SE	Midstream Mean ± SE	Downstream Mean ± SE	OVER ALL Mean ± SE	Range
1.	Air Temperature (^oC)	27.2 ±0.32	27.7 ±0.58	28.6 ±0.68	27.8 ±0.54	23 – 32
2.	Water Temperature (^oC)	27.5 ±0.46	28.4 ±0.51	28.6 ±0.58	26.3 ±0.50	25– 31
3.	Transparency (m)	0.46 ±0.03	0.47 ±0.06	0.55 ±0.08	0.49 ±0.05	0.3 – 1.9
4.	pH	6.8 ±0.14	6.6 ±0.11	6.6 ±0.11	6.6 ±0.11	5.9 – 7.6
5.	Total Dissolved Solid (mg/L)	168 ±45.8	177±36.9	197 ±37.3	180 ±36.5	42- 459
6.	Conductivity (µs/cm)	415 ±65.8	438 ±68.2	422 ±66.3	425 ±66.7	82 – 438
7.	Alkalinity (mg$CaCO_3$/L)	33.3±3.44	34.2 ±2.63	36.1 ±2.72	34.5 ±2.59	20.6 – 55.3
8.	Dissolved Oxygen (mg/L)	3.53 ±0.32	3.90 ±0.31	4.4 ±0.32	3.96 ±0.31	2.3 - 47.0
9.	Biochemical Oxygen Demand (mg/L)	2.62±0.32	2.45 ±0.26	3.35 ±0.51	2.80 ±0.36	0.63 - 3.9
10.	Chloride (mg/L)	195.1±65.9	202 ±67.0	214.6 ±67.0	204 ±67.3	22 – 650

Table 4.2. Seasonal variation (Mean ±S.E) of Physico-chemical parameters for Majidun River from September, 2019 to August, 2020.

S/N	Parameters	Rainy season Mean ±SE	Dry season Mean ± SE
1.	Air temperature (^{o}C)	28.1 ±0.91	29.1 ±3.29
2.	Water temperature (^{o}C)	28.6 ±1.65	28.7 ±2.25
3.	Transparency (m)	0.60 ±3.86	0.50 ±1.22
4.	pH	6.67±0.52	6.53 ± 0.20
5.	Total Dissolved Solid(mg/L)	271.0±1.40	124.0 ±0.69
6.	Conductivity (µs/cm)	450.3 ±1.62	302.0 ±1.88
7.	Alkalinity (mg/L)	34.2 ±10.5	38.0 ±8.69
8.	Dissolved oxygen (mg/L)	4.41 ±1.17	4.50 ±1.16
9.	Biochemical oxygen demand (mg/L)	2.30±1.24	4.40 ±1.68
10.	Chloride (mg/L)	19.9±2.43	23.0 ±2.57

Discussion

Water Temperature.

Water temperatures from Majidun downstream (28.6±0.54 ^{o}c) was higher compared with upstream station (27.5±0.46^{o}c). This could be attributed to decomposition of organic matter discharged into the downstream station of the River Olaniyan (2010) and Tyokumbor *et al*., (2002) reported similar elevated temperature at organic waste discharge point of Owena River, Ondo and Awba stream, Ibadan respectively..The mean temperature recorded in present study fell within the national and international limits of 30.00^{o}c-35.00^{o}c for aquatic organisms World health organization (W.H.O,1998) and Federal environmental protection agency (F.E.P.A,1991).

pH

pH varies between acidic to weakly alkalinity with means of 6.82±0.14, 6.67 ±0.4 and 6.60±0.11 respectively for Upstream, Midstream and Downstream stations with low pH in dry season (6.53±0.20) and high pH in rainy season (6.67±0.52). The pH is an important variable in water quality assessment as it influences many biological and chemical processes associated with water supply and treatment (Chapman and Kimstach, 1992).

pH of natural water ranged between 6.0-8.5 (Chapman and Kimstach, 1992).

PH at all stations was within the national and international limits, thus pH conditions are safe for aquatic life.

Conductivity and Total dissolved Solids.

In natural water conductivity is a measure of its ability to conduct an electrical current and is usually related to the concentration of Total Dissolved Solid (TDS) (Boyd,1979, Chapman and Kimstach,(1992).Conductivity from Upstream station (415.2±65.8µscm^{-1}) was lower compared with Midstream station (438.1±68.2 µscm^{-1}) and Downstream (422.3±66.3µscm^{-1}).However, the mean and highest electrical conductivity in the study sites were higher than 31-131µmhos/cm recorded by Adebisi (1981) in upper Ogun River, the monthly variation pattern followed a similar trend of

rising in dry season months and decreasing in the rainy season months this could be due to increased evaporation hence aggravated concentration of ions from reduced water volume. Similar to observation of Ogbeibu and Egborge (1995) on water bodies of Okomu forest Reservoir. TDS had regimes similar to conductivity with values of (168±34,8mg/l, 177±36.9mg/l and 197±37.8mg/l) respectively for Upstream, Midstream and Downstream stations. The variations in conductivity and TDS in Upstream station and Downstrea station could therefore be from regular deposition of anthropogenic waste from the resident people around the downstream station. However, most of the houses around this place has no toilet facilities, there faecal disposal seems to be the common ‘’shot put’’ system which grossly polluted the environment. TDS values from Upstream station devoid of any appreciable pollution from human activities. TDS, Conductivity values from Upstream, Midstream and Downstream stations were within the National and International limits of ≤200mg/l and 1000 μscm^{-1} F.E.P.A (1991) respectively.

Dissolved Oxygen.

Dissolved oxygen is the molecular oxygen that is dissolved in water; oxygen is produced during photosynthesis and consumed during respiration and decomposition (Michaud, 1991; Moore1989). Oxygen is essential to all forms of aquatic life, including those organisms responsible for the self purification process in natural water varies with temperature, salinity, turbulence, the photosynthetic activity of algae and plants and atmospheric pressure. The solubility of oxygen decreases as temperature and salinity increase. In fresh waters dissolved oxygen (DO) at sea level ranges from 15mg/l at 0^oC to 8mg/l at 25^oC (Chapman and Kimstach, 1992). DO with means of 3.53±0.32mg/l, 3.90±0.31mg/l and 4.45±0.32 for Upstream, Midstream and Downstream stations respectively DO fluctuations in this study could be attributed to waste input and biological activities which must have moderated factors associated by Boyd (1979), Cole (1975) and Chapman and Kinstach (1992) similar rainy season DO extreme observed in R.Ogun (Adebisi, 1981), and Nun River (Yakubu *et al.,* 1998*)*, Aiba Reservoir (Atobatele and Ugwumba, 2008) were also associated with algae bloom, photosynthesis, run-off and Turbulence were implicated. Chapman and Kinstach

(1992). DO values reported from this study at different periods were below the W.H.O (1998) threshold for protection of aquatic life.

Biological Oxygen Demand (BOD)

The highest and mean BOD_5 levels of the downstream station fell below the upper limit of 5 and 10mg/l F.E.PA (1991), W.H.O (1998).The lower BOD level recorded during rainy season (2.30±1.24) than dry season (4.40±1.64) in Majidun could be attributed to the dilution effects of the rains on the organic matter during rainy season.

BOD_5 provides a measure of the level of organic pollution as a result of consumption of oxygen in the course of biological process of breaking down of the organic molecules into inorganic forms (Abowei and Sikoki, 2005). Similar elevation level was recorded at human sewage discharge point of Awba stream in Ibadan by Yakub (2004) and Olaniyan (2010) of Owena Reservoir in Ondo.

CONCLUSION AND RECOMMENDATIONS

This study on physico-chemical parameters is considered important which can be utilized as a platform for impact assessment, planning and implementation of policies for monitoring and effective development of Majidun River.

The downstream of Majidun River which was slightly polluted confirmed that the residents' people were without toilet facilities but all their faeces and other anthropogenic wastes were dropped into the river. Thus, the common practice especially in Nigeria and other developing nations of using natural water bodies as disposal media for anthropogenic and faecal wastes poses a serious threat to the aquatic ecosystems.

The need for further evaluation of techniques is highlighted, and the need for national and international criteria for water quality is reinforced.

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