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THE PHYSICO-CHEMICAL PARAMETERS OF KALAIGIDAMA AND BASAMBIO CREEKS, KE IN RIVERS STATE, NIGERIA

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ABSTRACT: *Kalaigidama and Basambio creeks are estuarine creeks along the sombrero river in Ke Degema Local Government, Rivers State, Nigeria. This study was aimed at assessing the physico-chemical parameters of the creek considering the activities going on there. Four stations were selected along the creek equidistant from each other and sampled for 5 months from May to September. Surface water samples were collected for testing Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Nitrate, Phosphate and Sulphate in the laboratory following standard method while Dissolved Oxygen (DO), Temperature, Total Dissolved Solids (TDS), Conductivity, pH, Salinity and Transparency were determined in-situ. The mean and range of parameters were determined using appropriate statistics and values compared with DPR, FEPA and WHO standards. ANOVA was used to test for variation along sampling months and stations. The mean values of physiochemical parameter are temperature (26.86± 0.17°C – 28.84 ± 0.46°C), pH (6.97 ± 1.3 – 7.41 ± 0.09), DO (2.84 ± 1.01 mg/l – 4.5 ± 0.18mgl), Salinity (10.89 ± 2.4ppt – 20.7± 0.35ppt] conductivity [19.03± 6.13ms - 36.2 ± 0.83ms), TDS (16.11 ± 1.45ppt – 36.58 ± 1.22ppt), COD (16.6 ± 2.73mg/l – 50 ± 5.18mg/l), BOD (1.34 ± 0.82 mg/l – 3.96 ± 0. 02 mg/l), Transparency (6.2 ± 1.11cm – 10.06 ± 1.72cm), TSS (5.94 ± 1.02mg/l – 10.82 ± 1.61mg/l), Sulphate (164.86 ± 28.08mg/l – 402.47 ± 11.36mg/l) and nitrate (1.85 ± 0.46mg/l – 5.39 ± 1.86mg/l). The means of all parameters were significantly different at (P< 0.0001) exception of pH along the sampling months. The study revealed that the physico-chemical parameters of the water samples from all the stations except Sulphate and Dissolved Oxygen were within the permissible limits of DPR, FEPA and WHO. Which indicates that the creeks are under stress and cannot support aquatic life.*

KEYWORDS: Ke, Surface Water, Petroleum Activities, Sombreiro River

INTRODUCTION

Water constitutes part of the dynamic aquatic life-supporting system in which organic and inorganic substances are dissolved or suspended and in which a wide variety of organisms live and interrelate with each other (Awah, 2008). Also, water bodies provide valuable ecosystem services, such as water supply, production, recreation and aesthetics. Having it available in adequate quantity and quality contributes to the maintenance of health. Meanwhile, anthropogenic activities deteriorate surface waters (Chukwu *et al*., 2008). The quality of any given water body is governed by physical, chemical and biological factors. These factors interrelate with one another and with intrinsic parameter of each factor to greatly influence the water quality characteristics (Kemdirim, 2000). Coastline support many fish species for at least part of their life cycle, offering some of the most productive fisheries habitats in the world and support many other organisms with high public visibility or unique ecological significance

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(USEPA 2004). However, pollution of water bodies in third world countries has reached an alarming state and Nigeria is not exempted. A wealth of literature exists for physicochemical parameters of surface water in Nigeria. Such reports include Bolarinwa *et al*, (2016), Akpan (1993), Ekpo *et al*, (2012), Essien – Ibok *et al*, (2010), Vincent – Akpu and Nwachukwu (2016), Abowei (2010). However, there is deficiency of literature on the Kalaigidama and Basambio creeks.

This study is aimed at assessing the water quality of Kalaigidama and Basambio creeks.

MATERIALS AND METHOD

Study Area

Kalaigidama and Basambio creeks are estuarine in nature located between latitude 04^0 28’0”N and longitude 06^0 55’ 0”E are along the Sombreiro river (Fig.1). The vegetation of the area is dominated by mangroves: red mangrove (*Rhizophora racemosa*) and white mangrove (*Avicennia* sp). Human activities going on within the creek include petroleum activities, boating and fishing. Station 1: It is located between latitude $04^0$448N and longitude $06^0$88E at the entrance of the creek close to petroleum activities. Station 2: It is located between Latitude $04.44^0$5N and longitude 0.68877E it is in front of a fishing settlement Kalaigidama that is close to petroleum activities. Station 3: It is located between latitude 04.438N and longitude 0.68875E. It is closed to petroleum activities in the creek. Station 4: it is located between latitude 04.4380N and longitude 06.8889E. It is about 500 metres away from petroleum activities. Station 5 (Basambio Creek) control: It is located between latitude 04.46297N and 06.919E. There are no petroleum activities in the creek. It is close to the Ke Community Activities going in the creek are boating and fishing.

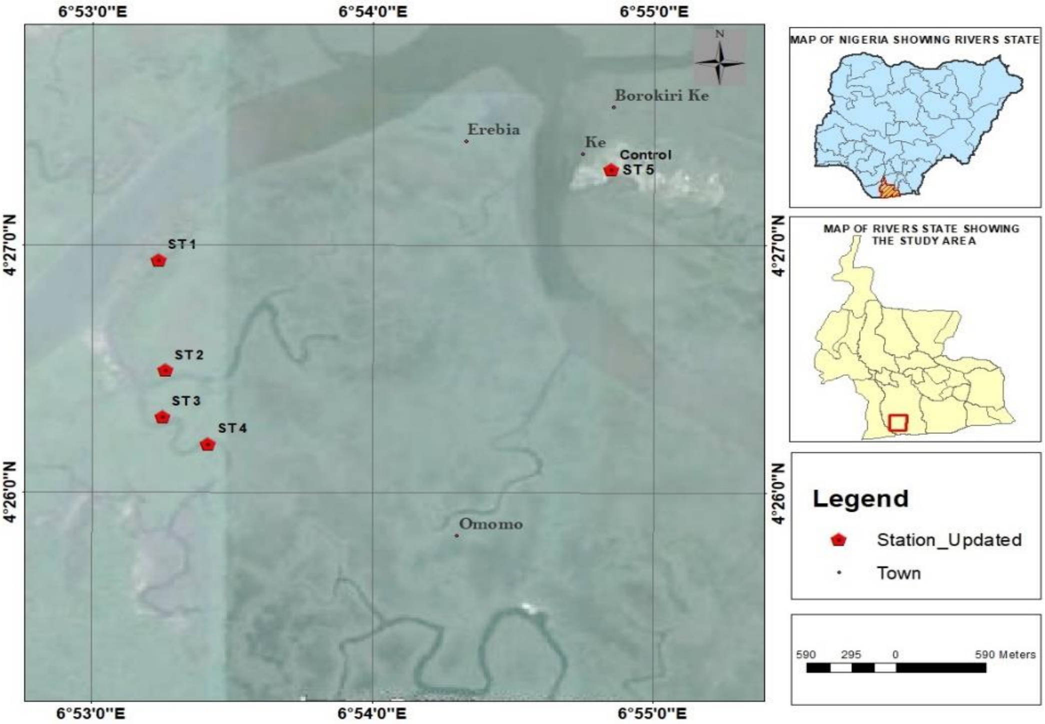

Fig.1: Map of Study Area

Sample Collection

Samples were collected for a period of five months from May to September 2018. Surface water temperature and dissolved oxygen were measured in-situ using JPB 608A DO ANALYSER. pH, Conductivity and Total Dissolved Solids were measured using 6PFC^{E} UTRAMETER II. Transparency was measured using Secchi disc while Salinity was measured using Scientific Water Quality Meter (860033). Winkler's was used to determine Biological Oxygen Demand (BOD), Titrimetric method was used for Chemical Oxygen Demand (COD), Turbidimetric method was used for Sulphate, stannous chloride method was applied for Phosphate, Colorimetric method was applied for Nitrate and Gravimetric method for Total Suspended Solids (TSS) were analysed in the laboratory following APHA (1998).

RESULTS AND DISCUSSION

Temperature of surface water in the creek ranged from 27.93 ± 0.7^{o}C to 28.26 ± 0.78^{o}C in the stations with a mean of 28.04 ± 0.79^{o}C. Station 5 recorded the highest temperature value of 28.26± 0.78^{o}C and the least was recorded in Station 1 (27.93± 0.7^{o}C) but the variations were not significant at $p < 0.005$ (Table 1). Monthly variations were significant at ($P < 0.0001$), and ranged from 26.86 ± 0.17^{o}C to 28.84 ± 0.46^{o}C (May) with a mean of 28.04 ±0.79^{o}C (Table 2). Highest temperature was in May (28.84 ± 0.46^{o}C) and lowest in August (26.86 ± 0.17^{o}C) which is normal for the humid tropical temperatures of Nigeria in the rainy season (NEDECO, 1961). This temperature was similar to Zabbey (2002) who reported temperatures of 26.3^{o}C and 30.4^{o}C, Sikoki and Zabbey (2006) between 26^{o}C and 27.8^{o}C, Abowei (2010) between 27.3± 0.24^{o}C and 33.7 ± 0.21^{o}C, Hart and Zabbey (2005) between 25.8^{o}C and 30.4^{o}C.

The pH of surface water in the stations ranged between 6.84 ± 1.27 (station 1) to 7.35 ± 0.09 (station 5) (Table 1) with a mean of 7.23 ± 0.33. There was no significant variation in the pH of the different stations and sampling period at ($P < 0.0001$). The pH values recorded in this study was within the recommended pH range of 6.0 to 9.0 for aquatic life (DPR 2002/FEPA, 2003). The findings of this work were similar to Adesalu (2012) who reported pH of between 6.79 to 7.3, Vincent-Akpu and Nwachukwu (2016) between 7.5 to 7.7. However, higher than 6.80 to 6.86 reported by Ekpo *et al*., (2012) in Ikpa river and lower than 8.8 to 9.2 reported by Nkwoji *et al*., (2010) in Lagos lagoon. Also, the pH values were not significantly different across the months. The pH values were within the normal range of FEPA (2003) and DPR (2002).

The DO of the surface water in all the sampled stations in Table.1 ranged from 3.15 ± 1.03 mg/l (station 4) to 4.35 ± 0.21 mg/l (station 5) (Table 1). For the months the highest value was recorded in August (4.5 ± 0.18 mg/l) and the least was recorded in May (2.84 ± 1.01 mg/l) (Table 2). There was no significant variation in the DO of the different sampled stations and the sampling period. The values were below the standards of FEPA/DPR and WHO requirement of 5.0mg/l. The low dissolved oxygen level observed in this study may be due to the oil film seen on the surface of the water due to the petroleum activities in the creek which prevent oxygen diffusion from the air and microbial degradation of hydrocarbon. Low transparency levels might have also affected the DO (Oniye *et al*., 2012). Also, the low DO of the control station 5 could also be attributed to oil film seen on the surface of the water as a result of tidal movement of the River and biodegradation of hydrocarbon. The findings of this

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study compare favourable with the work of Udoh and Akpan (2010) in Alakiri community in Okirika. The low DO values recorded in this study is an indication aerobic aquatic organism may be under stress in Kalaigidama creek (Bordoloi and Baruah 2015).

The salinity of surface water in the stations ranged from 15.8 ± 4.9 ppt (Station 1) to 18.52 ± 2.04 ppt (Station 5) (Table 1) with a mean of 16.85±3.92ppt the variation was not significant at (P < 0.05). Monthly mean was 16.85±3.92ppt. Monthly variations were significant at (P < 0.0001). The salinity of surface water ranged from 10.89 ± 2.4 ppt to 20.7 ± 0.33ppt across the months. The decrease in salinity could be attributed to dilution from rainfall during the months of sampling and salinity of an area depends on its distance from fresh or marine waters. Abowei (2010), McLusky (1989) and Bolarinwa *et al.*, (2016) also observed that decrease in salinity was as a result of dilution from rainfall. Adesalu *et al*., (2008) also reported low salinity values in rainy season.

The conductivity of surface water in all the sampled stations ranged from 27.27 ± 9.97mS/cm (Station 1) to 31.45 ± 5.37mS/cm (Station 5) (Table 4.1) with a mean of 28.88 ± 7.36ms. That of the months ranged from 19.03 ± 6.13mS/cm (September) to 36.2 ± 0.83mS/cm (May) (Table 2) with a mean of 28.88 ± 7.36mS/cm. The values were significantly different across the stations and the sampling period at (p < 0.0001). The conductivity values ranged from 19.03 ± 6.13ms to 36.2± 0.83mS/cm across the months and decreases across the months. The result is in agreement with Oniye *et al.*, (2002) that observed lower conductivity in rainy season due to dilution, differs with that of Adeosun (2007) and Odulate (2010) that observed higher conductivity in the rainy month of July.

The TDS of surface water in all the sampled stations ranged from 26.78 ± 9.52ppt (Station 4) to 30.63±7.32ppt (Station 5) (Table 1) with a mean of 28.21±9.02ppt. The variation was not significant. That of the months ranged from 16.11±1.45ppt (August) to 36.58±1.02ppt (May) with a mean of 28.21±9.02ppt. The mean values were significantly different.

The decrease in TDS across the sampling months from May (36.58 ± 1.02ppt) to September (19.48± 3.88ppt) could be attributed to dilution as a result of the rainy season. These findings agree with Adesalu (2012) who reported low TDS values in wet months, but does not agree with Fatoki *et al*., (2001) and Akpan (2004) with higher TDS values in rainy season.

The COD of surface water in all the sampled stations showed that station 4 have the highest mean value of 38.13±16.72mg/l and station I recorded the least value of 34.39±14.36mg/l (Table 1) with a mean of 35.95 ± 15.26mg/l the variation not significant. In the mean values of the months May (50±5.18mg/l) recorded the highest while September (16.6±2.73mg/l) recorded lowest (Table 2) with a mean of 35.95 ± 15.26mg/l. The mean values were significantly different at (P < 0.0001). The low COD value, observed in this study may be due to dilution and tidal movement of water. The compares with that of Adesalu (2012) and Ekpo *et al*., 2010 that reported low COD values.

The BOD of surface water in all the sampled stations ranged from 2.14±1.43 mg/l (Station 3) to 2.89±1.05mg/l (Station 5) (Table 1) with a mean of 2.52 ± 0.56mg/l. the variation was not significant at (P < 0.05). That of the months ranged from 1.34±0.82 mg/l (May) to 3.96± 0.02 mg/l (September) (Table 2) with a mean of 2.52±0.56mg/l. The variation was significantly different at (P < 0.0001). Biological oxygen demand (BOD) values recorded highest in September (3.96 ± 0.02 mg/l) and lowest in may (1.34 ± 0.82 mg/l) across the months. The result of this study was similar to the findings of Ekpo *et al*., (2012) and Bordoloi and Baruah (2015), however differs from the report of Essien – Ibok *et al*., (2010), Akpan and Akpan (1994) and Akpan (1993) that reported high BOD values during the rainy season. The BOD values recorded in this study are within permissible limits for aquatic organisms according to FEPA (2003) and DPR (2002).

The transparency of surface water in all the sampled station ranged from 6.18±1.55cm (Station 1) to 11.82±4.33cm (Station 5) (Table 1) with a mean of 7.84±2.28cm and that of the months ranged from 6.2 ± 1.11cm (September) to 10.06± 1.72 cm (June) (Table 2) with a mean of 7.84±2.2.28cm. The variation was significant across stations and sampling period. The low values observed in this study could be as a result of the oil film seen on the surface of the water in the creeks and run off during the rainy season. The low transparency values observed in this study was similar to Bolarinwa *et al*., (2016) and Adesalu (2012) that reported low transparency values but differ from that of Ekpo *et al*., (2012). The low transparency level may affect photosynthetic activities of phytoplankton which in turn will affect other invertebrates that depends on the phytoplankton.

The TSS in all the sampled stations was highest in station 4 (8.47±2.85mg/l) and lowest in station 3 (7.09±1.96 mg/l) (Table 1) with a mean of 7.55±2.07mg/l, the variation was not significant. For the months September (10.82±1.61 mg/l) recorded the highest value while June (5.94±1.02 mg/l) recorded the lowest value (Table 2) with a mean of 7.55±2.07mg/l. The variation was significant across the sampling period at (P = < 0.0001). Total suspended solids values ranged from 5.94± 1.02 mg/l to 10.82±1.96 mg/l. The low values observed in the study could be attributed to the time of sampling as sampling was done in the morning. The findings of this study are not in agreement with that of Ekpo *et al*., 2012 who reported high TSS values in Ikpa River, however higher than that of Adesalu (2012).

The highest mean value of phosphate in all the sampled stations was recorded in station 3 (0.75±0.22mg/l) and the lowest was recorded in station 4 (0.54±0.12 mg/l) (Table 1) with a mean of 0.65±0.18mg/l, the variation were not significant. Monthly variation was significant at (P < 0.001), ranged from 0.56±0.12mg/l to 0.72±0.21mg/l with mean of 0.65±0.18mg/l. May (0.72±0.21 mg/l) recorded the highest value and August (0.56±0.12 mg/l) recorded the lowest (Table 2). The mean phosphate value ranged from 0.56 ± 0.12mg/l in August to 0.72 ± 0.21mg/l in May. The low phosphate values observed could be attributed to the rain during the sampling months. The findings of this study was similar to Adesalu (2012) and Vincent-Akpu and Nwachukwu that recorded low phosphate values in Majidun creek in Lagos and Iwofe,Nembe and Bonny waterfronts, however negates that of Bolarinwa *et al*., (2016) and Ekpo *et al*., (2012) that recorded higher phosphate values in Ondo State coastal waters and Ikpa River. The values are within the acceptable limits by FEPA (2003) and DPR (2002).

The sulphate of surface water across the stations ranged from 261.84±89.15mg/l (station 2) to 278.8±118.27mg/l (Station 1) (Table 1) with a mean of 272.59±96.21mg/l, the variations were not significant. Monthly variations were significant at (P < 0.0001), ranged from 164.86 ± 28.08mg/l to 402.47 ± 11.36mg/l (Table 2) with a mean of 272.59±96.21mg/l. Highest sulphate was in June (402.47 ± 11.36mg/l) and the lowest was in May (164.86 ± 28.08mg/l). The high value of sulphate recorded in the study may be due to surface runoff during the rainy season. The findings of this study are higher than that of Ekpo *et al.*, 2012, Vincent-Akpu and Nwachukwu (2016) and Adesalu (2012) that reported low values of sulphate. The values recorded in this were above the permissible limits of 200mg/l by FEPA (2003).

The mean nitrate values of surface water across the stations ranged from 2.87±1.3gm/l (station 1) to 4.14±2.24mg/l (station 3) (Table 1) with a mean of 3.36±0.96mg/l, the variations were not significant. The months ranged from 1.85± 0.46mg/l (June) to 5.39±1.86mg/l (May) (Table 2) with a mean of 3.36±0.96mg/l. The variations were significant across the months at (P<0.0001). The lowest nitrate value was recorded in June, this might be due to the early morning rain before sampling. However, the findings of this study correspond with that of Adesalu (2012) who reported similar nitrate values in Majidun creek during the rainy season and Vincent-Akpu and Nwachukwu (2016) that also reported similar values. The values were higher than that of Onwugbuta-Enyi *et al.*, (2008) in Bodo creek and Bordoloi and Baruah (2015) in an effluent receiving stream of Assam, India.

CONCLUSION

The study revealed that the physico-chemical parameters of the water samples from all the stations except Sulphate and Dissolved Oxygen were within the permissible limits of DPR, FEPA and WHO due to the anthropogenic activities. This indicates that the creeks are under stress. The low DO level will favour anaerobic organisms while aerobic organisms will not strive in the creeks. However, the high sulphate level will enhance algal growth.

Table 1. Mean Spatial Variation of Physicochemical Parameters

	Station 1	Station 2	Station 3	Station 4	Station 5	Mean	P
Temp. (°C)	27.93±0.7[a]	28.07±0.93[a]	28.01±0.91[a]	27.91±0.64[a]	28.26±0.78[a]	28.04±0.79	0.770
pH	6.84±1.27[a]	7.3±0.11[a]	7.34±0.12[a]	7.3±0.08[a]	7.35±0.09[a]	7.23±0.33	0.087
DO (mg/l)	4.27±0.37[a]	3.69±0.86[ab]	3.68±0.68[ab]	3.15±1.03[b]	4.35±0.21[a]	3.83±0.63	<0.0001
Sal.(ppt)	15.8±4.9[a]	16.43±4.13[a]	16.9±4.09[a]	16.6±4.42[a]	18.52±2.04[a]	16.85±3.92	0.437
Cond.(mS/cm)	27.27±9.97[a]	29.24±6.28[a]	28.55±7.19[a]	27.9±7.97[a]	31.45±5.37[a]	28.88±7.38	0.601
TDS (ppt)	27.73±9.44[a]	27.81±8.97[a]	28.08±9.84[a]	26.78±9.52[a]	30.63±7.32[a]	28.21±9.02	0.822
COD(mg/l)	34.39±14.36[a]	36.09±17.13[a]	36.33±15.56[a]	38.13±16.72[a]	34.9±12.52[a]	35.97±15.26	0.969
BOD(mg/l)	2.85±0.86[a]	2.36±1.34[a]	2.14±1.43[a]	2.35±1.25[a]	2.89±1.05[a]	2.52±0.56	0.341
Transp (cm)	6.18±1.55[b]	6.56±1.65[b]	7.28±1.53[b]	7.36±2.33[b]	11.82±4.33[a]	7.84±2.28	<0.0001
TSS (mg/l)	7.13±1.03[a]	7.64±2.33[a]	7.09±1.96[a]	8.47±2.85[a]	7.41±2.18[a]	7.55±2.07	0.403
Phosphate (mg/l)	0.73±0.13[ab]	0.65±0.11[abc]	0.75±0.22[a]	0.54±0.12[c]	0.56±0.3[bc]	0.65±0.18	0.006
Sulphate (mg/l)	278.8±118.27[a]	261.84±89.15[a]	276.48±88.36[a]	276.09±90.24[a]	269.74±102.05[a]	272.59±96.21	0.990
Nitrate (mg/l)	2.87±1.1[a]	3±1.78[a]	4.14±2.24[a]	2.94±0.95[a]	3.87±0.96[a]	3.36±0.96	0.061

Table 2. Mean Monthly Variation of Physicochemical Parameters

	May	June	July	August	September	Mean	P
Temp. (ºC)	28.84±0.46[a]	28.37±0.39[b]	28.11±0.59[b]	26.86±0.17[c]	28.01±0.49[b]	28.04±0.79	< 0.0001
pH	7.41±0.09[a]	6.97±1.3[a]	7.34±0.12[a]	7.25±0.03[a]	7.17±0.16[a]	7.23±0.33	0.307
DO (mg/l)	2.84±1.01[c]	3.88±0.69[b]	3.8±0.56[b]	4.5±0.18[a]	4.13±0.11[ab]	3.83±0.63	< 0.0001
Sal.(ppt)	20.7±0.35[a]	19.49±0.43[b]	18.97±0.73[b]	14.2±2.37[c]	10.89±2.4[d]	16.85±3.92	< 0.0001
Cond. (mS/cm)	36.2±0.83[a]	33.58±0.94[b]	33.06±0.89[b]	22.54±2.68[c]	19.03±6.13[d]	28.88±7.38	< 0.0001
TDS (ppt)	36.58±1.02[a]	33.41±1.05[b]	35.46±1.28[a]	16.11±1.45[d]	19.48±3.83[c]	28.21±9.02	< 0.0001
COD(mg/l)	50±5.18[a]	46.28±4.99[b]	46.47±4.79[b]	20.49±1.8[c]	16.6±2.73[d]	35.97±15.26	< 0.0001
BOD(mg/l)	1.34±0.82[c]	2.03±0.75[b]	1.78±0.93[bc]	3.48±0.29[a]	3.96±0.02[a]	2.52±0.56	< 0.0001
Transp. (cm)	8.22±5.85[ab]	10.06±1.72[a]	7.44±2.49[ab]	7.28±0.69[ab]	6.2±1.11[b]	7.84±2.28	0.013
TSS (mg/l)	6.04±0.99[c]	5.94±1.02[c]	6.76±0.91[c]	8.17±1.16[b]	10.82±1.61[a]	7.55±2.07	< 0.0001
Phosphate (mg/l)	0.72±0.21[a]	0.71±0.18[a]	0.65±0.12[a]	0.56±0.12[a]	0.57±0.3[a]	0.64±0.18	0.093
Sulphate (mg/l)	164.86±28.08[d]	402.47±11.36[a]	184.09±29.47[d]	279.87±46.36[c]	331.67±43.27[b]	272.59±96.21	< 0.0001
Nitrate (mg/l)	5.39±1.86[a]	1.85±0.46[c]	3.1±0.87[b]	3.29±0.63[b]	3.2±0.96[b]	3.35±0.96	< 0.0001

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