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Seasonal Variation of Physico-Chemical Quality of Sediment from Ikoli Creek, Niger Delta

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ABSTRACT
This study investigated seasonal variation of physiochemical quality of sediment from Ikoli creek, Niger Delta, Nigeria. Triplicate samples were collected from 5 locations between June to August (wet season) and November to December (Dry season) 2015. The samples were collected and analyzed using standard analytical methods. Results for both seasons were pH (6.46 – 7.25), nitrite (0.06 – 0.45 mg/kg), nitrate (2.11 – 3.15 mg/kg), conductivity (134.33 – 600.00 µhmoscm^{-1}), phosphate (0.13 – 0.39 mg/kg) sulphate (0.28 – 1.31 mg/kg), nitrate (0.130 – 0.146mg/kg), calcium (2.53-6.76 mg/kg), potassium (1.07-1.76mg/kg), sodium (1.07-2.84 mg/kg), magnesium (1.21 – 3.82 mg/kg), total hydrocarbon content (2.31-6.81 mg/kg), organic carbon (3.35-8.27%). Apart from pH, there was no significance difference (P>0.05) between both seasons of study for each of the physicochemical parameters studied. Though, significant variation (P<0.05) exists in the spatial variation among all the parameters apart from pH. The findings from the study showed that season do not have significant effect on the physicochemical quality of sediment from Ikoli creek.
Keywords: Bayelsa state, Creek, Sediment, Water quality

INTRODUCTION
Water is an infinite resource utilized by vast number of biodiversity including plant, animals and humans. Water occurs in various forms including solid as ice, liquid as water and gas as water vapour (Akubuenyi et al., 2013; Agedah et al., 2015) and its colorless and odorless liquid in its pure form. Water resources are supplied from surface water (creek, creeklets, lake, pond, stream, river), rain water and groundwater (Izah et al., 2016; Agedah et al., 2015; Izah and Srivastav, 2015). Based on land mass, approximately 70% of the earth surface is occupied by water. Of all the water resources, surface water has the largest surface area and is distributed into marine, estuarine and freshwater. The fresh water is one of the least and is the most utilized water resources apart from transportation. Raut et al. (2011) reported that of all water resources only 2.7% is fresh water. Of these, 1% is ice free water found in rivers, lakes and atmosphere as biological water (Raut et al., 2011; Agedah et al., 2015).

Water is a chemical compound comprising of two atoms of hydrogen and one atom of oxygen which are covalently bonded to form one molecule (Ezekiel *et al*., 2011; Agedah et al., 2015). Furthermore, Ezekiel et al. (2011) reported that water in its pure form has 1 g/cm^3 at 4ºC (density), 760 mmHg (pressure), 0ºC (melting point) and 100ºC (boiling point).

Surface water is also habitat for several fish species and aquatic plants. Macrophytes such as such as *Eichhornia crassipe, Nymphaea lotus, N. maculate, Pistia stratiotes, Salvinia nymphellula, Azolla pinnata var africana, Dryopteris filixmas, Nephrolepis biserrata, Hydrolea palastris, Lemna paucicostata* have been severally reported in surface water in Nigeria (Ohimain and Akinnibosun, 2007, 2008; Ogamba et al., 2015a,b). Among these macropytes, *Eichhornia crassipes* is the most frequently reported aquatic plant found in surface water in Nigeria coastal ways (Ogamba *et al*., 2015a, b). Some of these macropytes such as *Eichhornia crassipes* aid in water purification (Ogamba et al., 2015c). Several fish species have been reported in different surface water in Nigeria by different authors (Izah and Angaye, 2016).

In coastal region, surface water act as dumpsite to several types of municipal wastes (Agedah et al., 2015). Also human wastes are also discharged onto the surface water from the use of pier toilet system (Ogamba et al., 2015d), wastes from abattoir (Ogamba et al., 2015d; Taiwo et al., 2014). These wastes stream has the tendency to alter the water quality parameters including physical, chemical and biological including microbial diversity and density.

The wastes end up in the aquatic ecosystem. The soluble wastes go into solution to form sediment, which can either be suspended and deposited sediment depending on its constituents. Like water quality parameters, sediment quality is also used to assess an aquatic ecosystem. All surface water has sediment.

In Bayelsa state different water bodies have been widely studied with regard to physical and chemical quality of this water. Some of this surface water include Epie creek (Izonfuo and Bariweni, 2001), river Igbedi (Seiyaboh et al., 2013a,b), river nun (Agedah et al., 2015; Nyananyo et al., 2007), Ikoli creek (Ogamba et al., 2015d), Kolo creek (Ogamba et al., 2015b; Aghoghovwia and Ohimain, 2014), Sagbama creek (Seiyaboh et al., 2017), Tombia bridge construction area in Yenagoa metropolis (Seiyaboh et al., 2013b). But information about sediment characteristics is scarce for most of the river.

However, sediment quality has been studied in Igbedi creek (Seiyaboh et al., 2013b), Sagbama creek (Seiyaboh et al., 2017). But information about the sediment quality from Ikoli creek is scares in literature. Hence this study assessed seasonal variation of sediment from Ikoli creek, Niger Delta Nigeria.

MATERIALS AND METHOD

Study area

Ikoli creek is a tributary of River Nun, which is located in Yenagoa, the Bayelsa state capital. Like other seasons in the Niger Delta, the area is characterized by wet season (April to October) and dry season (November to February). The temperature of the area ranged from 24 - 35ºC throughout the year. While the relative humidity ranged from 50 – 95% through the years. The vegetation of the area includes grasses, shrubs and trees such as raffia palm, oil palm etc (Ogamba et al., 2015d). Notable economic activities in the creek are dredging, fishing and navigation. Several wastes from abattoir area discharged into the creek (Ogamba et al., 2015d).

Sample collection and preparation

Triplicate samples of the sediment were collected using Eckman sediment grab from 5 locations including Akaba, Ikoli, Famgbe, Ogbogoro and Ogu for both seasons; i.e June to August (Wet season) and November to December (Dry season), 2015. The samples were wrapped with aluminum fossil and transported to the laboratory in an ice pack. At the laboratory, the samples were air-dried and sieved using mesh.

Physico-chemical analysis of the sediment

The sediment physico-chemical characteristics were analyzed following standard procedure. pH was measured ex-situ as described by Bates (1954). Calcium, magnesium, potassium and calcium were analyzed based on the method previously described by Nwakaudu et al. (2012). Organic carbon was determined by the method of Osuji and Adesiyan (2005) as described by Akubugwo *et al.* (2007). Nitrates, phosphates and sulphates were analyzed based on the method described by Dewis and Freitas (1970). Nitrogen was determined using the method previously described by Udoh and Ogunwale (1986). Conductivity were analyzed based on the method previously described by Aigberua et al. (2016). Total hydrocarbon content was analyzed using following ASTM D 9071B – 7 (Soxhlet Extraction Method).

Statistical Analysis

SPSS was used to carry out the statistical analysis. The mean of the spatial variation was carried followed by one way analysis of variance. Duncan multiple range test statistics was used to determine source of observed difference. t-test was used to show significance difference between both seasons. Test statistics was carried out P=0.05.

RESULTS AND DISCUSSION

The pH values ranged from 6.74-6.87 for spatial variation, being not significantly different (P>0.05) among the various location. Furthermore, there was significance different (P<0.05) between season with a mean of 6.55 (dry season) and 7.106 (wet season). Variation in pH among the various seasons suggests that effect of weather in water pH. During the dry season the water volume decrease compared to wet season when water volume increase due to effect of rainfall and flooding in coastal water ways. The trend in this study is comparable to the work of seiyaboh et al. (2017) on Sagbama creek; Etesin *et al*. (2013) in Iko River. Similarly, on spatial distribution the findings is close to previous work and far based on seasonal variation reported by Seiyaboh et al. (2013) from Igbedi creek. The difference could be due to variation in anthropogenic activities during sampling period.

Table 1: Spatial variation of physico-chemical quality of sediment from Ikoli creek

Parameters	Akaba	Ikoli	Famgbe	Ogbogoro	Ogu
pH	6.82^{ab}	6.74^{a}	6.78^{ab}	6.75^{a}	6.87^{a}
Conductivity, µhmoscm^{-1}	540.83^{d}	206.33^{b}	221.67^{c}	212.67^{b}	124.67^{a}
Nitrite, mg/kg	0.47^{d}	0.14^{c}	0.013^{b}	0.15^{c}	0.06^{a}
Nitrate, mg/kg	3.30^{c}	2.67^{b}	2.23^{a}	2.62^{b}	2.25^{a}
Sulphate, mg/kg	0.70^{c}	0.39^{b}	0.34^{a}	0.83^{d}	0.42^{b}
Phosphate, mg/kg	0.34^{c}	0.14^{a}	0.18^{b}	0.15^{a}	0.14^{a}
Calcium, mg/kg	5.67^{d}	3.34^{c}	2.62^{a}	2.92^{ab}	3.19^{c}
Magnesium, mg/kg	3.09^{c}	1.74^{b}	1.73^{b}	1.77^{b}	1.21^{a}
Sodium, mg/kg	2.36^{c}	1.80^{b}	2.68^{c}	1.18^{a}	1.22^{a}
Potassium, mg/kg	1.57^{b}	1.14^{a}	1.12^{a}	1.50^{a}	1.14^{a}
Total nitrogen,%	2.67^{d}	2.08^{c}	2.65^{d}	1.71^{b}	1.45^{a}
Organic carbon,%	7.27^{c}	5.20^{b}	3.94^{a}	4.95^{b}	3.57^{a}
C:N	2.71^{b}	2.48^{ab}	1.48^{a}	2.89^{b}	2.47^{ab}
Total hydrocarbon content, mg/kg	6.46^{d}	3.92^{c}	3.34^{b}	3.86^{c}	2.46^{a}

Different superscript letters along the row indicate significance difference (P<0.05) according to Duncan statistics

The conductivity values ranged from 124.67-540.83 µhmoscm^{-1}, being significantly different (P<0.05) among the various locations. The seasonal variation were significantly not different (P>0.05) from both seasons with mean value of 284.6 µhmoscm^{-1} (dry season) and 0.454 µhmoscm^{-1} (wet season). The sediment characteristics based on conductivity is an indication of the sediment to convey electrical current. The findings of this study are lower than the values previously reported by Seiyaboh et al. (2017) in sediment from Sagbama creek. The variation could be due to difference in pollution factor.

Based on the anion nutrient composition, their spatial concentration ranged from 0.06-0.47 mg/kg (nitrite), 2.23 – 3.30mg/kg (nitrate), 0.34 – 0.83mg/kg (sulphate) and 0.14 – 0.34 mg/kg (phosphate). Basically, there was significance difference (P<0.05) among the various location for each of the anions based on spatial distribution. However, seasonal influence showed that there is no significance difference (P>0.05) for the various anions under study. Their mean concentration for dry and wet season 0.19mg/kg and 0.17mg/kg respectively (nitrite), 2.702 mg/kg and 1.013mg/kg respectively (nitrate), 0.61 mg/kg and 0.458 mg/kg respectively (sulphate) and 0.204 mg/kg and 0.174 mg/kg (phosphate). The variation in spatial distribution suggests different activities in the river and source through which runoff empties into the creek. Based on seasons, lack variation suggests no difference in activities carried out in the creek at different climatic period of the year. However, the findings of this study are slightly lower than the concentration previously recorded in Sagbama creek by Seiyaboh et al. (2017). Also previous work by Seiyaboh et al. (2013) from Igbedi creek had higher sulphate and lower nitrate and nitrite compared to the

findings of this study. The difference could also be due to differences in anthropogenic activities in the area.

Table 2: Seasonal variation on physico-chemical quality of sediment from Ikoli creek

	Dry season		Wet season		t-value	P-value	Statistical implication
Parameters	Range	Mean	Range	Mean			
pH	6.46-6.83	6.548	7.01-7.250	7.106	-6.646	0.000	SD
Conductivity, µhmoscm^{-1}	134.33-600.00	284.6	115.00-481.67	237.964	0.454	0.662	NSD
Nitrite, mg/kg	0.07-0.45	0.19	0.06-0.39	0.17	0.229	0.825	NSD
Nitrate, mg/kg	2.36 - 3.11	2.702	2.11-3.15	2.46	1.013	0.341	NSD
Sulphate, mg/kg	0.28-1.31	0.61	0.30-0.62	0.458	0.739	0.481	NSD
Phosphate, mg/kg	0.14-0.39	0.204	0.13-0.28	0.174	0.547	0.600	NSD
Calcium, mg/kg	2.53-6.76	3.652	3.10-4.57	3.328	0.375	0.718	NSD
Magnesium, mg/kg	1.21-3.82	2.356	1.22-2.35	1.46	1.889	0.096	NSD
Sodium, mg/kg	1.37-2.84	2.314	1.07-2.51	1.78	1.459	0.183	NSD
Potassium, mg/kg	1.18-1.76	1.308	1.07-1.38	1.144	1.279	0.237	NSD
Total nitrogen,%	1.55-2.81	2.284	1.35-2.53	1.94	0.957	0.366	NSD
Organic carbon,%	3.79-8.27	5.582	3.35-6.27	4.43	1.252	0.246	NSD
C:N	1.55-3.14	2.476	1.42-2.48	2.268	0.589	0.572	NSD
Total hydrocarbon content, mg/kg	2.61-6.81	4.316	2.31-6.10	3.7	0.65	0.534	NSD
NSD= No significance difference; SD=Significance difference							

Based on the cations under study, their spatial concentration ranged from 2.62-5.67 mg/kg, 1.21 – 3.09 mg/kg, 1.22 – 2.68 mg/kg and 1.12 – 1.57 mg/kg for calcium, magnesium, sodium and potassium respectively. Basically, there was significance difference ($P<0.05$) among the various location for each of the cations. Furthermore, there was no significance difference ($P>0.05$) among the seasons of study. However, the mean concentration for dry and wet season ranged from 3.65 mg/kg and 3.328mg/kg respectively (calcium), 2.356 mg/kg and 1.46 mg/kg respectively (magnesium), 2.314 mg/kg and 1.74 mg/kg respectively (sodium) and 1.308 mg/kg and 1.44 mg/kg respectively (potassium). The findings of this study are higher in sodium and lower in calcium, magnesium and potassium compared to the work of Seiyaboh et al. (2013) from Igbedi creek. Similarly the cation concentration was lower than the values previously reported from Sagbama creek by Seiyaboh et al. (2017). Again the variation could be due to difference in anthropogenic activities in the area.

The total nitrogen, organic carbon and carbon: nitrogen ratio ranged from 1.45 – 2.67%, 3.57 – 7.27% and 2.48 – 2.89 respectively. Typically, there was significance difference ($P<0.05$) among the various location for each of the parameters apart from carbon: nitrogen ratio that was not significantly different ($P>0.05$) for spatial variation. Based on seasonal variation, dry and wet season were ranged from 2.284 mg/kg and 1.94 mg/kg respectively (total nitrogen), 5.582 mg/kg and 4.43 mg/kg (organic carbon) and 2.476 and 2.268 (carbon: nitrogen ratio). The concentration of this study is lower than previous work by other authors. Seiyaboh et al. (2013) reported higher organic carbon and total nitrogen in sediment from

dredging area in Igbedi creek. Also Seiyaboh et al. (2017) reported higher organic carbon and total nitrogen in sediment from Sagbama. The variation could be due to difference in among of wastes discharged into the water ways through human activities.

The total hydrocarbon content for the spatial variation ranged from 2.46 – 6.46mg/kg being significantly different ($P<0.05$) among the various location. Furthermore, the mean dry and wet season were 4.316 mg/kg and 3.70mg/kg respectively, being not significantly different ($P>0.05$) among both seasons. The occurrence of hydrocarbon in the water could result from transportation of crude oil via the water way. The total hydrocarbon content is the sediment in this study is higher than the concentration previously reported in Igbedi creek by Seiyaboh et al. (2013). The variation could be due different level of anthropogenic activities in the water.

CONCLUSION

This study investigated the seasonal variation of physicochemical quality of sediment from Ikoli creek. The sediment showed significant variation among the various locations apart from pH in the spatial distribution. Based on seasonal variation, there was no significant different among both season apart from pH. Hence, the study found that seasons do not affect the sediment quality from Ikoli creek. However, differences among the spatial distribution could be due to the effect anthropogenic activities among the different locations

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