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Spatial Temporal Water Quality of the Epie Creek in Niger Delta Region of Nigeria, Using Water Quality Index.

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Abstract: *The compounding problems on the challenges of poor access to potable water in the core Niger Delta region of Nigeria are ignorance, carelessness and the quest for fast profits; which has rendered most if not all natural water bodies into waste sink leaving untold health risk on the end user. This necessitated to the experimental study of the Epie Creek for eight months in two seasons. Water samples for physiochemical and biological parameters were analysed in triplicate from seven sample sites (2km a part) labelled A-G. The analysis shows that DO and phosphate during the wet season; faecal coliform, turbidity and* BOD_5*, in both seasons were above NIS (2015) recommended standards for drinking water; other parameters have suitable condition compared to standard level. At stations A and B, the water quality index during the dry season is class III classification, scientifically described as medium, while the mean water quality of the Epie creek at station "A, B and C" in both seasons also remained class III. At sample stations D, E, F and G, the water quality index during the dry season is classified into class III, scientifically described as medium, however during wet season samples; it is classified into class IV, scientifically described as poor. Furthermore, the overall mean results on the assessment of the Epie Creek water quality in various sampling points classified the Epie Creek into class III, scientifically described as medium; slightly better during the dry season. Hence, water from the Epie Creek should be treated before used to avoid related water born infections. Again, the Epie creek resources should be preserved against pollution, through the implementation of stringent rules and guidelines to enhance health and preserve water resources for future generations.*

Keywords: *Epie Creek, Water Quality Index, Water Quality Classification, Niger Delta, Physiochemical and Biological parameters*

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I. Introduction:

Water is an elixir of life and as such it is described as a blue gold (Gopal, 2007; Navneet, 2010). Water and its systems have a central role in social, economic development, human health and welfare such that several publications and international forum (SDGs) emphasises the need for adequate supply of quality water. The availability of surface and underground water can be a matter of life and death, depending on how it occurs and how it is managed, for when it is too much or too little, it bring destruction, misery or death. Irrespective of how it occurs, if properly managed, it can be an instrument for economic survival and growth (Khalil, Ouarda & St-Hilaire, 2011).

The quality and accessibility of potable water remains a global challenge especially in the rural and semi-rural communities in the developing countries (Ohwo & Abotutu, 2014). In Nigeria, the commonest sources of water supply available to local communities are fast being severed by a number of anthropogenic factors, of which pollution remains the most dominant factor.

In the Niger Delta region, surface and groundwater resources are critical as the only freshwater that is available for drinking, agricultural and domestic purposes is exposed to arrays of contamination, among leading factors is uncontrolled activities of man (Oribhabor, 2015). The compounding problems on the challenges of poor access to potable water in the core Niger Delta region of Nigeria are ignorance, carelessness and the quest for fast profits; which has rendered most if not all natural water bodies into waste sink, since it is theoretically believed that surface water sources has unlimited capabilities to process itself from raw waste which is far from reality considering the quantum of waste been discharged daily into water bodies.

In the light of the above, waste out of sight practice is obtainable in most semi and rural communities; thus, surface water sources is treated with contempt (Ebuete, Bisong, Chukuma, Ndiwari & Ebuete, 2019); causing systematic loss of creeks to over use, diversion or filling (David, Obot & Etim, 2016). It will interest you to know that despite the continues discharged of waste into surface water bodies, habitants still relying on the same water sources for most of their domestic needs, taken solace in the slogan (philosophical saying) of **'DIRTY NO THEY KILL AFRICA MAN"_ '**meaning **Africans are immune to dirt's** leaving an untold health challenges on the end users.

The Epie Creek is one of such inland water bodies in the Niger Delta receiving organic and chemical wastes arising from anthropogenic activities within the catchment area. A clear statements outlining the effect of increasing population and urbanization on water quality since Yenagoa attained the administrative capital of Bayelsa State in 1996. According to Oyadongha (2018), Epie creek was flowing with majestic splendour from the gateway town of Igbogene down to Ovom community before emptying into the Ekole River which was not only navigable all through the year, but also serves as natural drains to the sister communities in the area. Today, the reverse is the case due to urbanization, increasing population and uncontrollable activities of man, which has impacted negatively on the resources utilisation (Bariweni & Amukali, 2017). This study therefore aimed at determining by classifying the water quality of the Epie creek from the source (Igbogene) to the confluence with the Ekoli creek (Ovom) (Fig. 1 &2) in two seasons (dry and wet) using the National Sanitation Foundation Water Quality Index (NSFWQI).

On the whole, numerous studies such as Izonfuo & Bariweni, 2001; Nwankwoala, Udom & Ugwu, 2011; Rim-Rukeh & Agbozu, 2013; Seiyaboh, Inyang & Izah, 2016b; Ben-Eledo, Kigigha, Izah & Eledo, 2017a; Mbha, Ibe & Abu, 2017; Seiyaboh, 2018 had been conducted to asses surface water quality and to establish the extent of surface water contamination due to increasing human activities in the high risk Epie Creek in Niger Delta region of Nigeria, non has successfully classified the water quality status of the Epie creek. In as much as the study of Rim-Rukeh & Agbozu (2013) is commendable using the Malaysian Water Quality Index. However, the review of various water quality indices by Tyagi, Sharma, Singh & Dobhal (2013) and Kachroud, Trolard, Kefi, Jebari & Bourrié (2019) assured NSFWQI of been the best in water quality classification considering the few demerits associated with her used and the consideration on the biological properties (coliform counts) in the analysis process. Hence, the important of this study using the National Sanitation Foundation Water Quality Index (NSFWQI) to classified water quality of the Epie creek.

The National Sanitation Foundation Water Quality Index (NSFWQI) is one of the popular indexes classifying surface water quality that is determined based on Temperature (^oC), Phosphate (mg/l), Nitrate(mg/l), Dissolved Oxygen(mg/l), Total Disolved Solids(mg/l), Biological Oxygen Demand(mg/l), pH, Turbidity(NTU)and Faecal Coliform bacteria(CFU/100ml). The index is considered comprehensive for a qualitative classification of surface water (Kumar&Alappat, 2009; Hoseinzadeh, Khorsandi, Wei & Alipour, 2011; Shokuhi, Hosinzadeh, Roshanaei, Alipour & Hoseinzadeh, 2012).

It has been realized that the use of individual water quality variables in describing water quality for common public is not easily understandable, complex and sometimes misleading (Kazi, Arain, Jamali, Jalbani, Afridi, Sarfraz, Baig & Shah, 2013). However, the NSFWQI has the capability to reduce the bulk of such information into a single value to express the data in a simplified and logical form (Rosemond, Duro & Dubé, 2009; Lumb & Sharma, 2011a). Studies such asWills&Irvine,1996; Kumar & Alappat, 2009; Akoteyon, Omotayo,Soladoye & Olaoye, (2011); Shokuhi, Hosinzadeh, Roshanaei, Alipour & Hoseinzadeh, 2012; Ozlem, Ilker & Mustafa, 2013; Hoseinzadeh, Khorsandi, Wei & Alipour, 2015; Parastar, Jalilzadeh, Poureshg, Hashemi, Rezaee &Hossini, 2015;Misaghi, Delgosha, Razzaghmanesh & Myers,2017; Wu, Wang, Chen, Cai & Deng, 2018; has accredited NSFWQI to have demonstrated annual cycles, spatial and temporal variations in water quality and trends in water quality even at low concentrations in an efficient and timely manner. Hence, the application of NSFWQI in determining the spatial temporal surface water quality of the Epie creek.

The proposed method (NSFWQI) for comparing the water quality at various sample points of the Epie creek water sources recorded and transferred water quality data to a weighting curve chart, where a numerical value of Qi(table3.2) is obtained. The Qi values are further multiplied individually with their respective weight factors given in table 1.1. The nine (9) resulting values are then added to arrive at an overall water quality index figure. The single value is compared to a legend table1.2 for her readings and interpretation. The mathematical expression for NSFWQI is given below:

NSFWQI =∑QiQX.. Equ 1

Where: ∑ = Summation sign

Qi = sub-index for ith water quality parameter

QX= weight associated with ith water quality parameter

Table 1.1: Weighting Factors of Water Quality parameter and Water Quality Index Legend

Parameter	Weight factor
DO (mg/l)	0.17
F. Coli (cu/100ml)	0.16
pH	0.11
BOD_5 (mg/l)	0.11
Temperature (^OC)	0.11
Phosphate(mg/l)	0.10
Nitrate (mg/l)	0.10
Turbidity (NTU)	0.08
TDS (mg/l)	0.07

Source: Ebuete & Ebuete, 2018.

Table 1.2: QWI Classification Legend Table for Interpretation.

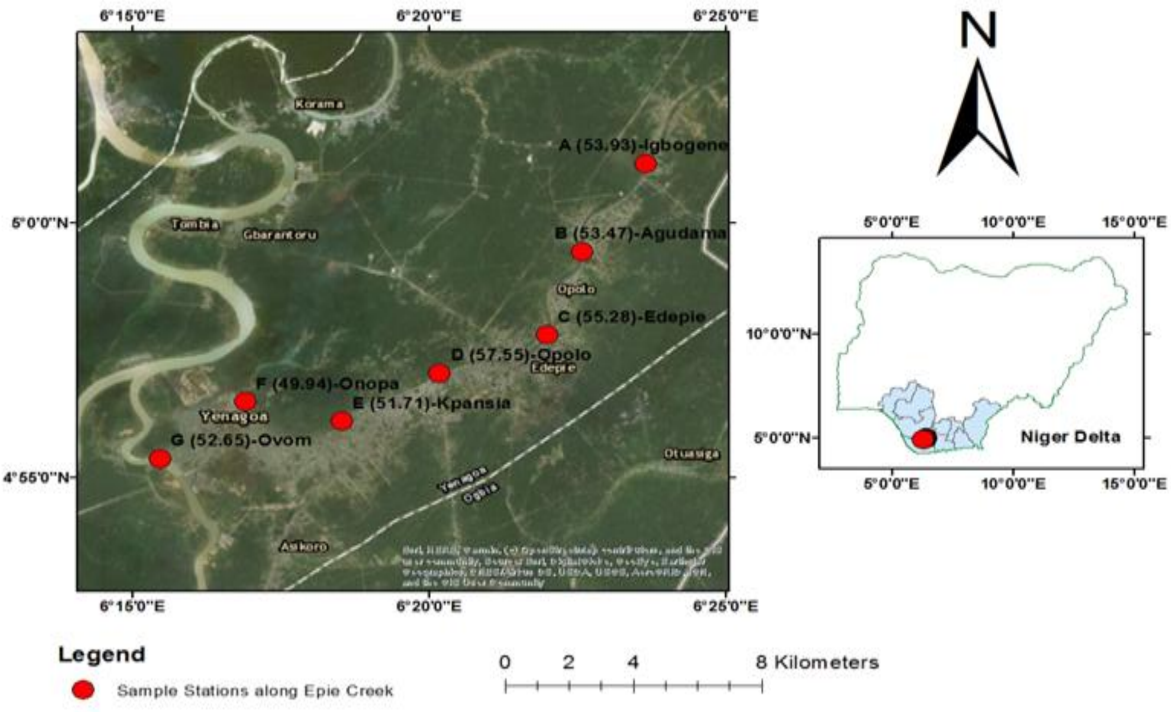
Range	Class	Quality Status
91-100	I	Excellent
71-90	II	Good
51-70	III	Medium
26-50	IV	Bad
0-25	V	Verybad

Source: Kachroud, Trolard, Kefi, Jebari & Bourrié (2019)

II. Materials And Methods

2.1. Study Area

The Epie creek is an important water body which runs (transverses) along the Yenagoa metropolis, the Bayelsa state administrative capital (Figure 1 &2).The creek lies between latitudes 4^{o}50’N to 5^{o}05’N and 5^{o}23'N and longitudes 6^{o}15'E to 6^{o}3'E having links with other creeks such as Taylor and Ekoli creeks (Izonfuo & Bariweni, 2001; Ben-Eledo, Kigigha, Izah & Eledo, 2017b). The creek serves as a receiver of poorly managed wastes given rise to eutrophication (plate 2) inspite of the fact that the creek is used for drinking, bathing, recreational and transportation activities. Several activities are carried out in the creek including dumpsite, fishing, and canoeing/boating, swimming and sand quarry.



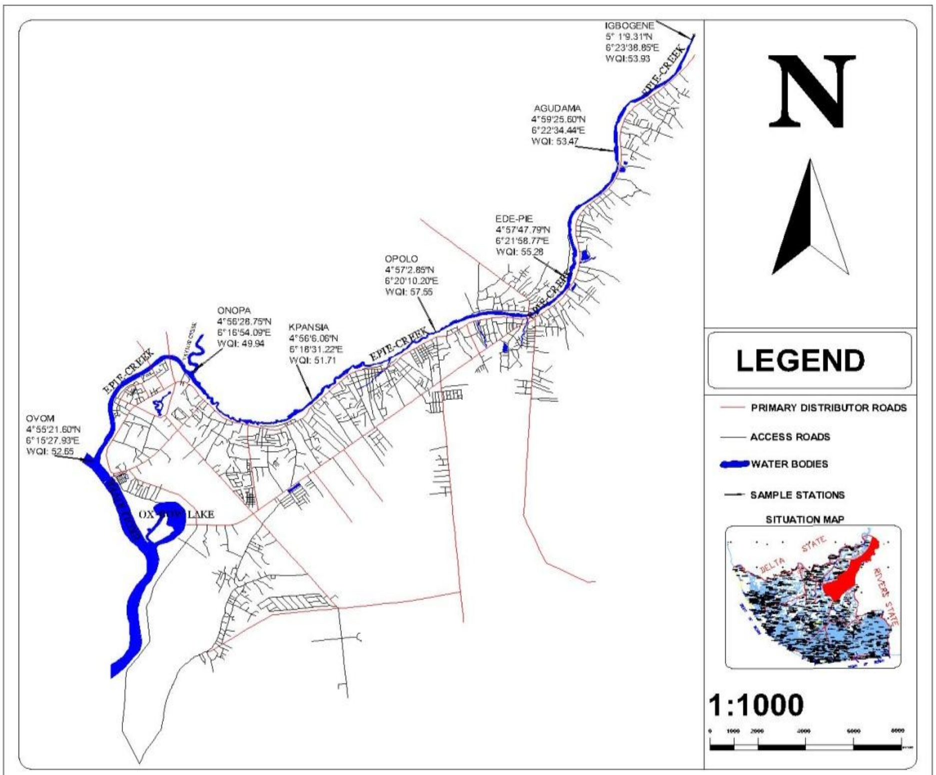


FIG 2. EPIE CREEK SHOWING SAMPLE STATIONS AND WATER QUALITY INDEX

Fig.1. The Epie Creek.

2.2. Sample and Analysis Techniques

To obtain the required information in investigating the water quality of the Epie Creek, water collected at 1.5 meters deep were sampled monthly in seven (7) stations labelled A-G (2km apart) for six months (Dec.2018, Jan., Feb., Aug., Sept. and Oct., 2019) to asses for physiochemical and biological parameters (Fig. 1). Based on locations, there are major market activities, slaughter houses, agricultural activities, residential and commercial buildings aligning the water body.

The samples meant for microbiological analysis were collected with sterile McCartney bottle. Others were collected in a clean 1.5 litre bottle carefully labelled, held at 4 °C in ice cooler box without acid preservation for laboratory analysis. The parameters of temperature (°C), pH and Dissolved Oxygen (DO) (mg/l) were measured *insitu* using boating, HQ40d portable meter, by adopting Hach (2011) and Wolfe (2019) instructions. The coliform (CFU/100ml) quality test was carried out using the three tube methods provided by Benson (2002) and Pepper & Gerba (2005) based on gas production and colour change. Phosphate (mg/l) as explained by Izonfuo & Bariweni (2000), Nitrate (mg/l) (APHA 4500), Turbidity (NTU) (Photometric method) (APHA 2130-B), Total Dissolved Solids (mg/l) (ASTM D 1888-78), Biological Oxygen Demand (mg/l) (BOD_5) (popular Winkler method).

III. Results And Discussion

3.1. Physiochemical and Biological Characteristics of the Epie Creek

Maximum benefits are derived from the use of water when it is within the accepted quality standard mostly determined using physicochemical and biological parameters. In this study, eight (8) physicochemical and biological parameters at various sampling points in two seasons (dry and wet) of the Epie Creek is presented in table 3.1 in compares to the Nigerian Industrial Standard (NIS, 2015).

Table 3.1 Mean Dry and Wet Season physiochemical and biological characteristics of Epie Creek

PARAMETRE	SESAONS	A	B	C	D	E	F	G	∑X	NIS
DO mg/l	DRY	6.9	6.7	6.8	6.5	6.5	6.7	6.8	**6.7**	**3-7**
	WET	9.8	9.1	8.9	7.23	7.01	7.6	7.8	**8.2**	
F.coli	DRY	9.9	10.3	10.5	10.4	11.2	11.0	10.9	**10.6**	**10**
	WET	14.0	14.8	15.5	15.6	15.6	15.2	15.4	**15.16**	
pH	DRY	7.64	7.53	7.37	7.24	7.68	6.77	6.64	**7.27**	**6.5-**

	WET	6.01	6.19	6.53	6.29	6.36	6.48	6.59	**6.35**	**8.9**
BOD_5 mg/l	DRY	84.27	84.29	84.34	84.49	84.50	84.52	84.57	**84.43**	**6**
	WET	73.51	73.63	73.74	73.79	73.43	73.55	73.64	**73.61**	
Tem ^{o}C	DRY	29.72	29.95	29.92	30.06	30.04	30.01	29.88	**29.94**	**20 - 30**
	WET	27.5	27.8	28.27	29.42	28.14	28.03	27.80	**28.18**	
Pho mg/l	DRY	0.26	0.27	0.27	0.32	0.34	0.29	0.28	**0.29**	**0.5**
	WET	1.06	1.20	0.55	1.53	1.40	1.62	1.60	**1.28**	
Nit mg/l	DRY	1.18	1.42	1.53	1.78	1.75	1.72	1.68	**1.58**	**50**
	WET	2.45	2.74	2.96	3.13	3.28	3.43	3.62	**3.09**	
Turb NTU	DRY	33.84	33.86	33.88	33.95	33.99	33.96	33.89	**33.98**	**5**
	WET	41.12	41.44	41.53	42.44	42.62	41.78	42.11	**41.86**	
TDS mg/l	DRY	146.1	146.4	146.6	146.8	147.2	147.4	147.8	**146.9**	**500**
	WET	163.1	163.7	164.3	162.5	162.9	162.8	162.2	**163.1**	

Source: Researcher, 2019; NIS (Nigerian Industrial Standard, 2015).

The amount of Dissolved Oxygen (DO) of the Epie creek during the dry season samples is within recommended standards of 3-7mg/l by NIS (2015), with a mean of 6.7mg/l. However, wet season samples with a mean of 8.2mg/l were above recommended limits, which accounted for 10% seasonal difference. This was a function of rapid in stream uses and increase in water level which has aerated the creek through water turbulence. More so, the waste product of photosynthesis from phytoplankton, algae and seaweed during the day also play advantageous role in DO concentration. Tekenah, Agi & Babatunde (2014) opined that, DO concentration vary with season, location and water depth in a fresh water system and that the higher the concentration of dissolved oxygen, better that water body provided it is below 50mg/l. Izonfuo & Bariweni (2001) also stated that in spite of any dilution effects in the wet season of the Epie creek, the observed seasonal fluctuation may be due to the effect of temperature on the solubility of oxygen in water. At high temperature, the solubility of oxygen decreases while at lower temperatures, it increases.

The mean Faecal coliform counts over the dry (10.6) and wet (15.16) season samples at all stations except at station A were above recommended standards of 10 cfu/100ml (Table 3.1) which accounted for 18% seasonal difference. An indication of recent used of the creek for convenience since most of the inhabitants aligning the creek directly linked their soil and sewage pipes into the creek and the practice of pier toilet systems, while some of the sewage tanks and soakage pits were submerged due to the increasing water level in addition to the unhygienic slaughter practices were animal waste are discharged indiscriminately into the Epie creek (see plate 1,2,3 &4). From the study, there is high risk of water contamination from faecal coliforms on a specific scale and other water quality monitoring parameters on a broad scale. Similarly, Rim-Rukeh & Agbozu (2013) reported mean values of 21.2 - 208cfu/100ml for the Epie creek; Seiyaboh & Kolawole (2017) 7.0-14.0cfu/100ml on the Orashi River along Mbiama town. Recorded values are higher than previous studies reported by Ben-Elodo *et al.* (2017) of 1.55-2.22cfu/100ml; Kigigha, Seiyaboh, Obua & Izah (2018) of 1.81-13.53 of River Nun; Agedah, Ineyougha, Izah & Orutugu (2015) 6.39-6.43 cfu/100ml in Wilberforce Island.

From the results (Table3.1), the surface water quality at the sampled locations is slightly acidic with pH ranging between 6.01-6.59 for dry season while wet season samples range between nearly neutral (6.64) to slightly alkalinity (7.77) which accounted for 7% seasonal differences along the Epie Creek. The mean results obtained over the study period were within the range of 6.5-8.9 as recommended by NIS (2015) for drinking water. The acidic pH during wet season samples may have resulted from humic acid (HA) formed from decaying organic matter which is consistent with the report of the Niger Delta swamp environment noted by Rim-rukeh & Agbozu (2013).The lower values suggested that the acid rain in the region, higher water levels and runoff water mixed with substances from wastewater sewage treatment plant contributed to the parameters in the rainy season, otherwise It could have been neutral or basic. The result is similar with initial studies reported by Izonfuo & Bariweni (2001)(7.46-7.25); Ben-Eledo et al (2017b) (6.52-7.11) on Epie Creek; Ebuete & Ebuete (2018) (7.25±23 - 6.77±42) for Kolo creek; Agedah et al. (2015) (6.53-7.11) in some water in Wilber force Island.

BOD_5 measure the amount of food for bacteria that is found in water. Table3.1 shows the mean BOD_5 recorded during the dry season is 84.43mg/l and73.61mg/l for wet season respectively which accounted for 6.84% seasonal difference. The recorded mean values were above recommended limits of 6mg/l by NIS (2015)(table 3.1), which indicates the amount of biodegradable waste present in the Epie creek resulting from indiscriminate waste dump into the Epie creek and runoff. According to Radojevic & Bashkin (1999) rivers self-purified provided the BOD is below 4mg/l which is non attainable in this study. Similarly, Ben-Eledo et al. (2017b) recorded a range of 65.17-94.95mg/l for dry season and 76.51-85.46mg/l in wet season; Rim-rukeh & Agbozu (2013) reported a range of 12.4mg/l-36.7mg/l for the Epie creek. On the contrary, Izonfuo & Bariweni (2001) recorded lesser value of 4.28mg/l for dry season and 2.25mg/l for wet season respectively for the Epie creek; Ebuete & Ebuete (2018) 0.96mg/l - 0.23mg/l for Kolo Creek.

The mean temperature of the Epie Creek were within NIS (2015)(30ºC) recommended standard during the wet and dry season except at station D, E and F during the dry season (table 3.1). However, seasonal temperature difference accounted 3.02% which were within the range of National Guideline and standards for water quality (20-33ºC) in Nigeria for aquatic life, industrial and agricultural uses NIS (2015). Aghoghovwia and Ohimain (2014) reported that seasonal fluctuation can be observed in water temperature values, lower during rainy season due to climatic conditions and the dilution effect of rain and flood cycles. More so, the high temperature values observed at station D, E and F is as a result of thermal effect arising from the use of the creek water as coolant. On a similar studies, Izonfuo & Bariweni (2001) reported a mean of 29.73^{o}C and 28.27^{o}C for dry and wet season respectively on the Epie creek; Ebuete & Ebuete (2018) 32-28.3 for the Kolo Creek, Agedah et al. (2015) 28.27-29.73 in Wilberforce Island.

Rim-rukeh & Agbozu (2013) opined that nutrient content of water is an indication of the degree of sustainability of the system of primary production and at very high concentration of nutrients such as total phosphate and ammonia nitrogen, eutrophication in river bodies may be possible. The seasonal mean phosphate (mg/l) results obtained from the seven sampled stations range between 0.26-0.34mg/l for dry season and 0.55-1.62mg/l for wet seasons which accounted for 63.06% seasonal difference. On the whole, both season samples were within the NIS (2015) maximum permissible limits of 0.5mg/l for drinking water. The mean phosphate levels of the Epie creek were lower in the dry season (0.29mg/l) than in the wet season (1.28mg/l) (table 3.1) due to runoff water, which has contributed to the significant proportion of the constituents in Epie creek as earlier stated by Izonfuo & Bariweni (2001) with a mean of 0.91-0.33mg/l; Rim-rukeh & Agbozu (2013) (0.73-1.73mg/l) on the Epie creek.

The seasonal mean nitrate results obtained from the seven sampled stations for both seasons were within the NIS (2015) maximum permissible limits of 50gm/l for drinking water (table 3.1). Seasonal sample difference accounted for about 32.34%. The relatively high values obtained during wet seasons are as a result of discharge of organic materials into the water, compounded by runoff. Similar studies on the Epie creek by Izonfuo & Bariweni reported a mean of 0.16 and 0.20mg/l; Ben-Eledo et al. (2017b) (0.90-1.69).Other related reports are Ebuete & Ebuete (2018) (0.86-1.00mg/l) for the Kolo Creek;0.31 mg/l from Taylor Creek (Daka, Amakiri-Whyte & Inyang, 2014); Seiyaboh, Izah & Oweibi (2017) (0.12-0.13mg/l) for Sagbama Creek.

Turbidity is an optical property relating to light adsorption and scattering in water bodies. It is an important parameter because it affects the penetration of sunlight into the water body(Rim-Rukeh & Agbozu, 2013).The water turbidity across sampling points ranged between 33.84 - 33.99and41.2-42.62Nephelometric Turbidity Units (NTU) for dry and wet seasons samples respectively (table 3.1). The mean seasonal samples ranged between 33.98for dry and 41.86 for wet which accounted for 10.39% seasonal difference. Izonfuo & Bariweni (2001) opened that increased turbidity in the Epie creek during the wet season is as a result of high runoff. Samples at all stations were above regulatory limits of 5mg/l (NIS, 2015). The relatively high turbidity accounts for non visibility of river bed from the surface, which may also affect the transmission of light rays of the sun and hence have effect on the bottom dwelling phytoplankton. The higher turbidity values are due to the presence of human activities such as washing of clothes and runoff especially during the rainy season. Similarly, Izonfuo &Bariweni (2001) previously reported a range of 14.89 - 34.7 NTU; 21.5 and 34.7 by Rim-Rukeh & Agbozu (2013); 31.29 - 105.09 by Ben-Eledo et al. (2017b) on the same Epie Creek. Most of the high turbidity values were gotten during sand dredging project at a section of Agudama-Epie and Akenfa town along the Epie Creek.

Total dissolved solid is a measure of the solid materials dissolved in water bodies which included salt, organic material, nutrient and other toxic materials. The mean seasonal Total Dissolved Solids result of 146mg/l and 169mg/l during dry and wet season respectively were within the recommended value of (500 Mg/l) by the National guideline and standards for water quality in Nigeria (NIS, 2015) specification limit for drinking water (table3.1). The seasonal differences between the dry and wet season samples accounted for about 5.22%, suggesting the effects of runoff during the wet season from floodplain (fadama) agricultural activities. On the Epie creek, formal studies like Rim-Rukeh & Agbozu (2013) reported a range between 57.3-187mg/l; Ben-Eledo et. al. (2017b) recorded mean range of174.20-529.60mg/l; in Kolo creek, Ebuete & Ebuete (2018) ranged between 68.5-168mg/l. However, Izonfuo & Bariweni (2001) recoded lesser values ranging between 59.33-35.1mg/l.

Table 3.2: Extracted Qi-values (sub index) from the physiochemical and biological parameters

Parameters	Weight Factor	A	B	C	D	E	F	G
DO mg/l	0.17	4.8	4.6	4.7	4.4	4.4	4.5	4.7
		6.9	6.4	6.2	5.4	5.1	5.6	5.9
F. Coli	0.16	71.5	70.1	69.3	69.1	68.4	68.4	68.8
		66.80	66.92	65.85	65.82	65.82	65.93	65.88
pH	0.11	90.1	91.3	90.3	90.1	89.9	89.5	89.8
		56.5	56.9	68.5	57.8	58.8	64.7	69.2
BOD_5 mg/l	0.11	2	2	2	2	2	2	2
		2	2	2	2	2	2	2
Temp. ^oC	0.11	72.5	71.8	72.1	74.5	74.3	74.1	71.7
		78.9	78.5	77.6	71.1	77.8	77.9	78.6
Phos. Mg/l	0.10	90.2	90.1	90.1	80.3	80.1	39.8	89.9
		40.2	39.9	70.1	35.6	32.7	30.9	30.6
Nitr. Mg/l	0.10	96.6	95.2	94.9	92.6	92.8	93.2	93.9
		90.1	89.6	89.1	80.7	80.2	79.3	78.4
Turb. Mg/l	0.08	49.8	49.9	49.2	48.7	48.3	48.6	49.1

		45.8	45.2	44.7	43.6	44.4	44.1	43.9
TDS mg/l	0.07	79.89	79.82	79.62	79.79	79.64	79.59	79.80
		74.40	74.39	74.25	74.88	74.83	74.84	74.92

Source: Researcher, 2019.

3.2.WaterQualityIndex(NFSWQI) of the Epie Creek

Table 3.3: Seasonal Mean and total calculated Water Quality Index per seasons in all stations

Seasons / Stations	A	B	C	D	E	F	G	∑X WQI
Dry WQI	58.59	58.24	57.98	56.90	56.70	52.68	57.64	**56.96**
Wet WQI	49.26	48.70	52.58	46.20	46.72	47.19	47.68	**48.33**
∑X Season	**53.93**	**53.47**	**55.28**	**51.55**	**51.71**	**49.94**	**52.66**	**52.65**

Source: Researcher, 2019.

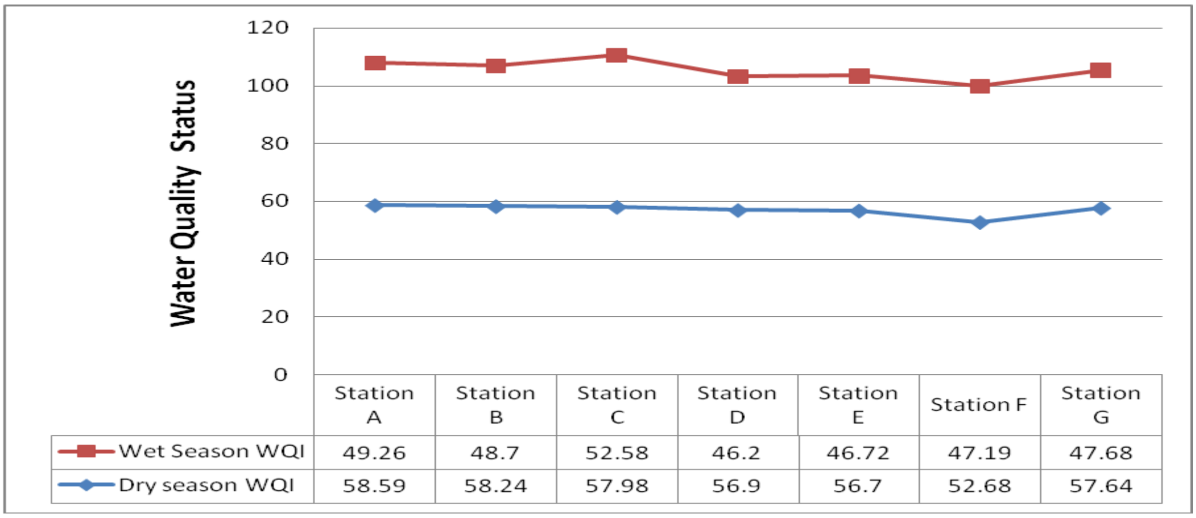


Fig. 3. 3: Wet and Dry Season Water Quality Status of theEpie creek per station

At sample stationsA and B, the water quality index during the dry season is classified into class III, scientifically described as medium, however during wet season samples, it is classified into class IV, scientifically described as poor (figure 2)(table 2.2&3.3) which accounted for 8.65%and 8.92% seasonal difference that is mostly influenced by natural and human factors such as runoff, increased water volume and intense human activities. All the same, the mean water quality of the Epie creek at station "AandB"in both season remained class III (table 3.3; Fig. 2.3).

At sample station "C"the mean water quality of the Epie creek for both seasons is classified into class III, scientifically described as medium. This indicated that the creek at this section has a higher natural purificationstrength despite been served as waste sink. More so, the flowing regime of the creek is also very high at station C, which enables constant flow out of solidandliquid waste material.

AtsamplestationsD, E, FandG,thewaterqualityindexduringthedryseasonisclassifiedintoclassIII,scientificallydescribedasmedium,howeverduringwetseasonsamples,itisclassifiedintoclassIV,scientificallydescribed as poor(table2.2&3.3)whichaccountedfor10.38%,9.66%,5.50% and 9.46%seasonaldifference respectively.These fluctuations isa function of runoff from rainfall,indiscriminate wastes dump, increased water volume that has submerged floodplain agricultural farms, floodplains waste dump site, soakage pits and other related human activities.

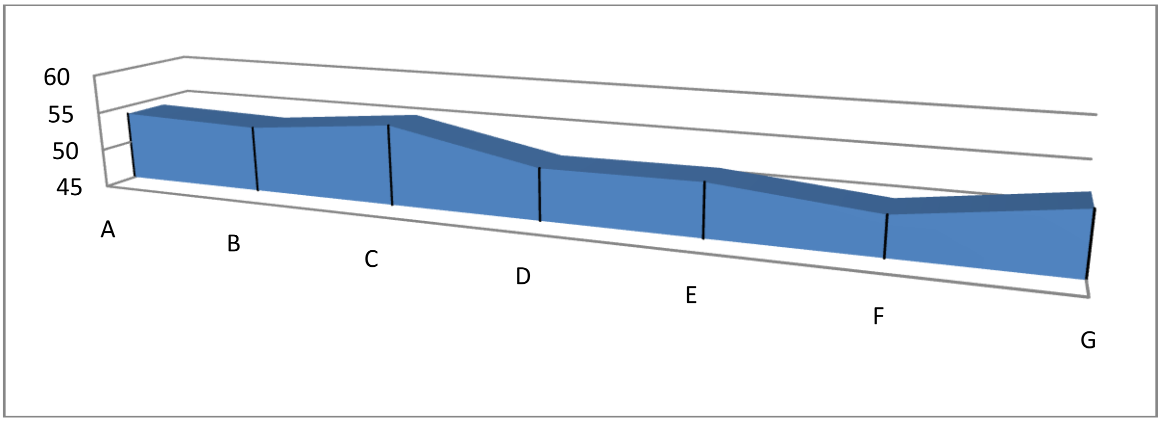


Fig.3.4: Mean Seasonal Water Quality Index of the Epie Creek.

Specifically, on a general classification, the Epie creek is classified into class III, scientifically described as "medium"(table3.3, Fig. 3.4) which is farbetter in quality than previous study by Rim-Rukeh& Agbozu (2013) thatclassifiedthe Epie Creek into class IV, scientifically described as poor. Although, some sections of the creek (A,B,D,E,F& G)during the wet seasons responded to the poor state of the Epie creek, however the general summaryclassified the Epie creek into class III.Recent research has shown that water level is an important parameter regulating the structure and function of natural water ecosystems (Evtimova & Donohue, 2016).Based on the WQI method, our study shows that increased water level and runoff during the dry season has a net negative effect on the water quality of Epie creek at a seasonal scale.

IV. Conclusion

The spatial temporal water quality study of the Epie creek in Bayelsa State, Southern Nigeria has been studied experimentally for two seasons at seven (2km apart) sampled stations (A-G); sequel to the fact that the Epie creek served the purpose for drinking, hygiene and other domestic purposes. The results of the physiochemical and biological parameters of the Epie Creek in this study shows that DO and phosphate during the wet season; faecal coliform, turbidity and BOD_5 ,in both seasons were above NIS (2015) recommended standards for drinking water. Other parameters have suitable condition compared to standard level. Furthermore, results on the assessment of the Epie Creek water quality in various sampling points classified the water quality into class III, scientifically described as medium; slightly better during the dry season. Additionally, the maximum and minimum WQI values were observed in Station A and E respectively. However, spatially and temporarily, narrow variations in WQI were observed among six (6) out of seven (7) sampling sites. This result was likely due to water mobility and increase in water volume in the Epie creek. Since, the Epie creek is connected to the Ekoli River and Taylor creek, these two water bodies may have influenced the spatial and temporal variations in water quality at a certain level of the Epie Creek. The high mobility and rapid exchange reduce the spatial differences in water quality. Finally, the results can be concluded that with wastewater from agricultural activities, gardens, fish farms, construction activities, soakage pits, surface runoff and the resultant wastewater discharge, the Epie creek water quality has declined.

V. Recommendations

- Water from the Epie Creek should be treated before used
- Water resources in the Epie creek should be preserved against pollution, through the implementation of stringent rules and guidelines to enhance health and preserve water resources for future generations.
- The government should muster the political will and commit enough resources to managed and develop the Epie Creek, to serve domestic, tourism purpose, navigational or our environmental (flooding) needs.

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