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Assessment of The Physicochemical Quality of Epie-Creek, Yenagoa, Bayelsa State, Nigeria

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Abstract: This study assessed the physicochemical quality of Epie Creek, Yenagoa, Bayelsa State, Nigeria. The study adopted the survey research design. The purposive sampling technique was employed in the selection of sampling locations. Data were collected from Primary and secondary sources. The physicochemical parameters were determined using standard methods adapted for the examination of water samples. The instruments used were calibrated according to manufacturer's specification. Laboratory results were analysed using simple descriptive statistics and T-test, using SPSS, version 20. Results at different sampling point's shows that Epie creek water is polluted and not suitable for drinking, domestic and recreational uses except it is adequately treated. The study equally revealed that there was significant difference in terms of pollutant concentration during the dry and rainy seasons respectively. This may not be far from the fact that during the dry season, the tide in Epie creek is very low, hence leading to higher concentration, coupled with other factors. The study recommends amongst others that potable water supply for the inhabitants of Yenagoa metropolis should be provided by the government, especially to the natives who live along the bank of the river.

Key words: Physicochemical · Epie-Creek · Drinking · Water and River

INTRODUCTION

Water has always been an essential vehicle for the existence and evolution of living matter in all forms and has always had an important contribution to the society. The role of water and its necessity are both undeniable to human life, plants and animals, as well as its role in providing habitat to aquatic organisms. Water is also useful in industries, commercial, cultural, agricultural and recreational activities in both urban and rural settlements. Potable or wholesome drinking water is a necessary requirement for the health and productive life of humans in any society [1].

The UN Committee on Economic, Social and Cultural Rights declared that, "The human right to water is indispensable for leading a life in human dignity, it is a prerequisite for the realization of other human rights" [2]. Water has been viewed as not only a commercial product but rather a heritage which must be protected and defended (EU Water Framework Directorate, 2009). According to [3], the principal goal of water management globally is to assess and manage the water resources that are available and this is not in exemption of the developing countries.

Yenagoa city, the capital of Bayelsa State lacks adequate municipal water supply. As a result of this, there is heavy dependence on groundwater from shallow boreholes, as the primary sources of water for drinking, domestic and other uses. [4] argued that, reducing unregulated discharge of wastewater and securing safe water are among the most important interventions for improving global public health and achieving sustainable development.

The problem of indiscriminate discharge of untreated wastewater is compounded by ignorance on the part of the people who are unable to identify health risks

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associated with their actions; other fact is the unwillingness of governmental agency to enforce existing laws on proper waste management and the issue of obsolete laws that are fast eroding with the passage of time. It is noteworthy that the discharge of untreated wastewater in Epie-creek poses serious environmental consequences on human health, as well as on the socio-economic and cultural activities. This is so because, the discharge of untreated wastewater would enormously increase the organic load in the water body with a corresponding reduction in dissolved oxygen and the nutrient enrichment may bring about eutrophication with its attendant limiting problem of aerobic organisms. Polluted surface water, resulting from untreated wastewater has the tendency of causing major epidemic and other chronic diseases in human beings.

According to Group Expert on the Scientific Aspects of Marine Protection (2001), contamination of the coastal marine environment by sewage, leads to significant numbers of infectious diseases linked to bathing and swimming in a marine water and to the consumption of sea food. [5] estimates that, bathing in polluted waters causes some 250million cases of gastroenteritis and upper respiratory diseases annually. Water is needed by every society for variety of uses including agricultural, recreational, cultural and domestic uses but if not properly managed, protected and developed, water could serve as an agent of disease transmission and self-supporting ecocide. Thus, this study therefore, seeks to assess the water quality of Epic-Creek.

Geography of the Area

Location: Yenagoa city is the capital of Bayelsa State in the Niger Delta region of Nigeria. It is geographically located between Latitudes 4°51' and 5°01' North and between Longitudes 6°12' and 6°27' East, in the southern part of Nigeria. Bayelsa state and in particular Yenagoa metropolis, is a low-lying environment, which slopes toward North-South direction to the sea.

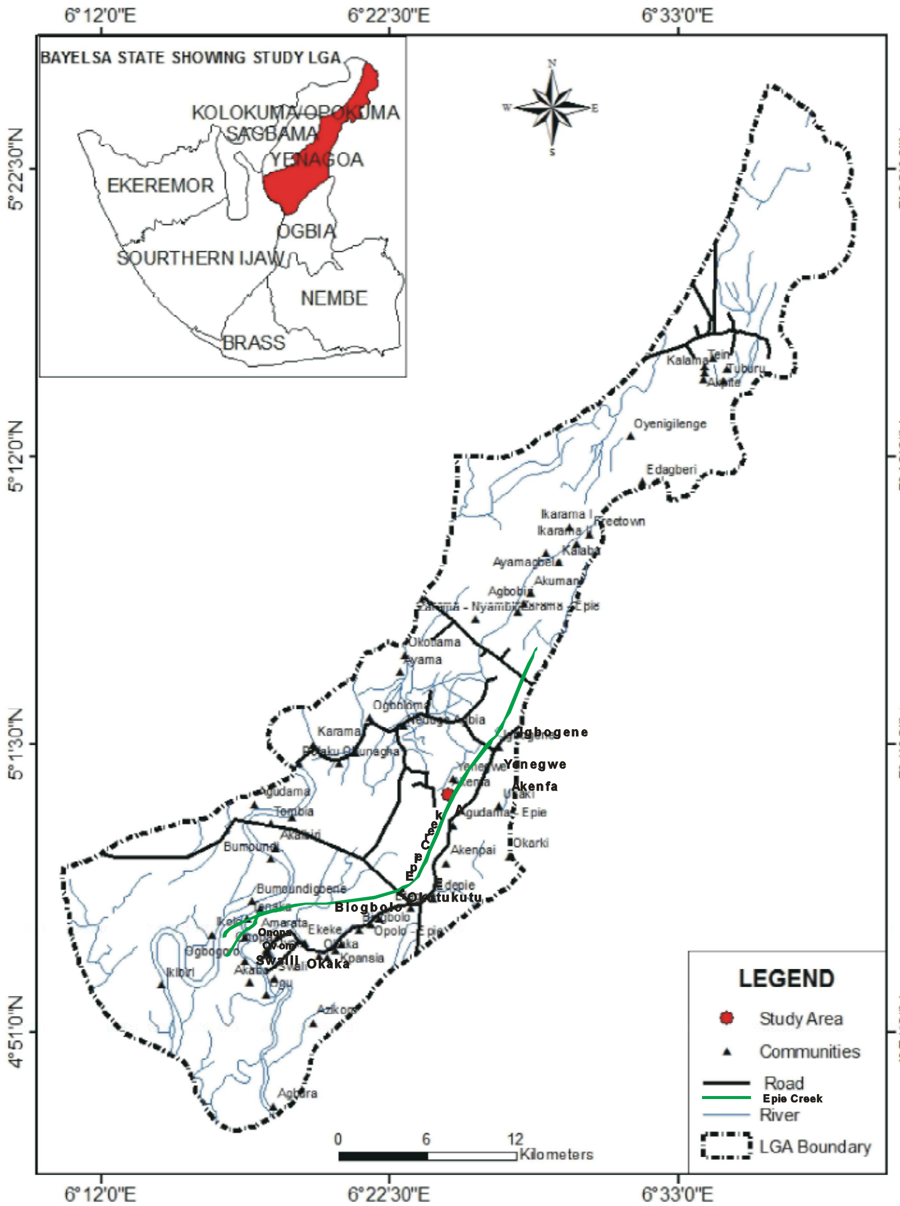
Climate and Vegetation: The study area has a tropical climatic condition. The mean monthly temperature ranges from 25°C to 27°C with a range of 2°C between wet and dry seasons [6]. The hottest months are December to April and the relative humidity is high throughout the year decreasing slightly in the dry season. The rainfall varies in amount from one area to another. The vegetation falls within the fresh water swamp forest, comprised of evergreen trees, small climbers, epiphytes, shrubs and grasses, as well as other economic trees like *Elaeis guineense* (oil palm trees), *Raphia hooker* (Raffia palm), *Irvingia gaboneense,* etc.

Soil and Geology: The soil is mainly deltaic in nature comprising of mainly loamy and alluvial soil, close to the River Bank [7]. The soils of the coastal plain are rich in topsoil nutrients and best for planting crops such as cassava, etc.

Hydrology and Drainage: The natural drainage system of Yenagoa metropolis is characterized by creeks and swamps crisscrossing each other as they flow through the Epie Creek and finally empties to the Atlantic Ocean through River Nun. Epie creek runs from Orashi River up North to Yenagoa River down South. In addition, the area is rich with streams and ponds which are hosts to fishes, reptiles and hydrophytes such as water Hyacinth (*Eichhornia crasspes),* water lettuce (*pistiastraliotes)* among others.

Socio-Economic and Cultural Activities: Epie Creek is used for various socio-economic and cultural activities, ranging from fishing and agricultural activities at the bank of the creek, canoe racing and recreational activities like bathing and in rare occasions, it is used in processing food items by the natives. Therefore, discharging of untreated wastewater into the creek is a direct abuse and negation of the proper use of this environmental resource, for the development and betterment of society as it concerns Yenagoa city. As a result of its well-endowed natural oil and gas resource deposits, the area plays host to multi-national companies such as Shell Multi-National Petroleum Company at Gbarin oil and gas flow Station. With these naturally abundant resources, it equally serves as a hub of other ancillary economic activities as artisanship which service the oil companies.

Method of Study: The study adopted the survey research design. The population of the study consists of Epie Creek from where water samples were collected. The purposive sampling technique was employed in the selection of sampling locations. This was based on observed land use and anthropogenic activities around the creek. Five sampling locations were therefore, selected for this study, namely, Akenfa I, Akenfa III, Okutukutu, Amaranta and Ovom. Data were collected from Primary



and secondary sources. Primary data for this study includes results of water sample analysed across the study locations, field measurements and precautionary measures to ensure sample integrity. Secondary data were sourced from journals, textbooks, maps and internet sources.

Research Instruments: The instruments that were used in this work are; p^H meter, Crucible, Oven, Desicator, Analytical balance, Wash bottles, Magnetic stirrers, Distongs, Spectrophotometer, HACH DR/2010 type, Electrometric meter, Turbid meter (NTU), H183200 multiperameter for Nitrate, Pipettes, Beakers, H183200 multiperameter bench photometer-for phosphate, Polyethylene bottles, Hand glove, Coverall, Plastic bottle with ices park.

Data Collection Procedure: Surface water samples were collected once in December and June (representing dry and wet seasons), between 6.00am -7.00am. At each sampling site, the time of collection, date and name of the location were taken and indicated on sample bottles. pH and DO were determined *in-situ* due to their volatile nature. All necessary measures to ensure quality assurance and quality control were observed in terms of preservation, storage and transportation. Properly rinsed 100cl polyethylene bottles were used in the collection of the water samples at randomly selected areas (five points) within the study locations. The polyethylene bottles were submerged to the depth of about 15cm - 20cm with the mouth facing toward the water current. The bottles were capped immediately and placed in cooler box with ice storage container and taken to the laboratory within twenty-four (24) hours.

Laboratory Procedure: The physicochemical parameters were determined using standard methods adapted for the examination of water samples. The instruments used were calibrated according to manufacturer's specification. The parameters measured were; Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Total suspended solid (TSS), Total dissolved solid (TDS), Turbidity (NTU), Sulphate, Nitrate, Phosphate and Lead.

The p^H was measured using p^H meter with glass electrode, Total Solids (TS, mg/l) was analyzed using the gravimetric method. The total solids are made up of dissolved solids (DS) and suspended solids (SS). Dissolved Oxygen (DO, mg/l) was determined using DO meter. Biochemical Oxygen Demand (BOD, mg/l) was determined by measuring the dissolved oxygen (DO) of the samples contained in a BOD bottle before and after five days of incubation at 20°C.

Turbidity (NTU) was determined by photometric method using HACH DR/2010 spectrometer at a wavelength of 860nm and programme number 750. Nitrate (mg/l) was determined by cadmium reduction method using HI83200 multiparameter bench photometer at a wavelength of 525nm. Phosphate was determined by amino acid methods using HI83200 multiparameter bench photometer at a wavelength of 525mm. Sulphate was determined by turbid meter method using HI 83200 multi parameter bench photometer at a wave length of 466 nm. Lead was determined using Spectrophotometric Method.

Data Analysis Techniques: Results of the samples from the laboratory were analysed using simple descriptive statistics such as range, mean, standard deviation and tables. T-test was used to test for the level of significant differences at 0.005 alpha level in the means of water quality parameters obtained from the different seasons using SPSS, version 20.

RESULTS AND DISCUSSIONS

The results of laboratory analysis of water samples collected from Epie creek are presented and analysed in Tables 1 and 2.

pH value; Dissolved oxygen (DO) & Biochemical Oxygen Demand (BOD_5): pH is the indicator of acidic or alkaline condition of water status. The pH value of unpolluted river is neutral or slightly alkaline. The standard of pH value as recommended by WHO for any purpose is 6.5-8-5mg/l, anything below or above this level is unhealthy for aquatic organisms and for human use. In this study, pH values ranges from 5.8mg/l to 6.4mg/l and 6.0mg/l to 6.5mg/l in both dry and rainy seasons respectively. During rainy season, pH values were within recommended limits apart from sample stations 2, 3 and 4 (see Table 2) which were slightly lower than the recommended limits. The reason for this could be due to the high tide during rainy season. For the dry season samples, pH values were slightly acidic when compared with the WHO recommendation value. This may not be far from the low tide that is normally observed during the dry season in Epie creek.

Table 1: Physicochemical Properties of Epie Creek (Dry Season)

Parameters	SPL 1	SPL 2	SPL 3	SPL 4	SPL 5	Mean values	Std. Dev.	WHO std.
pH	6.0	5.8	6.2	6.3	6.4	6.1	0.2	6.5- 8.5
DO (mg/l)	1.30	1.0	1.20	0.80	2.0	1.3	0.5	80-120
BOD (mg/l)	208	185.2	170	168.4	108	169.9	37.1	20 - 60
TSS (mg/l)	392	358.4	350	296.4	132.6	305.9	102.8	150
TDS (mg/l)	507.5	498.7	386.2	344.8	252.6	398.0	107.5	1000
Turbidity (mg/l)	25.6	28	19.2	22.5	15.6	22.2	4.95	5
Sulphate (mg/l)	8.6	9.20	7.5	6.5	3.5	7.1	2.2	0.04
Nitrate (mg/l)	9.90	9.5	10.28	12.00	9.40	10.22	1.06	5
Phosphate (mg/l)	4.20	6.00	8.5	6.5	2.5	5.5	2.3	5
Lead (mg/l)	0.02	0.01	0.00	0.1	0.1	0.05	0.05	0.05

Table 2: Physicochemical Properties of Epie Creek (Rainy Season)

Parameters	SPL 1	SPL 2	SPL 3	SPL 4	SPL 5	Mean values	Std. Dev.	WHO stds. For domestic use.	Diff. in mean values of both seasons (p-values)
pH	6.5	6.0	6.4	6.4	6.5	6.4	0.2	6.5 - 8.5	0.04
DO (mg/l)	1.38	0.50	1.40	0.96	2.40	1.3	0.7	80 - 120	0.68
BOD (mg/l)	186.3	176	172	179.4	98	162.3	36.4	20 - 60	0.37
TSS (mg/l)	320	315.4	330	285.4	108	271.8	93.0	150	0.03
TDS (mg/l)	486	492.4	347	325.5	224	375.0	114.2	500-1000	0.01
Turbidity (mg/l)	24.5	26.2	18.0	20.34	16.5	21.1	4.2	5	0.11
Sulphate (mg/l)	8.00	7.72	6.00	5.70	2.01	5.9	2.4	0.04	0.004
Nitrate (mg/l)	5.81	5.1	5.01	4.4	3.5	4.8	0.9	5	0.001
Phosphate (mg/l)	3.81	5.80	6.20	7.6	0.32	4.7	2.8	5	0.29
Lead (mg/l)	0.01	0.00	0.00	0.1	0.00	0.02	0.04	0.05	0.29

Note: The following applies to both Tables 1 and 2.

SPL = Sample; Std. Dev. = Standard Deviation; SPL 5 = Upstream

SPL 1 = Ovom Community

SPL 2 = Amarata Community

SPL 3 = Okutukutu Community

SPL 4 = Akenfa 1 Community

SPL 5 = Akenfa 111 Community

In the dry season, Dissolved oxygen (DO) ranged from 1.0mg/l to 2.0mg/l across all sample stations while that of rainy season ranged from 0.50mgl to 2.40mg/l (see Tables 1 & 2). BOD_5 varied from 108mg/l to 208mg/l and 98mg/l to 186.3mg/l for the dry and rainy seasons respectively. The presence of BOD is an indication of pollutant in the river and therefore affects water quality depending on the level of BOD found in the water. This also underscores the fact that dissolved oxygen is needed to breakdown the biodegradable materials, hence, this will lead to the depletion of oxygen in that water body. Looking at the result recorded across the sample stations, it shows that biochemical oxygen demand (BOD) is high given rise to the very low dissolved oxygen (DO) as a result of the high demand by biodegradable organisms.

The poor oxygen content in the River could result in the death of fishes and other aquatic animals. BOD_5 has been used as a measurement in determining the degree of organic pollutants of water. From the study, it was observed that the areas with high population density (Amarata and Ovom) has very low DO level because of increased human activities. In all the sampled stations, the results are far below the WHO recommended standard, hence, this will affect aquatic life and socio-economic activities of the inhabitants who primarily make use of the creek for various economic activities and domestic uses.

Turbidity, Total Dissolved Solids (TDS) & Total Suspended Solids (TSS): Turbidity is the cloudiness and haziness of a fluid caused by individual particles (suspended solids) that are generally visible to the un-aided eye. From the result obtained, turbidity in all sample stations ranges from 15.6mg/l to 28mg/l for the dry season while that of the rainy season recorded 16.5mg/l to 26.2mg/l. The results in both seasons indicate that turbidity level was far above WHO recommended unit of 5mg/l (NTU). This may affect the transmission of light-rays of the sun and hence have effect on the bottom dwelling phytoplankton. The high turbidity values could be attributed to the presence of decaying organic matter and runoff especially during the rainy season and that of low tide in the dry season.

Total dissolved solid (TDS) are the total amount of mobile charged ions, including salts, minerals and metals dissolved in water. The TDS levels in this study falls between 252.6mg/l and 507.5mg/l for the dry season while the rainy season recorded 224mg/l to 492.4mg/l. The recommended unit for surface water ranges from 500mg/l and at most 1000mg/l as the case may. The study shows that only sample station 1 (Table 1) is above the recommended unit. The high TDS observed during the dry season can be linked to the low tide in the dry season.

Total suspended solids (TSS) comprises of organic and inorganic materials that are carried along by water as it runs off the land and contribute to the turbidity of a water body. The result obtained in the dry season ranges from 132.6mg/l to 392mg/l, while that of the rainy season recorded 108mg/l to 330mg/l. WHO limit for TSS in terms of inland water is 150mg/l. A close look at the results shows that both seasons recorded high levels of TSS across the sample locations with the exception of sample station 5, which is the upstream. This can affect the aquatic life such as fishes, as suspend solid may clog fish gills, resulting in either death or reduction of growth rate. It can equally impede the penetration of light thereby reducing the ability of algae to produce food and oxygen.

Nitrate, Sulphate and Phosphate: Nitrate is one of the nitrogen compound that serves as nitrifies to plants. Increased concentration of nitrate in the aquatic environment triggers growth of water hyacinth and eventually lead to a condition known as eutrophication. Result of nitrate concentration in the study shows that dry season results falls between 9.40mg/l to 12.00mg/l while that of the rainy season recorded 3.5mg/l to 5.81mg/l. Judging from the results in both seasons, dry season indicates that the concentration of nitrate is higher than WHO recommended limit of 5mg/l, while only station 1 (rainy season) exceeded the WHO recommended limit. Hence, the excessive growth of water hyacinth in the creek.

Sulphates are organic elements that are useful to several aquatic microscopic organisms which help stimulate their growth. So, increased sulphate leads to rapid growth of organisms that aids food chain right from the level of algal growth. In the present study, the result of sulphate concentration in the dry season ranges from 3.5mg/l to 9.20mg/l (Table1), while the rainy season recorded 2.0lmg/l to 8.00mg/l. At all the sample stations in both dry and rainy seasons across the study area shows that concentration of sulphate exceeds the WHO recommended limit of 0.04mg/l, hence the attendant growth of water hyacinth.

Phosphate stimulates growth of plankton and other aquatic plants which serves as food for fishes, but excess of phosphate in the body of water triggers rapid growth of algae and other aquatic plants. This will also lead to depletion of oxygen as organisms will need more oxygen for productive activities. Results in for phosphate in this study for the dry season ranges from 2.5mg/l to 8.5mg/l. while the rainy season recorded, 0.32g/l to 7.6mg/l. only sample stations 1 and 5 were slightly below the WHO recommended limit of 5mg/l.

Lead is a highly toxic heavy metal that causes environmental and health problems because of its stability in contaminated site and complexity of mechanisms in biological toxicity. It's particularly dangerous for children leading to mental retardation when it exceeds normal concentration in the body fluid. Lead concentration in the present study ranges from 0.00mg/l to 0.02mg/l and 0.00mg/l to 0.1mg/l in both dry and rainy seasons respectively. The study indicates that sample station 3 (Table 1) and sample stations 2, 3 and 5 (Table 2) shows no trace of lead concentration, while the highest point of lead concentrations were recorded in sample stations 4 and 5 (Table 1) during the dry seasons. However, the results shows that only in sample stations 4 and 5 (dry season) and station 4 (rainy season) that recorded an increase in concentration beyond the recommended limit of WHO.

Recommendations: Potable water supply for the inhabitants of Yenagoa metropolis should be provided by the government, especially to the natives who live along the bank of the river. The Epie creek should be dredged and de-silted to allow easy flow of water and other navigation activities.

CONCLUSION

The water quality of Epie creek was laboratory tested and analyzed. This is sequel to the fact that Epie creek serve a number of purposes. Based on the results obtained from the laboratory, Epie creek water is polluted and not suitable for drinking, domestic and recreational uses except if adequately treated.

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