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Locational Analysis of Surface Water Quality, Sediment and Dredge Spoil At Nembe, Bayelsa State-NIGERIA

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Abstract

The objective of this research was spatial characterization of the biological and physico chemistry of the surface water, sediment and dredge spoil samples from the Dredging activity at Obama creek in Bayelsa State. A total of nine (9) samples were collected, four (4) from surface water and the other four (4) from sediment samples from dredging station, 200m upstream/downstream and 500m-800m, away from the reference location and one (1) sample of dredge spoil. GPS receivers was used to capture coordinates of monitoring stations. ArcGIS 10.2 used for processing of locational data. Surface water outcomes at the four stations with pH of 6.22 to 7.38. Conductivity values are from 62.0 to 78.0µS/cm and other sample parameters as shown in the table of results. The Heavy metals are Cd, Pb, and Cr, and had values from 0.011 to 0.026mg/l, 0.119-0.128mg/l, and 0.064 to 0.092mg/l respectively. Ni recorded values are from 0.061 to 0.072mg/l while Zn values are from 0.194 to 0.232mg/l. Total and Faecal Coliform ranged from <2.00 to 30.0MPN/100ml and <2.00 to 23.0MPN/100ml respectively. Sediment and Dredge Spoil at five stations of pH values are from 5.40 to 6.97. Conductivity values are 170 to 306µS/cm while Salinity values ranged from 0.048- 0.086ppt. Heavy metals and other results are as shown in result tables. Based on the laboratory analyses results, impact on the biological characteristics and physico chemistry of the environment is minimal. Monitoring the pollution of Water (inland Rivers, lakes and streams) will ensure sustainable environmental development. This study shows once again that environmental data should be combined with location data to formulate decisions in terms of physical planning for sustainable resource management.

Keywords: Environmental Monitoring, Bio-Physic-Chemistry, Water Pollution, Obama Creek, Geodata

Introduction

It is known that the need to know the interactions of human and environment better as a result of the experience of anthropogenic climate change and its effects (Eludoyin et al, 2011; Papila, et al., 2019). Environmental monitoring activities with relevance to Agenda 21 of the Rio Earth Summit and the Kyoto principles address deforestation, desertification, air, soil and water pollution, erosion, meteorology and climatology as some of the key issues (Gazioğlu, et al., 2013; GAF, 1999).

Ecologically, the environment is view as the physiochemical parameters of the habitat (Gazioğlu, 2018; Ülker et al., 2018). Ecology is the science of pant and animals in relation to their environment. Water bodies provide water for both domestic and industrial uses for man (Simav et al., 2013; Nkwo, 2001). The physiochemical parameters of water surface are the environmental indicators study in this work (Gazioğlu et al., 2010-2013). According to GAF (1999), the task consists of monitoring changes to the environment is by observing s environmental indicators over time. Environmental indicators are tools used to measure progress towards long-term sustainability and are observed simultaneously to economic and social indicators. These indicators supply decision-makers with answers to the four basic questions about the environment (GAF, 1999);

- What is happening?
- Why is it happening?
- Is it significant?
- What has to be done about it?

Location technology, in addition to aiding data gathering and data management, allows the introduction of more adequately representation of information. Point data allows results to be presented in the form of an advanced integrated framework (maps) in support of environmental reporting and policy implementation (Balkıs, et al., 2010). Due to the environmental insensitivity of oil surveys in inland waters and rivers, it results in water pollution in the Niger delta. Water pollution has thus become a limiting factor in the sustainable development of a number of countries including Nigeria. Dredging activities unbalanced the water ecosystem, thus environmental monitoring of demobilization phase of such project very useful in answering the above four questions.

There were the needs to sweep and dredge Obama creek for the passage of the marine boat and other oil and gas marine transport activities. The Obama creek was be

dredged to a depth of 3m and generate a total of 35,950 m3 of dredged spoils using a Suction Dredger.

The environmental monitoring was to determine the impact of the Dredging activity on the biological characteristics of dredge spoils, surface water and sediment samples at the dredging point including the upstream and downstream on the environment. Environmental Monitoring of biological and physico chemistry characteristics of the surface water, sediment and dredge spoil samples after demobilization from the Dredging activity at Obama creek in Bayelsa State is the aim of this work. The objectives for this study were;

- Acquire geospatial data of monitoring locations
- Sampling of surface water, sediments/soil and dredged spoils at designated points and
- Conduct analytical assessment on the collected samples.

Study Area

The study area, Obama creek, is in Nembe South Local Government Area of Bayelsa State. Obama creek lies in the freshwater swamp forest characterized by thick forests belt and low lying lands which are subject to seasonal flooding.

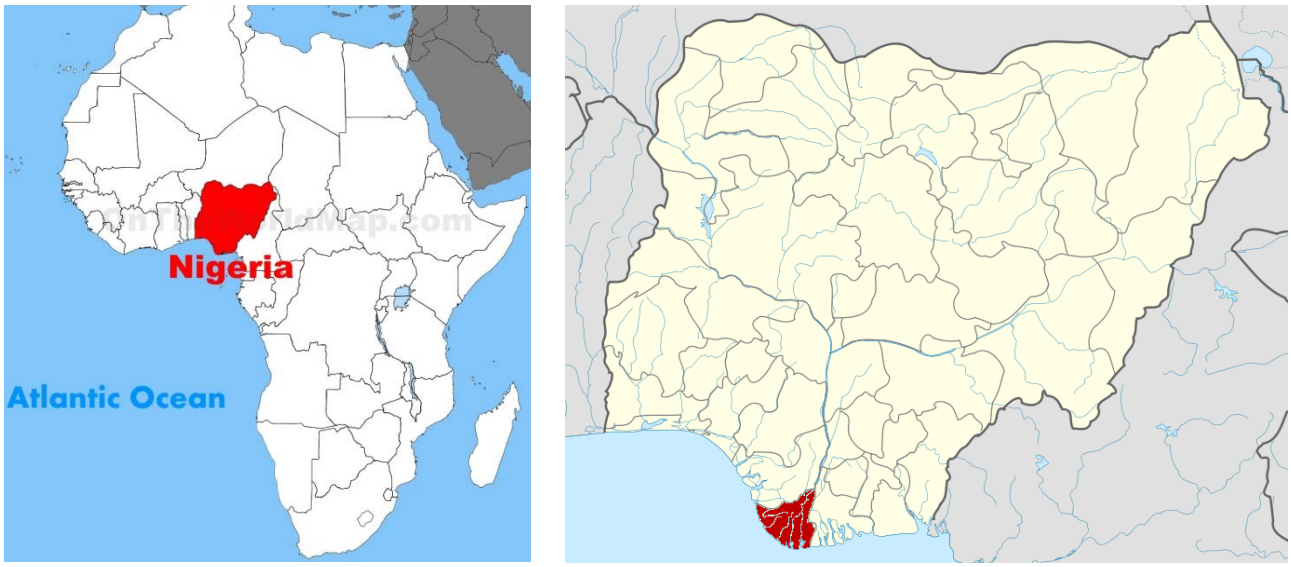

Figure 1-2. Map of Nigeria with location of Bayelsa State

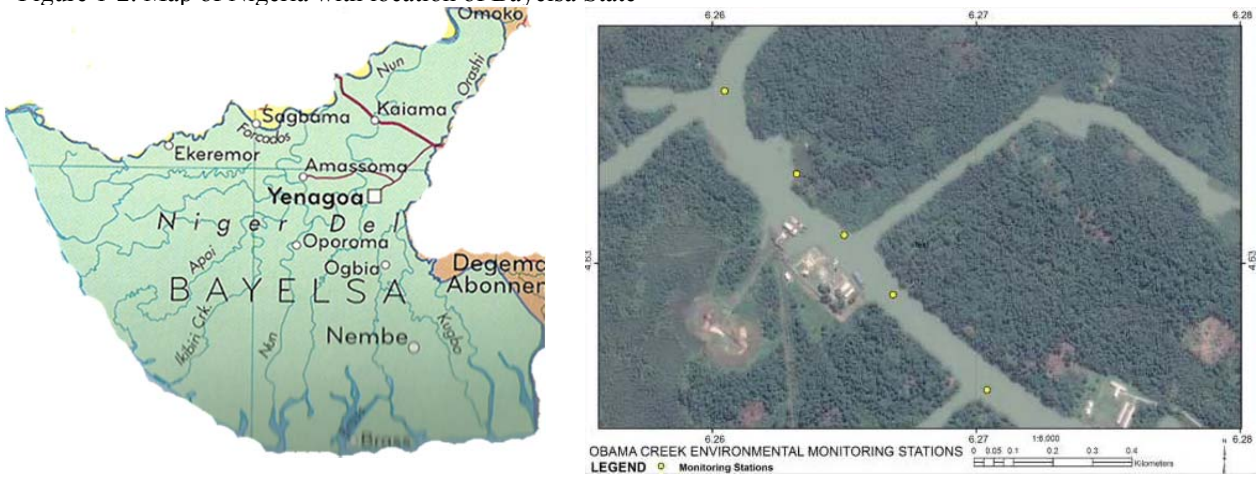

Figure 3. Study area.

It is criss-crossed by creeks/creeklets, which receives some tidal water from the Atlantic Ocean through the southern axis. Thus, in most parts, it is a large expanse of freshwater or riparian forest. However, in the southern axis, patches of mangrove occupy the flanks of the creeks ecosystem. Obama creek is within the Niger Delta (Bayelsa state) humid tropical zone that is defined with dry (usually November to March) and rainy (around April to October) period (seasons). The Nigeria southern rainy season comes from the Southwest trade ocean current (wind) from the coast of Atlantic Ocean. Oguntoyinbo and Hayward (1987) describes study area as dry, mostly dusty and with cold Northeast trade wind moving from the northern desert (Sahara) and dominates the dry period and comes with little harmattan season. The Niger Delta relative humidity is high within January to July with percentage values of 70 to 80. According to Gobo (1998), the area average atmospheric temperature is 25.5 °C during the rainy period and 30 °C in the dry months.

Materials and Methods

Various equipment and material was used. In addition the table 1 below , GPSmap 60CSx was used to capture GPS coordinates of samples location. Basically, Satellite imagery was downloaded from Google earth professional edition desktop software. GPS receiver was used to capture the longitude and latitude of the sample parameters location. The sample parameters was collected using appropriate equipment (see table 2) and results were analysed. The satellite imagery was then geo-referenced in ArcGIS 10.1. Global positioning systems received using laboratory methods. The analytical results were presented in samples and geo-database tabular data format (see figure 4 for methodology flowchart).

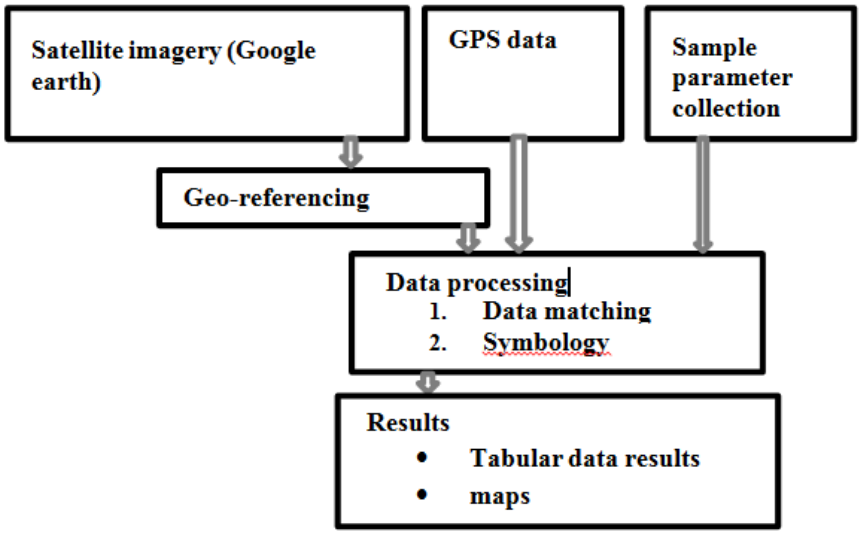

Figure 4. Methodology flowchart.

Table 1: List of Equipment

S/N	Equipment/Materials	Uses
1.	Horiba Multi-meter	In-situ Water Measurement
2.	Ice Chest	Storage of water samples
3.	Coolers	Storage of samples and preservation
4.	Plastic Bottles (500ml)	Collection of Water for physico-chemistry
5.	Amber-colored bottles (250ml)	Collection of water for Microbiology test.
6	1L glass bottles	Collection of water for Hydrocarbon
7	100ml sample bottles	Water for heavy metals
8	Hand Gloves (disposable, latex & chemical resistant)	For hand protection
9	Markers/masking tapes/Labels	Identification of Samples
10	Sulphuric Acid	Preservation
11	Nitric Acid	
12	PPEs	Field Work / Personnel Protection

**PPEs: (safety shoe, helmet, ear- muffs, life jacket, fisherman suit)*

Table 2: Standard Test Methods used for Laboratory Analysis

Parameter	**Methods**	**Equipment Name**
pH	APHA 4500-H+ B	HANNA Multi-parameter Meter
Temperature	APHA 2550 B	HANNA Multi-parameter Meter
Turbidity	APHA 2130 B	DRT-15CE PORTABLE TURBIDIMETER
Dissolved Oxygen	Electrometric	HANNA Multi-parameter Meter
Conductivity	APHA 2510 B	HANNA Multi-parameter Meter
Salinity	APHA 2520 B	HANNA Multi-parameter Meter
Total Dissolved	Electrometric	HANNA Multi-parameter Meter
Total Suspended	APHA 2540 D	HACH DR 2000 UV- Spectrophotometer
Sulphate	APHA 4500-SO42- E	HACH DR 2000 UV- Spectrophotometer
Phosphate	APHA 4500-P. C	HACH DR 2000 UV- Spectrophotometer
Nitrate	APHA 4500- NO3-- E	HACH DR 2000 UV- Spectrophotometer
Chromium	ASTM D 1687	Shimadzu AA - 6650/Hydride Generator
Lead	ASTM D 3559	Shimadzu AA - 6650/Hydride Generator
Zinc	ASTM D 1691	Shimadzu AA - 6650/Hydride Generator

Table 3: the coordinates of collected samples

S/N	**Sample ID**	**Longitude**	**Latitude**
1.	200m Up stream	6.264277778	4.633916667
2.	Dredging Point	6.265916667	4.632027778
3.	200m Down Stream	6.268111111	4.629277778
4.	500m-800m	6.270250000	4.627111111
5.	Dredging spoils	6.267000000	4.630638889

Table 4: Physico-Chemical and Microbiological Characteristics of Surface Water Samples

Parameter	**Sampling Station Id**				
	Upstream (200m)	**Downstream (200m)**	**Downstream (500-800m)**	**Dredging Point**	**DPR Limits**
pH	7.38	6.80	6.22	7.03	6.50-8.50
Temperature(°C)	29.1	30.2	30.1	29.2	NA
Conductivity (µs/cm)	78.0	66.0	62.0	71.0	NA
TDS (mg/l)	40.0	34.0	32.0	36.0	NA
TSS (mg/l)	24.0	26.0	20.0	27.0	NA
THC(mg/l)	<0.01	<0.01	<0.01	<0.01	NA
Turbidity (NTU)	5.00	5.00	5.00	5.00	NA
Salinity(ppt)	0.03	0.03	0.03	0.03	10
DO (mg/l)	5.66	5.49	5.40	5.50	NA
Sulphate(mg/l)	8.29	7.67	7.60	8.56	NA
Phosphate(mg/l)	0.072	0.050	0.051	0.080	NA
Nitrate(mg/l)	0.060	0.053	0.076	0.051	NA
Cadmium (mg/l)	0.015	0.018	0.011	0.026	NA
Lead(mg/l)	0.123	0.119	0.125	0.128	NA
Chromium (mg/l)	0.064	0.078	0.084	0.092	NA
Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	NA
Nickel (mg/l)	0.068	0.065	0.061	0.072	NA
Zinc (mg/l)	0.211	0.194	0.220	0.232	NA
THB(cfu/ml)	$<1.00\times10^{1}$	1.00×10^{3}	8.40×10^{3}	$<1.00\times10^{1}$	NA
HUB(cfu/ml)	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	NA
THF(cfu/ml)	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	NA
HUF(cfu/ml)	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	NA
Faecal Coliform(MPN/100ml)	<2.00	4.00	23.0	<2.00	NA
Total Coliform(MPN/100ml)	<2.00	14.0	30.0	<2.00	NA

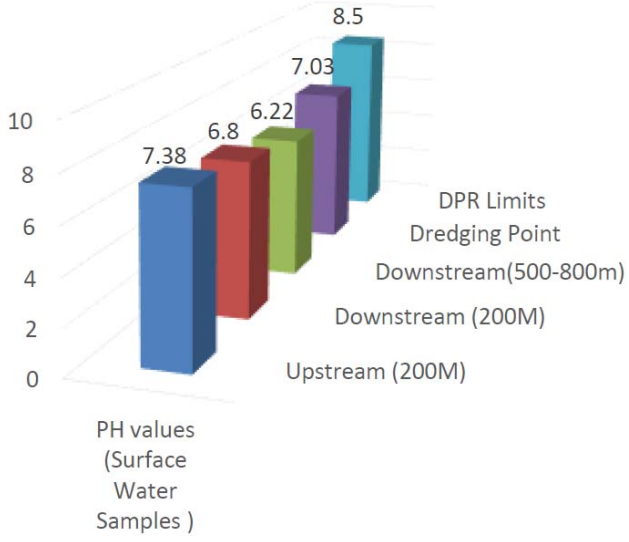

Figure 5. PH and DPR limits values for surface water samples

Table 5: Physico-Chemical and Microbiological Characteristics of Sediment /Dredged Spoil Samples

PARAMETER	SAMPLING STATION ID					
	Upstream (200m)	Downstream (200m)	Downstream (500-800m)	Dredging Point	Dredging Spoils	DPR Limits
pH	5.71	5.40	6.25	6.97	5.76	6.50 –
Conductivity (µS/cm)	291	267	229	306	170	NA
THC(mg/kg)	0.348	0.174	0.869	1.04	0.174	NA
TPH(mg/kg)	NA	NA	NA	NA	<0.010	NA
PAH(mg/kg)	NA	NA	NA	NA	<0.001	NA
TOC (%)	0.782	0.157	0.352	1.25	0.196	NA
Salinity(ppt)	0.082	0.074	0.064	0.086	0.048	NA
Sulphate (mg/kg)	17.8	32.2	58.2	125	54.8	NA
Phosphate(mg/kg)	9.72	0.280	0.860	3.31	0.620	NA
Nitrate(mg/kg)	1.44	6.45	2.56	1.18	1.01	NA
Cadmium (mg/kg)	0.321	0.421	0.331	0.510	0.512	NA
Lead(mg/kg)	1.24	1.30	1.44	1.52	1.19	NA
Chromium (mg/kg)	1.00	1.05	1.09	1.16	1.10	NA
Mercury (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	NA
Nickel (mg/kg	1.01	1.29	1.03	1.09	1.13	NA
Zinc (mg/kg)	2.31	2.22	2.26	2.40	2.11	1.5
THB(cfu/g)	2.00×10^{4}	7.60×10^{5}	9.30×10^{5}	2.56×10^{5}	NA	NA
HUB(cfu/g)	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	5.50×10^{4}	NA	NA
THF(cfu/g)	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	NA	NA
HUF(cfu/mg)	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	$<1.00\times10^{1}$	NA	NA
Faecal	<2.00	13.0	8.00	8.00	NA	NA
Total	2.00	50.0	90.0	23.0	NA	NA

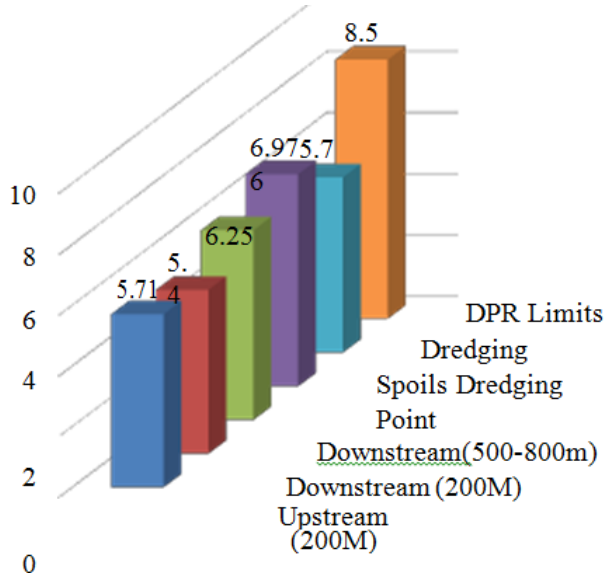

Figure 6. PH and DPR limits values for sediments and dredge spoil samples

Discussion

The pH minimum and maximum values are from 6.22 – 7.38. These values are within the Department Petroleum Resources (DPR) Limits range of 6.50 – 8.50.

Results of Conductivity samples shows across all the points is within 62.0 – 78.0µS/cm while Total Suspended Solids (TSS) values are from 20.0 – 27.0mg/l. Salinity value was constant (0.03ppt) at all monitored the points.

Total Hydrocarbon Content (THC) recorded values of <0.010mg/l. Results are within DPR regulatory limit of 10mg/L.

The nutrients of Sulphate, Phosphate and Nitrate, shows values from 7.60 – 8.56mg/l; 0.050 – 0.080mg/l; and 0.051 – 0.076mg/l respectively. The Heavy metals, Cd, Pb, and Cr, values are from 0.011 – 0.026mg/l; 0.119 – 0.128mg/l; and 0.064 – 0.094mg/l respectively. Mercury was below equipment detection limit of 0.001mg/l. Ni had values ranging from 0.061 – 0.072mg/l while values obtained for Zn ranged from 0.194 – 0.232mg/l.

Total and Fecal Coliform values are from <2.00 – 30.0 MPN/100mL and <2.00 – 23.00 MPN/100mL respectively.

Sediment and Dredge Spoil results obtained at the five location of pH maximum and minimum values are from 5.40 – 6.97.

Conductivity recorded range values are 170.0 – 306.0 µS/cm, while Salinity are from 0.048 – 0.086ppt.

Total Hydrocarbon Content (THC) recorded values ranging from 0.174 – 1.04mg/kg. These Surface water results: analyses at the values are within DPR regulatory limit of 30mg/Kg.

The nutrients: Sulphate, Phosphate and Nitrate, recorded 17.8 – 125mg/kg; 0.280 – 9.72mg/kg; and 1.01 – 6.45mg/kg respectively.

Results of Heavy metal analysis showed Cd, Pb, and Cr, with values ranging from 0.321 – 0.512mg/kg; 1.19 – 1.52mg/kg; and 1.00 – 1.16mg/kg respectively. Hg was below the equipment detection limit of <0.001mg/kg. Ni had values ranging from 1.01 – 1.29mg/kg while values for Zn ranged from 2.11 – 2.40mg/kg.

The Total and Faecal Coliform values for sediment ranged from 2.00 – 90.0 MPN/100mg and <2.00 – 13.0MPN/100mg respectively which is within acceptable limit.

Conclusions

The outcome of the Environmental Monitoring research at Obama creek from data capture/collection to the analyses at the laboratory showed that the water surface and sediments values were within acceptable limit, therefore the impact on the environment based on the samples examined in accordance with both Nigeria and the international bodies and regulatory agency requirement is minimal.

However, air quality, vegetation and aquatic animals require assessment for effective environmental sustainability and management and balancing the ecosystem. The integration of locational data enhances visualization using Geographical Information system (GIS).

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