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SPATIAL ASSESSMENT OF THE IMPACTS OF WATER QUALITY ON PUBLIC HEALTH OF RESIDENTS IN THE NIGER DELTA BASIN, NIGERIA

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ABSTRACT

The present study assessed the impact of water quality on public health challenges of residents in the Niger Delta basin. Mixed research design was adopted in this study. Nun River, Sagbama River, Andoni River, New Calabar River and Forcados River were purposively selected for the study. Grab method was used to collect the water samples. In each selected rivers selected, three water samples were collected at three different sampling points. The sampling points were about 500meters apart from each other. Samples were collected against the flow of the water, where any flow was discernible. Water samples were collected at about 10-20cm depth. Determination of water quality was conducted in the laboratory. Case notes of patients were retrieved and assessed for diagnosis of various water-related diseases and outbreak. Descriptive statistics was used in the course of data analysis for the present study. Water quality benchmarks were used to compare water quality whiles the Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index method. Laboratory results of water quality analyses indicates that almost all the water quality parameters measured parameters were above the acceptable water quality standards which implies that the water is polluted. Seasonal variations were observed in the concentrations of various water quality parameters. While most of the parameters showed higher concentrations during dry season when water volume is low, others showed lower concentration when the water volume is relatively low. Based on the results, it becomes expedient to discontinue the practice where surface waters are used as a receptacle for the dumping of all sorts of waste. There is the need for regular surveillance of rivers within the Niger Delta to safeguard the users of this vital resource.

Keywords: Water Quality; Contamination; Public Health Challenges.

1. INTRODUCTION

Surface water is a finite resource that is very essential for human existence. It is an important component of the biosphere containing less than one percent of global freshwater; hence it's ecological and social significance. Its flow is affected by a number of factors, which include but not restricted to: surface runoff, direct precipitation, inter flow, and water table discharge. The chemical, physical, and biological composition of these various flow inputs obviously influences the quality of water in river and other surface waters. The quality of a river at any point reflects several major influences, including the lithology of the basin, atmospheric inputs, climatic conditions, and anthropogenic inputs (Mustapha, Aris, Juahir & Ramli, 2012). The source of rivers, streams and creeks make them susceptible to pollution.

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Surface water is increasingly deteriorating in quality. It is being polluted by indiscriminate disposal of sewerage waste, indiscriminate industrial waste, and by human activities that affect their physical and chemical characteristics. It is increasingly and frequently been contaminated through several routes including direct deposition of wastes and indirectly through runoff. The compositing of the wastes and runoff affects the water quality parameters including physicochemical, heavy metals and microbial diversity and density (Seiyaboh & Kolawole, 2017).

Anthropogenic activities have been so extensive that the surface water bodies have lost their self-purification capacity to a large extent owning to contamination. Thus, man in his ambivalent relationship with surface water has treated it with more contempt than respect (Omotoriogun, Uyi & Egbo, 2012). Creeks, estuarine, streams and rivers are repeatedly used as receptacles for the effluents arising from industrial activities. Surface water bodies are becoming polluted as the day goes by, making clean water a scarce resource. Thus, the contamination of freshwater with a wide range of pollutants has become a matter of great concern as it has rendered many water bodies unsuitable for usage.

Industrial effluent contamination of natural water bodies has emerged as a major challenge in third world countries (Tawati, Risjani, Djati, Yanuwiadi & Leksono, 2018). Streams and rivers are contaminated by the activities of the adjoining populations and industrial establishments as the river systems are used as receptacle for disposal of waste, especially the effluents from industries that are near them. These effluents have a great deal of influence on the pollution of the surface water body, due to its ability to alter the physical, chemical and biological nature of the receiving water body (Raji, Ibrahim, Tytler & Ehinmidu, 2015).

The scarcity of potable water and contamination of surface water arising from anthropogenic activities has led to a situation in which one-fifth of the urban residents in third world countries and three quarters of their rural population do not have access to potable water supplies (Muhammad, 2014). According to the World Bank Group nearly half of the world population lacks access to potable water supply. This is worse among third world countries (Onyegeme-Okerenta & Ogunka-Nnoka, 2017).

According to W.H.O (2005) and Obeta, Ocheje & Nwokocha (2015) poor water quality is a serious issue in the world as it is responsible for a number of diseases and fatalities. Water quality is of importance owning to the ability of water to spread diseases. Polluted water is an important medium for the spread of diseases (Ayobahan, Ezenwa, Orogun, Uriri, & Wemimo, 2014). Since water quality is directly related to health and important for the determination of water utilities, it is vital to test the quality before being used (Tawati, Risjani, Djati, Yanuwiadi & Leksono, 2018), hence the need to carry out a spatial assessment of the impact of water quality on public health challenges of residents in the Niger Delta basin..

Study Area

This study was conducted within the Niger Delta Basin. The Niger Delta River Basin covers about three states which are: Rivers, Bayelsa and Delta States. The Niger Delta Basin is located in the southern part of Nigeria. It is situated along the Niger River delta. The Basin covers Rivers State, Bayelsa State and part of Edo State drained by Benin, Escravos, Forcadoes and Ramos River creek system. Niger Delta is located between latitudes 4º 00'N and 6º 10'N and longitudes 5º 00'E and 8º 00'E (Fig.1).

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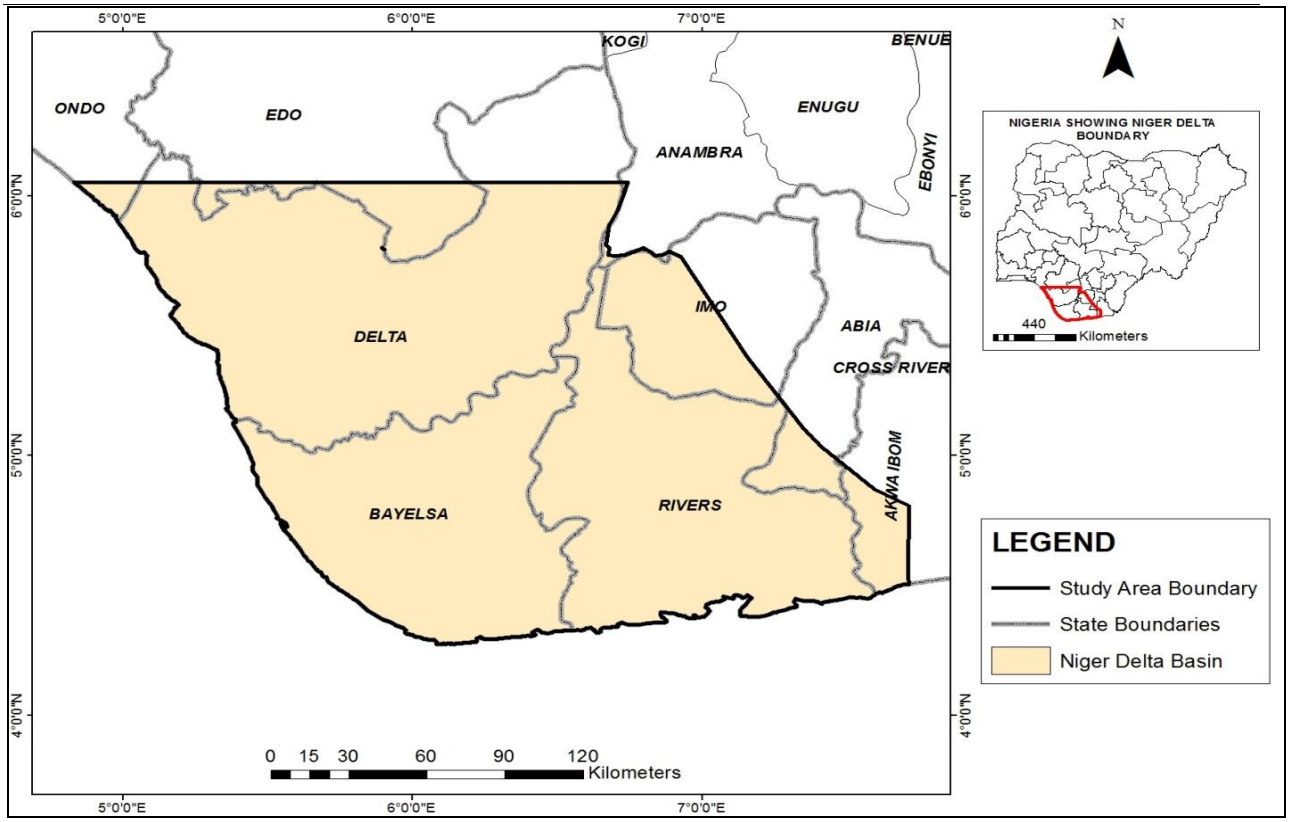

Fig. 1:
Niger Delta Basin

According to Nwankwoala and Ngah (2014), the geologic sequence of the areas drain by Niger Delta River Basin consists of three main tertiary subsurface lithostratigraphic units which are overlain by various types of quaternary deposits. The study area falls within the coastal plain sands and the alluvial deposits of the Quaternary sediments of the Niger Delta. The area can be divided into three stratigraphic units, namely: Akata, Agbada and Benin formation (Oyegun, 1999).

The soils of the study area consist of various types of superficial deposits overlying thick Tertiary sandy and clayey deposits which are over 100m thick in places. Two broad groups of soils make up the study area. These are soils derived from the older sediments and those formed on younger Quartenary and Recent alluvium. The older soils have textures dominated by coarse sandy clays and loose reddish brown sandy loam topsoil. The younger soils have textures which vary from sand to clay but are mainly loamy. These soils are poorly drained (Oyegun, 1999). Most soils in the area are poorly drained, hydromorphic and alluvial in nature.

The Niger Delta Basin is characterized by low-lying to moderately high plain topography. The topography of the area is essentially flat, sloping gently seawards. However, there exists little physiographic differentiation over the entire area, which is generally uniformly undulating. The topography of the area ranges from about 3m above mean sea level mostly around the coastal areas to about 60m which can be observed from a few deeper valleys (Williams, 2018). The area is drained by network of distributaries. The study area is criss-crossed by a number of rivers,

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streams, creeks, rivulets and lakes (Amangabara & Obenade, 2015; Williams, 2018). A prominent feature of rivers and creeks in the Niger Delta River Basin is the occurrence of natural levees on both banks, behind which occur vast of backswamps and lagoons where surface flow is negligible (Nwankwoala & Ngah, 2014). Notable rivers in the Niger Delta River Basin includes: Escravos, Forcados, Benin, New Calabar and Bonny River, Santa Barbara River, Andoni River, Nun River, River Orashi, San Bartholomeo River, Sombreiro River, St Nicholas River, Otamiriochie River, Ogochie River, Oloshi River and Opobo Channel River.Some of these rivers are subjected to tidal fluctuations and receptacle to freshwater inflow during the wet season.

Climatic condition of the area drain by the Niger Delta Basin can be classified as humid tropical climate with relatively long rainy season. Rainfall in the study area is generally seasonal, variable, as well as heavy. The only dry months are January and February. Rainfall in this area is not only heavy but also more persistent. The area experiences her wet season between March and October through November. Rainfall within the areas drained by the Niger Delta River Basin is at its peak in the month of July and September with slight dry season occurring in the month of August. The annual rain fall in the Niger Delta is high and varies from 500mm per annum at the coast to 300mm at the northern part of the Delta (Etu-Efeotor & Odigi, 1983; Nwankwoala & Ngah, 2014). Temperatures are generally high in the region and fairly constant with little variation throughout the year. The warmest months are February, March and early April in most parts of the study area. Temperature during these months ranges from 28 to 33°C. The coolest months are June through to September during the peak of the wet season. Average temperatures are typically between 25-28°C (NDRDMP, 2005). Minimum temperature values are almost consistent throughout the year.

2. MATERIALS AND METHODS

The present study adopted a mixed research design. In other words, mixed research design which in this case involves experimental and cross-sectional research designs was adopted in this study. The target population for the present study includes all communities living along the selected rivers in Niger Delta basin (Nun River, Sangana River, Andoni River, New Calabar River and Forcados River). The communities along Nun, Sangana, Andoni, New Calabar and Forcados Rivers constitute the target population. Health records from health facilities in these communities were used in the course of the study to find out common ailment in the area. Nun River, Sagbama River, Andoni River, New Calabar River and Forcados River were purposively selected for the study. Fifty four communities were selected in the study area to gather the needed information the public health impact arising from river pollution. The inclusive/exclusive criteria considered is that the communities are selected based on the presence of public hospitals of not more than 500meters from the community and their proximity to the active river channels that are selected for the study. Taro Yamane sample size formula was used to obtain the sample size for the study. The sample size was proportionally distributed among the communities selected for the study.

The required data for the study were gathered via: field survey and laboratory analysis. Hospital records were used to gather the needed data on common ailments and health challenges faced by residents of communities along selected Rivers in the study area. Hospital records in health facilities within the communities along selected Rivers in Niger Delta basin were used to find out

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common ailments in the communities. Case notes of patients were retrieved and assessed for diagnosis of various water-related diseases and outbreak.

Grab water collection technique were used to collect water samples. In each selected river, three water samples were collected at three different sampling points using random sampling technique. The sampling points were about 500meters apart from each other. Samples were collected as near to the middle of the water body as could be reached. Samples were collected against the flow of the water, where any flow was discernible. Water samples were collected at about 10-20cm depth using sterile screw-capped bottles. The sampling bottles were submerged to a depth of 10-20cm so as to collect the water sample. Determination of water quality including physical, chemical and microbiological properties was conducted in the laboratory. Heavy metals in the surface water were determined by the use of Atomic Absorption Spectrophotometer (AAS). Descriptive statistics was used in the course of data analysis for the present study. The WHO and Federal Ministry of Environment guidelines on drinking water were used as the benchmark for the interpretation of water quality. Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index method.

3. RESULTS AND DISCUSSIONS

Assessment of mean seasonal variation water quality of selected Rivers in the Niger Delta basin

This section compares the mean variation of physico-chemical and biological parameters of water quality of Rivers in Niger Delta basin. It examines the seasonal variation of these water quality parameters. The result is presented as follows in Table 1.

Table 1: Mean seasonal variation of water quality parameters of Rivers in Niger Delta basin

S/N	Parameters	Mean Seasonal Variation									
		Andoni River		Forcados River		New Calabar River		Nun River		Sangana River	
		Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Physical Parameters											
1	pH	6.00	7.93	6.58	7.71	5.73	7.26	6.84	7.95	6.44	7.92
2	Temperature (^oC)	27.0	28.5	27.3	29.5	27.3	28.5	27.0	29.2	27.2	28.3
3	Total Suspended Solids (mg/L)	0.07	1.27	0.08	1.27	0.04	1.01	0.09	1.04	0.09	1.12
4	Total Dissolved Solids (mg/L)	0.21	1.79	0.21	1.09	0.20	0.68	0.21	0.95	0.25	0.91

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5	Dissolved Oxygen (mg/L)	6.5	3.5	6.4	4.7	7.5	5.9	7.5	6.5	7.1	7.1
6	Turbidity (NTU)	36.0	166.9	36.0	131.0	51.7	135.5	48.7	428.5	33.7	119.0
7	Biological Oxygen Demand (mg/L)	7.0	4.8	6.0	6.5	7.0	7.8	8.0	6.2	8.3	7.5
8	Chemical Oxygen Demand (mg/L)	2.23	0.92	2.06	0.92	2.05	1.30	1.87	1.60	2.27	1.78
Chemical Parameters											
9	Electrical Conductivity (µs/cm)	2108	3225	098	1271	045	739	087	1129	079	1081
10	Nitrate (mg/L)	0.015	0.049	0.049	0.090	0.011	0.047	0.009	0.041	0.010	0.048
11	Sulphate (mg/L)	1.922	1.670	1.259	1.463	0.294	0.513	1.393	1.264	1.000	0.954
12	Chloride (mg/L)	95.7	59.1	121.3	54.9	111.3	50.0	126.7	90.0	87.3	71.3
13	Phosphate (mg/L)	0.211	0.149	0.251	0.149	0.208	0.122	0.258	0.148	0.243	0.136
14	Mg (mg/L)	7.75	12.06	9.82	12.22	7.30	10.22	9.37	12.39	8.57	9.81
Heavy Metal											
15	Pb (mg/L)	0.018	2.77	0.021	2.87	0.024	2.60	0.024	2.25	0.022	2.83
16	Cd (mg/L)	0.003	2.045	0.002	1.564	0.001	1.298	0.004	2.072	0.002	1.367
17	Cr (mg/L)	0.002	1.606	0.002	1.791	0.006	1.289	0.003	1.886	0.003	1.593
18	As (mg/L)	0.004	1.538	0.002	1.463	0.005	1.485	0.003	1.423	0.005	1.428

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19	Hg (mg/L)	0.005	1.341	0.006	1.657	0.008	1.929	0.006	1.571	0.006	1.328
20	Ni (mg/L)	0.013	2.900	0.009	2.453	0.009	2.529	0.010	2.364	0.009	2.626
21	Fe (mg/L)	0.015	3.103	0.014	3.320	0.016	3.573	0.014	2.173	0.017	2.325

Seasonal variations were observed in the concentrations of various physical parameters. From the analysis, pH, temperature, total suspended solids (TSS), total dissolved solids (TDS), dissolved oxygen (DO) and turbidity showed higher concentrations during the dry season when water volume is low. Physical parameters showed a higher concentration in dry season. For most sampled Rivers, the value of biological oxygen demand (BOD) and chemical oxygen demand (COD) were higher during wet season when water volume is increased to its maximum and lower during dry season when water volume had lowered.

Most chemical parameters such as: electrical conductivity (EC), nitrate, sulphate and Mg showed higher concentration during dry season when compared to the concentration during wet season when water level is high. On the other hand, chloride and phosphate showed higher concentration during wet season when compared with its concentration during dry season. Heavy metals such as: Pb, Cd, Cr, As ad Fe values for the selected Rivers were found to be higher during dry season when compared to wet season values. The concentrations of heavy metals were higher in dry season.

The result is in agreement with the findings of Onwugbuta-Enyi, Zabbey & Erondu (2008) who observed obvious seasonal fluxes in the water parameters except nitrate concentrations that were not statistically significant. It is also in tandem with the observation of Akinnawo, Abiola & Edward (2016) who observed a seasonal variation in physico-chemical and microbial characterization of sediment and water samples from selected coastal areas in Ondo state. The findings shows the water properties exceeding the WHO standard renders the water unfit for drinking and domestic use.

Comparison of water quality of Rivers in Niger Delta Basin with national and international standardized limits

The mean water quality of Rivers in Niger Delta basin was compared with Federal Environmental Protection Agency (FEPA) and World Health Organization (WHO) permissible standards. This is presented as follows.

Table 2: Wet season mean value of water quality Parameters of Rivers in Niger Delta Basin in comparison with permissible standards

S/N	Parameters	Mean Value for River Water Quality (Wet Season)						
		Andoni River	Forcados River	New Calabar River	Nun River	Sangana River	Permissible Standards	
							FEPA	WHO
Physical Parameters								
1	pH	6.00	6.58	5.73	6.84	6.44	6.0 - 9.0	6.5 - 9.2

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2	Temperature (ºC)	27.0	27.3	27.3	27.0	27.2	26	10 – 15
3	Total Suspended Solids (mg/L)	0.07	0.08	0.04	0.09	0.09	-	-
4	Total Dissolved Solids (mg/L)	0.21	0.21	0.20	0.21	0.25	148	500
5	Dissolved Oxygen (mg/L)	6.5	6.4	7.5	7.5	7.1	< 2	6
6	Turbidity (NTU)	36.0	36.0	51.7	48.7	33.7	< 1	5.0
7	Biological Oxygen Demand (mg/L)	7.0	6.0	7.0	8.0	8.3	10	50
8	Chemical Oxygen Demand (mg/L)	2.23	2.06	2.05	1.87	2.27	80	1000
Chemical Parameters								
9	Electrical Conductivity (µs/cm)	2108	098	045	087	079	70	300
10	Nitrate (mg/L)	0.015	0.049	0.011	0.009	0.010	20	< 45
11	Sulphate (mg/L)	1.922	1.259	0.294	1.393	1.000	20	250
12	Chloride (mg/L)	95.7	121.3	111.3	126.7	87.3	240	250
13	Phosphate (mg/L)	0.211	0.251	0.208	0.258	0.243	-	0.5
14	Mg (mg/L)	7.75	9.82	7.30	9.37	8.57	0.20	30
Heavy Metal								
15	Pb (mg/L)	0.018	0.021	0.024	0.024	0.022	0.01	0.05
16	Cd (mg/L)	0.003	0.002	0.001	0.004	0.002	0.05	0.01
17	Cr (mg/L)	0.002	0.002	0.006	0.003	0.003	0.02	0.05
18	As (mg/L)	0.004	0.002	0.005	0.003	0.005	-	0.01
19	Hg (mg/L)	0.005	0.006	0.008	0.006	0.006	0.001	0.001
20	Ni (mg/L)	0.013	0.009	0.009	0.010	0.009	0.02	0.07
21	Fe (mg/L)	0.015	0.014	0.016	0.014	0.017	0.05	0.30

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FEPA (1991), WHO (1997), WHO (2003)

Table 3: Wet season mean value of water quality Parameters of Rivers in Niger Delta Basin in comparison with permissible standards

S/N	Physico-chemical Parameters	Mean Value for River Water Quality (Dry Season)						
		Andoni River	Forcados River	New Calabar River	Nun River	Sangana River	Permissible Standards	
							FEPA	WHO
Phsical Parameters								
1	pH	7.93	7.71	7.26	7.95	7.92	6.0 - 9.0	6.5 - 9.2
2	Temperature (°C)	28.5	29.5	28.5	29.2	28.3	26	10 – 15
3	Total Suspended Solids (mg/L)	1.27	1.27	1.01	1.04	1.12	-	-
4	Total Dissolved Solids (mg/L)	1.79	1.09	0.68	0.95	0.91	148	500
5	Dissolved Oxygen (mg/L)	3.5	4.7	5.9	6.5	7.1	< 2	6
6	Turbidity (NTU)	166.9	131.0	135.5	428.5	119.0	< 1	5.0
7	Biological Oxygen Demand (mg/L)	4.8	6.5	7.8	6.2	7.5	10	50
8	Chemical Oxygen Demand (mg/L)	0.92	0.92	1.30	1.60	1.78	80	1000
Chemical Parameters								
9	Electrical Conductivity (µs/cm)	3225	1271	739	1129	1081	70	300
10	Nitrate (mg/L)	0.049	0.090	0.047	0.041	0.048	20	< 45
11	Sulphate (mg/L)	1.670	1.463	0.513	1.264	0.954	20	250
12	Chloride (mg/L)	59.1	54.9	50.0	90.0	71.3	240	250
13	Phosphate (mg/L)	0.149	0.149	0.122	0.148	0.136	-	0.5
14	Mg (mg/L)	12.06	12.22	10.22	12.39	9.81	0.20	30
Heavy Metal								

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15	Pb (mg/L)	2.77	2.87	2.60	2.25	2.83	0.01	0.05
16	Cd (mg/L)	2.045	1.564	1.298	2.072	1.367	0.05	0.01
17	Cr (mg/L)	1.606	1.791	1.289	1.886	1.593	0.02	0.05
18	As (mg/L)	1.538	1.463	1.485	1.423	1.428	-	0.01
19	Hg (mg/L)	1.341	1.657	1.929	1.571	1.328	0.001	0.001
20	Ni (mg/L)	2.900	2.453	2.529	2.364	2.626	0.02	0.07
21	Fe (mg/L)	3.103	3.320	3.573	2.173	2.325	0.05	0.30

FEPA (1991), WHO (1997), WHO (2003)

Mean wet and dry season water quality for majority of physical parameters including: temperature, dissolved oxygen (DO) and turbidity for the sampled Rivers in the Niger Delta basin were observed to be above the permissible limit allowed by Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO). On the other hand, physical water quality parameters such as pH, biological oxygen demand (BOD) and chemical oxygen demand (COD) were found to be below the permissible limit allowed by Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO). Mean wet and dry season water quality for majority of chemical parameters assessed including: nitrate, sulphate, chloride and phosphate were observed to be lower than the permissible standard set by Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO). On the other hand, wet and dry season electrical conductivity (EC) values for the sampled Rivers were above the permissible limit of 70µS/cm and 300µS/cm allowed by Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO). The mean wet season values of some heavy metals such as: Pb and Hg were above the permissible standards allowed by Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO) while the mean wet season values of Cd, Cr, As, Ni and Fe were below the national and international regulatory standards. On the other hand, the mean value of all heavy metals (Pb, Cd, Cr, As, Hg, Ni and Fe) in dry seasons were above the permissible standards allowed by Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO). This is similar to the study carried out by Ohaji and Akujieze (1989) who noted the objectionable proportion of Fe level in groundwater across various formation of Benin.

Water Quality Index of Rivers within in the Niger Delta basin

This section shows the result of water quality index of Rivers in the Niger Delta basin at different seasons. The section that follows presents the water quality parameters used for the calculation and their respective unit weight.

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Table 4: Water quality parameters, standard values and unit weight

S/N	Parameters	Standard Values (S_i)	$\frac{1}{S_i}$	Unit Weight (w_i) = $\frac{k}{S_i}$
1	pH	8.00	0.125	0.000075
2	Temperature (°C)	28	0.036	0.00002
3	Total Suspended Solids (mg/L)	500	0.002	0.0000012
4	Total Dissolved Solids (mg/L)	500	0.002	0.0000012
5	Dissolved Oxygen (mg/L)	5.0	0.2	0.00012
6	Turbidity (NTU)	5	0.2	0.00012
7	Biological Oxygen Demand (mg/L)	5	0.2	0.00012
8	Chemical Oxygen Demand (mg/L)	5	0.2	0.00012
9	Electrical Conductivity (µs/cm)	1000	0.001	0.0000006
10	Nitrate (mg/L)	50	0.02	0.000012
11	Sulphate (mg/L)	100	0.01	0.000006
12	Chloride (mg/L)	250	0.004	0.0000024
13	Phosphate (mg/L)	100	0.01	0.000006
14	Mg (mg/L)	0.20	5	0.003
15	Pb (mg/L)	0.01	100	0.06
16	Cd (mg/L)	0.003	333.33	0.2
17	Cr (mg/L)	0.05	20	0.012
18	As (mg/L)	0.01	100	0.06
19	Hg (mg/L)	0.001	1000	0.06
20	Ni (mg/L)	0.02	50	0.03
21	Fe (mg/L)	0.3	3.33	0.002
22	Total coliform count (cfus/ml)	10	0.1	0.00006

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			$\sum\left(\frac{1}{S_i}\right) = 1612.77$	

*** $K = \frac{1}{\sum(S_i)} = 0.0006$

The standard values (S_i) used for calculating water quality index are those from the Federal Environmental Protection Agency (FEPA). With these, the unit weights for the various parameters were computed.

Wet season water quality index for Rivers within the Niger Delta River Basin

The section that follows presents the result of water quality index for the selected rivers in the Niger Delta basin.

Table 5: Wet season water quality Index for Rivers within the Niger Delta River Basin

S/N	Parameters	Standard Values (S_i)	Unit Weight $(w_i) = \frac{k}{S_i}$	Quality Rating $(Q_1) = \frac{C_i}{S_i} \times 100$					Quality Rating (W_1Q_1)				
				Andoni River Q_1	Forcados River Q_2	New Calabar River Q_3	Nun River Q_4	Sangana River Q_5	Andoni River W_1Q_1	Forcados River W_1Q_2	New Calabar River W_1Q_3	Nun River W_1Q_4	Sangana River W_1Q_5
1	pH	8.00	0.000075	75	82.25	71.63	85.5	80.50	0.005625	0.006169	0.005372	0.006413	0.006038
2	Temp	28	0.00002	96.429	97.50	97.50	96.429	97.143	0.00192858	0.0195	0.00195	0.00192858	0.00194286
3	TSS	500	0.0000012	0.014	0.016	0.008	0.018	0.018	0.0000001 6	0.0000001 9	0.0000000 9	0.0000000 21	0.0000000 21
4	TDS	500	0.0000012	0.042	0.042	0.04	0.042	0.05	0.000 00005	0.000 00005	0.0000004 8	0.0000000 5	0.0000000 6
5	DO	5.0	0.00012	130	128	150	150	142	0.156	0.1536	0.81	0.81	0.1704
6	Turbidity	5	0.00012	720	720	1034	974	674	0.0864	0.0864	0.12408	0.11688	0.08088

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7	BOD	5	0.00012	140	120	140	160	166	0.0168	0.0144	0.0168	0.0192	0.01992
8	COD	5	0.00012	44.6	41.2	41.0	37.4.	45.4	0.005352	0.004944	0.333122	0.004488	0.005448
9	EC	1000	0.0000006	210.8	9.8	4.5	8.7	7.9	0.00012648	0.00000588	0.0000027	0.00000522	0.00000474
10	Nitrate	50	0.000012	0.03	0.098	0.022	0.018	0.02	0.00000036	0.000001176	0.000000264	0.000000216	0.000000246
11	Sulphate	100	0.000006	1.922	1.259	0.294	1.393	1.000	0.0000011532	0.0000007554	0.0000001764	0.0000008358	0.000006
12	Chloride	250	0.0000024	0.38288	48.52	44.52	50.68	34.92	0.00000091 8	0.000116448	0.000106848	0.000121632	0.000083808
13	Phosphate	100	0.000006	0.211	0.251	0.208	0.258	0.243	0.00000126 6	0.00000150 6	0.00000124 8	0.00000154 8	0.00001458
14	Mg	0.20	0.003	3875	4910	3650	4685	4285	111.625	14.73	10.95	14.055	12.855
15	Pb	0.01	0.06	180	210	240	240	220	10.8	12.6	14.4	14.4	13.2
16	Cd	0.003	0.2	100	66.67	33.33	133.33	66.67	20	13.334	6.666	26.666	13.334
17	Cr	0.05	0.012	4	4	12	6	6	0.048	0.048	0.144	0.072	0.072
18	As	0.01	0.06	40	20	50	30	50	2.4	1.2	3.0	1.8	3.0
19	Hg	0.001	0.06	500	600	800	600	600	30	36	48	36	36
20	Ni	0.02	0.03	65	45	45	50	45	1.95	1.35	1.35	1.5	1.35

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21	Fe	0.3	0.002	5	4.67	5.33	4.67	5.67	0.01	0.00934	0.01066	0.00934	0.01134
22	TCC	10	0.00006	230	160	210	80	230	0.0138	0.0096	0.0126	0.0046	0.0138
									$\sum W_1 Q_1$ = 77.12 WQI = $\frac{\sum W_1 Q_1}{\sum W_1}$ = 180.87	$\sum W_1 Q_2$ = 79.55 WQI = $\frac{\sum W_1 Q_2}{\sum W_1}$ = 185.54	$\sum W_1 Q_3$ = 84.87 WQI = $\frac{\sum W_1 Q_3}{\sum W_1}$ = 197.94	$\sum W_1 Q_4$ = 94.84 WQI = $\frac{\sum W_1 Q_4}{\sum W_1}$ = 221.19	$\sum W_1 Q_4$ = 80.12 WQI = $\frac{\sum W_1 Q_5}{\sum W_1}$ = 186.87

Source: Researchers Field Report (2021)

Table 4.10 put the water quality index for Andoni River at 180.87. For Forcados River, the water quality index was 185.54; the index for New Calabar River was 197.94 while that for Nun River stood at 221.19. The water quality index for Sangana River stood at 186.87. The wet season water quality indexes for the selected River were compared against the standard in Table 4.11 below.

Table 6: Categorization of Water Quality Index

S/N	WQI Rating	Classification
1	0 – 25	Excellent
2	25 – 50	Slightly polluted (Good)
3	50 – 75	Moderately polluted (Poor)
4	75 – 100	Polluted (Very poor)
5	>100	Excessively polluted (Unsuitable)

Based on the calculated water quality index, the value of all the Rivers in the Niger Delta Basin are above 100. This implies that the Rivers are excessively polluted. In other words, the water quality of the selected surface water is unsuitable.

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Dry Season Water Quality Index for Rivers within the Niger Delta River Basin

The section that follows presents the result of water quality index for the selected rivers in the Niger Delta basin.

Table 7: Dry Season Water Quality Index for Rivers within the Niger Delta River Basin

S/N	Parameter	Standard Values (S_i)	Unit Weight (w_i) $= \frac{k}{S_i}$	Quality Rating (Q_1) $= \frac{C_i}{S_i} \times 100$					Quality Rating (W_1Q_1)				
				Andoni River Q_1	Forcados River Q_2	New Calabar River Q_3	Nun River Q_4	Sangana River Q_5	Andoni River W_1Q_1	Forcados River W_1Q_2	New Calabar River W_1Q_3	Nun River W_1Q_4	Sangana River W_1Q_5
1	Ph	8.00	0.000075	99.13	96.38	90.75	99.34	99.00	0.0074344	0.00722813	0.0068063	0.0074531	0.00742500
2	Temp	28	0.00002	101.79	105.36	10179	104.29	101.07	0.0020357	0.00210711 4	0.0020357	0.0020857	0.00202142
3	TSS	500	0.0000012	0.254	0.254	0.202	0.208	0.224	0.0000003	0.00000030	0.00000024	0.00000024	0.00000027
4	TDS	500	0.0000012	0.358	0.218	0.136	0.190	0.182	0.00000043	0.00000026	0.00000016	0.00000023	0.00000022
5	DO	5.0	0.00012	70	128	150	150	142	0.0840	0.1536	0.1800	0.1800	0.1704
6	Turbidity	5	0.00012	3338	2620	2710	8570	2380	0.40056	0.3144	0.3252	1.0284	0.2856
7	BOD	5	0.00012	96	130	156	124	150	0.01152	0.01560	1.8720	0.01488	0.01800
8	COD	5	0.00012	18.4	18.4	26.0	32.0	35.6	0.002208	0.002208	0.00312	0.00384	0.00427
9	EC	100	0.000	32	127.	73.	11	108	0.000	0.000	0.000	0.000	0.000

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		0	0006	2.5	1	9	2.9	.1	1935	07626	04434	06774	06486
10	Nitrate	50	0.000012	0.098	0.180	0.094	0.082	0.096	0.0000012	0.0000022	0.0000011	0.0000009	0.0000012
11	Sulphate	100	0.000006	1.670	1.463	0.513	1.264	0.954	0.0000100	0.0000087	0.0000031	0.0000076	0.0000057
12	Chloride	250	0.0000024	23.64	21.96	20.00	36.00	28.52	0.0000567	0.0000527	0.0000480	0.0000860	0.0000684
13	Phosphate	100	0.000006	0.149	0.149	0.122	0.148	0.136	0.00000089	0.00000089	0.00000073	0.00000089	0.00000082
14	Mg	0.20	0.003	6030	6110	5110	6195	4905	18.09	18.33	15.33	18.59	14.72
15	Pb	0.01	0.06	2770	28700	26000	22500	28300	1662	1722	1560	1350	1698
16	Cd	0.003	0.2	68166	52133	43267	69067	45567	13633	10427	8653	13813	9113
17	Cr	0.05	0.012	3212	3582	2578	3772	3186	38.54	42.98	30.94	45.26	38.23
18	As	0.01	0.06	15380	14630	14850	14230	14280	922.8	877.0	891.0	853.8	856.8
19	Hg	0.001	0.06	1341 00	165700	192900	157100	132800	8046	9942	11574	9426	7968
20	Ni	0.02	0.03	14500	12265	12645	11820	13130	435.0	379.35	379.35	354.60	393.90
21	Fe	0.3	0.002	1034.3	1106.6	1191.00	724.33	775.00	2.0687	2.2133	2.382	1.4487	1.550

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22	TCC	10	0.00006	180	370	450	230	170	0.0108	0.0222	0.027	0.0138	0.0102
									$\sum W_1 Q_1$ = 24758.35 WQI = $\frac{\sum W_1 Q_1}{\sum W_1}$ = 57746	$\sum W_1 Q_2$ = 23400.46 WQI = $\frac{\sum W_1 Q_2}{\sum W_1}$ = 54579	$\sum W_1 Q_3$ = 23108.74 WQI = $\frac{\sum W_1 Q_3}{\sum W_1}$ = 53899	$\sum W_1 Q_4$ = 25864.28 WQI = $\frac{\sum W_1 Q_4}{\sum W_1}$ = 60326	$\sum W_1 Q_4$ = 20085.03 WQI = $\frac{\sum W_1 Q_5}{\sum W_1}$ = 46846

According to Table 7 dry season water quality index for Andoni River at 57746. The dry season water quality index for Forcados River stood at 54579; the index for New Calabar River was 53899 while that for Nun River stood at 60326. The water quality index for Sangana River stood at 46846. In comparison with Table 6, the calculated water quality index, for all the Rivers in the Niger Delta Basin are above 100. This implies that the Rivers are excessively polluted.

Analysis of common water-related ailment from medical records

This section analyzed common water-related ailment of communities along selected Rivers within the Niger Delta basin. The common water-related ailments were made possible through medical report of hospitals within the communities where the selected Rivers within the Niger Delta Basin drained. This is presented as follows.

Table 8: The number of patients with reported complaints and diagnosed with water-related diseases from June 2020 to May 2021

S/N	Water-Related Ailment	Hospitals					
		Ngo Central Hospital	Bomadi General Hospital	University of Port Harcourt Teaching Hospital	Niger Delta University Teaching Hospital	Sangana Primary Health Centre	**Percentage**
1	Typhoid	27	26	12	29	20	48.31

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2	Hepatitis A	5	5	1	7	2	8.47
3	Acute Gastroestertis	2	3	1	2	7	6.36
4	Dysentery	6	10	30	7	5	24.58
5	Cholera	3	4	8	5	-	8.47
6	Diarrhea	-	3	-	4	-	2.97
7	Salmonellosis	-	-	1	-	-	0.42
8	Shigellosis	-	-	1	-	-	0.42
	Total	43	51	54	54	34	100

Source: Medical Records (June, 2020 to May, 2021)

Residents of communities along the sampled Rivers and by implication in Niger Delta basin face a number of water-related ailments. Analysis of patients with reported complaints and diagnosed with water-related diseases from June 2020 to May 2021 from major health institutions within the borders of the sampled Rivers showed that residents come-down with not only the commonly known water-related illness like: typhoid fever, dysentery, hepatitis A and cholera but also with the not commonly known ailments like: acute gastroestertis salmonellosis and shigellosis. This is in consonance with the observation of Ordinioha & Brisibe (2013) who observed the prevalence of diarrhea - basically a water-borne disease in the Niger Delta.

3. CONCLUSION AND RECOMMENDATIONS

Water quality in Niger Delta basin is generally poor. This can be seen from the water quality index result of selected Rivers within the basin. In addition to this, the physical, chemical and microbial parameters of water from the selected rivers were above the permissible standards and guidelines of national and international regulatory agencies. Laboratory results of the analyses shows that most parameters analyzed were not above the acceptable water quality standards and therefore indicate the existence of pollution. The deviation of water quality of these Rivers from permissible standards poses a challenge to the availability of potable drinking water for communities within the Niger Delta basin. Seasonal variations were observed in the concentrations of various water quality parameters. While most of the parameters showed higher concentrations during dry season when water volume is low, others showed lower concentration when the water volume is relatively low. From the results of this study, the following recommendations are put forward:

1. The use of water bodies as a receptacle for the dumping of waste of all sorts should be discontinued. Environmental agencies should as a matter of urgency stop the use of surface water as dumping sites for waste.
2. There should be regular surveillance of rivers within the Niger Delta to safeguard the users of this vital resource.

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3. Since the responsibility of protecting surface water resources is a collective responsibility, an aggressive public awareness programme should be embarked. This will help to discourage the public from using the river as a receptacle for dumping of waste.
4. There is a need for effective management of surface water bodies within the Niger Delta basin. This has become imperative in other to eradicate the water-related ailment in the communities within the basin.

REFERENCES

Akinnawo, S., Abiola, C. & Edward, O. (2016). Seasonal variation in the physico-chemical and microbial characterization of sediment and water samples from selected areas in Ondo coastal region, Nigeria. *Journal of Geography, Environment and Earth Science International 5(1): 1-12*

Ayobahan, S. U., Ezenwa, I. M., Orogun, E. E., Uriri, J. E. & Wemimo, I. J. (2014). Assessment of anthropogenic activities on water quality of Benin River. *Journal of Applied Science and Environmental Management, 8(4): 629-636.*

McMillan, J. H. & Schumacher, S. (2001). Research in education: A conceptual understanding. Haprer Collins, New York.

Mustapha, A., Aris, A. Z., Juahir, H. & Ramli, R. F. (2012). Surface water quality contamination source apportionment and physicochemical characterization at the upper section of the Jakara Basin, Nigeria. *Arabian Journal of Geosciences.*

Nwankwoala, H. O. & Ngah, S. A. (2014). Groundwater resources of the Niger Delta: Quality implications and management considerations. International Journal of Water Resources and Environmental Engineering, 6 (5): 155-163.

Obeta, M. C., Ocheje, J. F. & Nwokocha , V. C. (2015). Analysis of the physico-chemical and microbiological quality of Imabolo stream water in Ankpa urban area of Kogi State, Nigeria. *Mediterranean Journal of Social Sciences, 6(6): 549-557.*

Omotoriogun, T. C., Uyi, O. O and Egbon, I. N. (2012). The physicochemical characteristics of Ibiekuma River Ekpoma, Nigeria. *Journal of Wetlands Ecology, 6: 1-6*

Onwugbuta-Enyi, J., Zabbey, N. & Erondu, E. S. (2008). Water quality of Bodo Creek in the Lower Niger Delta Basin. *Advances in Environmental Biology, 2(3): 132-136.*

Onyekuru, S. O., Nwankwoala, H. O. & Uzor, I. (2017). Heavy metal analysis of Otamiri River in Imo state, Southeastern Nigeria. *Journal of Ecology and Natural Resources, 1(3): 1-7.*

Ordinioha, B. & Brisibe, S. (2013). The human health implications of crude oil spills in the Niger Delta, Nigeria: An interpretation of published studies. *Nigerian Medical Journal, 54(1): 10-16.*

Osborn, M. (2005). Sample Collection Methods.

Oyegun, C. U. (1999). Geology and sedimentary environment. In C. U. Oyegun and M. A. Adeyemo, (eds), *Port Harcourt Region*, Paragraphics, Port Harcourt: 13-32.

Raji, M. I., Ibrahim, Y. K., Tytler, B.A. & Ehinmidu, J. O. (2015). Physicochemical characteristics of water samples collected from River Sokoto, North-western Nigeria. *Atmospheric and Climate Sciences, 5: 194-199.*

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Seiyaboh, E. I. & Kolawole, E. P. (2017). Diversity and levels of bacteriological contamination in Orashi River, Mbiama community, River State, Nigeria. *Journal of Advances in Microbiology, 4(3): 1-6*

Tawati, F., Risjani, Y., Djati, M. S., Yanuwiadi, B. & Leksono, A. S. (2018). The analysis of the physical and chemical properties of the water quality in the rainy season in the Sumber Maron River-Kepanjen, Malang-Indonesia. *Resources and Environment, 8 (1): 1-5.*