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Quality Assessment of Water Potability in Aguobiri Southern Ijaw Local Government Area, Bayelsa State, Nigeria

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Keywords: Aguobiri, Water Not Potable Sustainable Monitoring Treatment.

ABSTRACT: Fifteen (15) water samples were collected from boreholes, pond water and rivers located at different points in Aguobiri Community in Southern Ijaw Local Government Area of Bayelsa State. The samples were then analysed for physico-chemical parameters, bacteriological (coliform), heavy metals and Total Petroleum Hydrocarbon Content (TPC) in order to determine their concentrations in the rivers, ponds and borehole water.Results obtained from the analysis were compared with standards of Standard Organization of Nigeria (SON), Department of Petroleum Resources (DPR) and Federal Environmental Protection Agency (FEPA). The results indicate that Pb^{2+}, TPC, Cd^{2+}, Fe^{2+}, coliform, hardness and N_i^{2+} are above the recommended value for any drinking water in some locations. However, pH, TDS, TSS, Mg^{2+}, Na^{+}, Ca^{2+}, K^{+}, SO_4^{2-}, PO_4^{3-}, Cu^{2+}, Zn^{2+}, Cr^{2+} and Cl^{-} values are within the permissible limit. But most of the heavy metals and TPC exceeded the threshold value. Consequently there is need for a holistic and sustainable monitoring and treatment of water before drinking in the area, particularly the river water. Public health appears to be threatened in the area as the water is unsafe, not potable as toxic substances may be absorbed through oral ingestion which then bio-accumulate in the tissues of man. @ JASEM

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The potability of water is a function of its intended use. Hence the people of Aguobiri in Southern Ijaw Local Government Area of Bayelsa State use the river water for drinking and other domestic purposes. Aguobiri Community in Southern Ijaw L.G.A of Bayelsa State (the area of this study), lies within latitude $04^0\ 49'$ to $04^0\ 49.2'N$ and longitude $06^0\ 09.1'E$. It is bounded by villages like Igeibiri and Angama Ijaw in the East, Oweikorogha and Otuan on the northern side. Emete Ozezebiri is at the southern end while Angiama gbene and Ohiduon are situated at the western side. The community is accessible by air, road and river transportation. It is about 45 minutes' drive by boat from Yenagoa Water Front (Fig. 1).

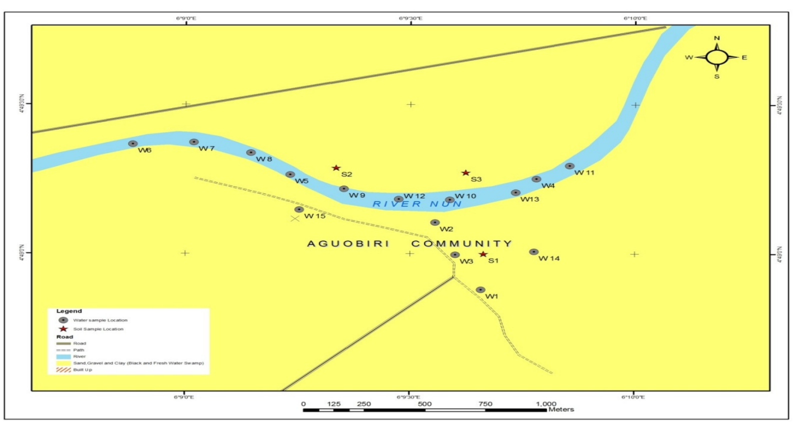

Fig. 1. Location Map showing the sampled points

Brief Background Into Oil Activities And Environmental Impact: Nigerian first crude oil export came from Oloibiri field in February 1958; in the present Bayelsa State, Southern Nigeria. The first Nigerian crude oil pipeline was laid from Oloibiri oil field to Port-Harcourt (Rivers State) on the Bonny terminal by Shell Darcy, now Shell Petroleum Development Company (SPDC) of

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Nigeria. Aguobiri Community is one of the pipeline communities in which Shell Petroleum Development Company (SPDC) laid their pipeline in 1973 to serve as a conduit to transport crude oil from the flow station.

Crude oil pollution which is caused by oil and gas spillage, occur due to corrosion (rupturing of pipeline), sabotage (illegal vandals), and most recently artisanal refineries which is now a major challenge going on in the region.

The oil activities in the area have immensely threatened the regional geology, earth resource, biodiversity, land use, forest and grass land (ecosystem), air, weather and climate. Crude oil spill has over the years become a major source of economic and environmental strangulation, not only to the Niger Delta region but to Nigeria at large. Be it, corrosion, sabotage by illegal vandals or even oil installation and production activities, they all serve as a point source to environmental degradation witnessed in the region today. What is recently most disturbing in the region is the new dimension of oil theft to embark on the illegal storage of the stolen petroleum crude by "cooking" the crude oil separating into petrol, kerosene, diesel and the waste are discharged into the environment un-treated; endangering the environment, making it totally susceptible to immense environmental degradation. Consequently about 5 to 10% of the region's fresh water, forest, the ecosystem have been wiped out by these illegal activities and spreading to un-impacted areas through surface runoff discharge to entire biodiversity, flora, fauna, agriculture, surface water and groundwater in the study area.

The people of Aguobiri whose occupation is predominantly itinerant fishing and peasant farming suffer from the damage that accompanied crude oil spill which devastated the water bodies and endangered the biodiversity. Moreover the people of Aguobiri use the river water for drinking and other domestic purposes hence there is an urgent need to study the quality status of the water and to report environmental impact arising from the activities of crude oil, and to make recommendation to reduce environmental degradation induced by pipeline leakage using geochemical anlaysis of groundwater and surface water in the area.

Brief Geology Of The Study Area**:** The area of investigation, Aguobiri Community in Southern Ijaw Local Government Area of Bayelsa State, Southern Nigeria is underlain by the Benin Formation, Kogbe (1989). Details of the geology and hydrogeology of the Benin Formation have been documented by Reyment (1965). Short and Stauble (1967). Aguobiri Community in Bayelsa State is located within the lower delta plain believed to have been formed during the Holocene of the Quaternary period by accumulation of sedimentary deposits. The major geological characteristic of the area is sedimentary alluvium; loamy clay and sandy soil are also common. The main river in the area is River Nun which is interconnected with various crecks in the Niger Delta. (Fig. 3). The river is very turbid during the wet season due to influx of sediments through surface runoff into it. The river becomes less turbid and clearer during the dry season. It is a tidal environment characterized by alternating flow of the river in the course of each day.

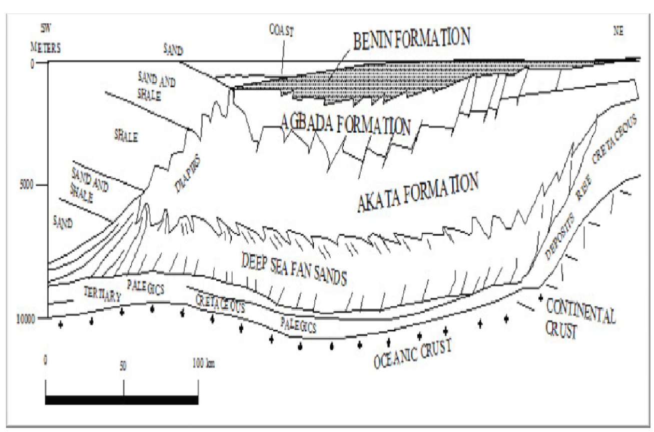

Fig. 2. Sedimentary Formations and Structures in the Niger Delta Basin(Short and Stauble 1967)

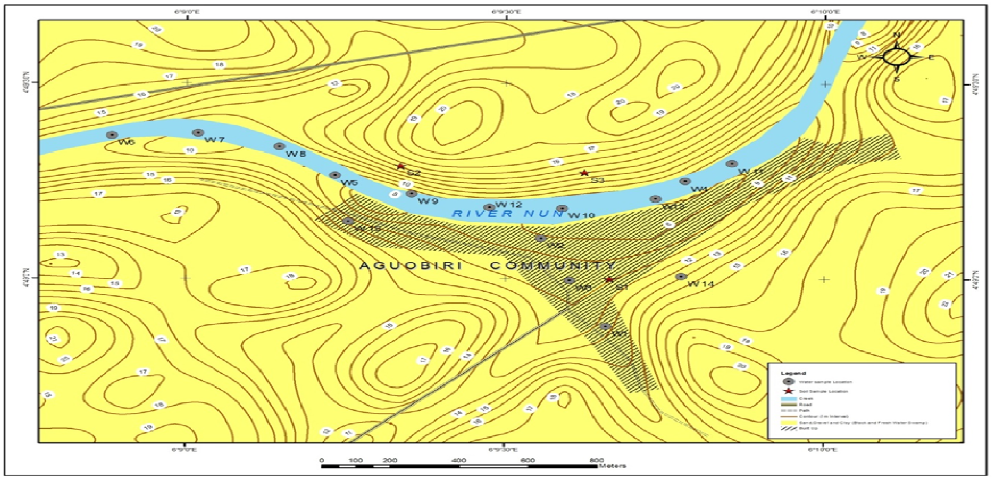

Fig. 3. Geologic Map of the study area showing River NUN and the sample locations

MATERIALS AND METHOD

Fifteen (15) water samples were collected from Aguobiri Community in Southern Ijaw LG.A of Bayelsa State; consisting of two(2) from a functional borehole, three (3) from surface pond water and ten (10) from surface flowing river.

Quality Assurance Test: Parameters such as temperature, p^H, conductivity, salinity were measured insitu on the field, while Total Dissolved Solid (TDS), Turbidity, dissolved oxygen (DO) and others were measured as soon as samples arrived in the laboratory with modern hand held instruments, some of which were based on the principle of electrode potentiometry. Some anionic and cationic constituents; Cl^-, SO_4^{2-}, NO_3^-, NO_2 that are indicators of general water quality were determined within 48 hours, using versatile standard methods.

The Biological Oxygen Demand (BOD), Turbidity (NTU), Total Dissolved Solid (TDS), Total Hydrocarbon Content (THC) and other parameters were determined using standard methods; U.S. EPA (1986), Sawyer et al., (2003). Abbot (1948), Young et. al; (1981).

PRESENTATION OF RESULTS

The analytical results of the physico-chemical parameters determined in this investigation are presented in Tables 1 – 3 below in comparison with FEPA (1991) SON (2002), and DPR (1991) Standards where available
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Table 1: Physcio-Chemical Water Result

Location	pH	Temp ^{0}C	Electrical Conductivity µs/cm	TDS (Mg/l)	Turbidity (NTU)	Acidity (Mg/l)	Alkalinity (Mg/l)
BH1	5.8	27.9	82	41	0.001	22.00	45.76
BH2	5.4	28.3	43	21.5	0.01	11.0	22.88
POND 1	5.8	28.2	136	68	0.09	44.0	83.90
RIVER 1	5.8	28.1	98.0	48.0	0.050	22.01	45.77
RIVER 2	5.8	28.4	28.0	15.0	0.05	BDL	15.26
RIVER 3	6.1	28.2	32.0	15.6	0.003	BDL	30.52
RIVER 4	6.1	28.1	28.0	15.6	0.030	22.01	22.89
RIVER 5	6.1	28.1	28.0	14.0	0.02	11.01	22.89
RIVER 6	6.1	28.2	29.0	15.0	0.013	11.01	22.89
RIVER 7	6.2	27.8	28.0	14.0	0.012	BDL	15.26
RIVER 8	6.2	28.2	4.33	3.0	0.002	BDL	22.0
RIVER 9	5.8	28.3	2.00	0.60	0.020	BDL	7.64
RIVER 10	5.7	28.3	110	56.00	0.020	33.0	38.15
POND 2	5.9	28.3	94.00	48.00	0.016	BDL	30.52
POND 3	5.9	28.3	164	83.00	0.030	44.01	91.54
FEPA	6-8.5	N/S	100	500	5	N/S	100
SON	6.5-8.5	N/S	100	500	N/S	N/S	100
DPR	N/S	N/S	N/S	N/S	N/S	N/S	N/S

Table 2: Presentation of Physico-Chemical Water Result

Location	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	Na^{+} (mg/l)	K^{+} (mg/l)	Hardness (mg/l)	Dissolved oxygen DO (mg/l)
BH 1	8.02	2.44	16.5	21.32	35.59	4.8
BH 2	5.61	0.48	8.7	11.18	222.08	2.0
POND 1	32.06	2.44	27.09	35.36	1423.46	8.80
RIVER 1	21.70	0.97	19.50	25.22	959.04	8.40
RIVER 2	8.01	1.46	5.6	7.28	355.95	4.40
RIVER 3	6.41	0.98	6.2	8.06	284.74	0.80
RIVER 4	60.41	11.98	5.6	7.28	284.74	0.80
RIVER 5	5.61	10.97	5.6	7.28	222.09	1.60
RIVER 6	4.80	10.97	5.8	7.54	213.52	0.80
RIVER 7	5.61	10.97	5.6	7.26	222.08	4.80
RIVER 8	8.01	13.88	2.8	3.64	355.91	5.60
RIVER 9	3.20	14.37	2.2	2.86	142.346	5.20
RIVER 10	19.23	14.38	22.05	28.67	854.16	9.20
POND 2	18.43	12.44	18.08	24.44	818.558	9.20
POND 3	39.28	23.50	32.8	42.64	1743.9	2.8
FEPA	75	50	N/S	N/S	N/S	N/S
SON	75	N/S	200	N/S	150	N/S
DPR	N/S	N/S	N/S	N/S	N/S	N/S

Table 3: Physico-Chemical Parameters

Location	Cl^{-} (mg/l)	SO_4^{2-} (mg/l)	PO_4^{3-} (mg/l)	BOD (mg/l)	Ammonium Nitrogen (mg/l)	TSS (mg/l)
BH 1	26.25	ND	0.02	2.8	ND	0.001
BH 2	13.76	0.75	0.75	1.2	0.34	0.01
POND 1	43.52	0.43	0.34	5.2	0.08	0.09
RIVER 1	31.01	0.18	0.22	3.2	0.48	0.05
RIVER 2	8.98	1.41	0.04	2.4	0.06	0.05
RIVER 3	9.93	0.49	0.22	0.4	0.51	0.05
RIVER 4	8.97	0.03	0.09	0.4	0.03	0.03
RIVER 5	8.97	0.27	0.02	0.8	0.03	0.05
RIVER 6	9.28	0.03	0.05	0.8	0.04	0.06
RIVER 7	4.48	0.16	0.06	2.0	0.05	ND
RIVER 8	4.48	0.90	0.02	1.6	0.08	ND
RIVER 9	3.52	ND	0.03	2.0	0.26	ND
RIVER 10	35.30	ND	0.03	2.4	0.03	0.05
POND 2	30.08	ND	0.04	2.0	0.08	0.05
POND 3	52.48	ND	0.23	1.6	0.05	0.05
FEPA	200	200	N/S	N/S	N/S	N/S
SON	250	100	N/S	N/S	N/S	500
DPR	N/S	N/S	N/S	N/S	N/S	N/S

DISCUSSION

The pH values determined for all the samples fall within the permissible limit given by FEPA (1991) and SON (2002). While accepted values by FEPA, SON and DPR were not available the temperatures measured for the water samples range between 27.8^0 and 28.5^0C, most of the electrical conductivity values measured in the sampled locations fall below the standard permissible limit of 100µs/cm. However, the result obtained for POND 1 and POND 3 are above the threshold value which is probably due to dissolved ions and solid in the open pond and stagnant water.

When compared with standards given as 500mg/l the total dissolved solid (TDS) of the sampled locations are within the acceptable limit (Table 1) and as such does not induce any form of pollution or health implication in human.

The values of calcium (Ca^{2+}) ion in the sampled area (Table 2) range from 3.20 to 60.41mg/l which are within the permissible limit of 75ppm given by FEPA (1991) standard. There is no sign of higher calcium concentration in the study area which may have been due to carbonate rocks and rapid decay of calcareous organisms on the sea floor. In any case there is no documented deleterious effect of calcium to human health.

The concentration of magnesium (Mg^{2+}) ion in the sampled area varies from 0.48 to 23.50mg/l which is within the permissible limit of FEPA (1991) standards given as 50ppm. Similarly sodium (Na^{+}) ion concentration in the sampled area fall within the allowable limit of 200mg/l given by SON (2002).

While there are no stated values by any standard for potassium (K^+) ion, the values obtained for the sampled locations appear relatively low (2.86 – 42.64ppm) and are within allowable limit. High contribution of potassium in water could be from igneous rocks i.e K-feldsparthic rocks and clays, potassium could also be from fertilizer application. Although, potassium is not a useful element to aquatic body it is a source of manure to plants. The hardness values in almost all the samples are above the threshold given by SON (2002) as 150mg/l. Only one sample BH 1 has a value (35.59mg/l) which is within the permissible limit of SON (Table 1). Consequently the water is generally hard; the hardness which is due to magnesium (Mg^{2+}) sodium (Na^+) and bicarbonate (HCO_3^-) ions. However, there is no health implication of hard water except that it produces scales in boiler feed and inhibits foaming with soap in water. The value of dissolved oxygen (DO) varies from 0.80 to 9.20 in the study area. There is no specification or threshold value for DO by any standard; it is the oxygen available for any aquatic body which sustains life.

Values of Chloride (Cl^-) ion obtained for water samples from the area of investigation vary from 3.52 to 52.48mg/l which are within the permissible limits of FEPA (1991) given as 200mg/l and SON (2002) given as 250mg/l, (Table 3). Hence the concentration of chloride (Cl^-) ion does not pose any danger to health, however, higher chloride content may be due to anthropogenic activities of urine and soap in the water. Anon (1970), Ademoroti (1996).

The value of sulphate (SO_4^{2-}) concentration varies from 0.03 to 1.41mgll in the study area which is within the allowable limit of 100mg/l and 200ppm stated by SON (2002) and FEPA (1991) respectively. However, there is no documented effect of sulphate (SO_4^{2-}) ion to human.

Although no stated allowable limits are available for comparison, phosphate (PO_4^{3-}) ion values vary from 0.02 to 0.75 in the study area (Table 3). The source of phosphate is mostly from fertilizer application but, it can also come from paints, waste water from tooth paste etc. Phosphate has no documented deleterious effect on human, but it depletes oxygen in aquatic environment.

For purpose of comparison there are no specified FEPA, SON and DPR standards available for BOD. However, the mean value of BOD in the study area is 1.96mg/l (Table 3). BOD is an expression of the organic load in any aquatic body which is the oxygen demanded for a biodegradable substance to be broken down by the micro-organism. It is an indirect way of assessing pollution in any aquatic body. While it has no effect on human health the following, (Table 4) illustrates the BOD standard for raw water in the study area.

Table 4: BOD Standards (after K_0 tandarama & Ewing (1969)

S/N	Bod values	Strength	Strength in study area
1	0.25 – 1.5	Excellent source	Loc 2, 6, 7, 8, 9
2	1.5 – 2.5	Good source	Loc 5, 10, 11, 12, 13, 14, 15
3	2.5 – 4.0	Porous	Loc 1, 5
4	> 4.0	Rejectable	Loc 3

The values of Ammonium Nitrogen obtained from the sampled locations vary from 0.03 to 0.51mg/l which are above the background value for ammonium nitrogen as nitrite. (Table 3). Ammonium nitrogen is the primary form of nitrogen in any aquatic body and it portrays the level of pollution of the water. Nitrogen depletes oxygen in any aquatic body and nitrogen leads to the formation of blue green algae which eventually leads to euthrophication under anaerobic condition. Higher concentration of ammonium nitrogen as nitrates in water causes cynanosis and ashyxia (blue-baby syndrome) in infants under 3 months. Location 2, 4, and 12 are above the permissible limit of ammonium nitrogen as nitrites.

As indicated in table 5, there are no available specified standards for comparing Chemical Oxygen Demand (COD) but the COD values obtained for samples from the area of study vary from 4.40 to 55.90mg/l. Although COD does not have health implication to human body it is oxygen equivalent for a non-biodegradable substance to be broken down by micro-organism in any aquatic body. Coliform concentration in the area of study range from <0.01 to 0.2mg/l. Whereas WHO recommend zero value for bacteria and pathogens in potable water the study area recorded traces of coliform in the river locations. This is probably due to the fact that the river is used as a toilet and several untreated wastes are discharged into the river aggravating the disease causing organism. For public hygiene coliform are not expected to be present in any drinking water.

Total petroleum hydrocarbon content (TPC) was not present in any of the boreholes sampled but was found in all the river samples, (Table 5). This may have resulted from the loading and reloading of separated crude oil in the area due to the artisanal refineries and the discharge of untreated waste generated by these unsustainable artisanal activities. The river is the only means of transportation and most of the transport ferries are flying boat and wooden boats that use fuel, engine oil and diesel. The products of these boats are not environmentally friendly and hence constitute a threat to aquatic life. It is probably one of the sources of the concentration of the total petroleum hydrocarbon content (TPC) in the water of the study area. When compared with the 10mg/l recommended by the DPR it shows an elevated concentration for any waste water to be discharged into the environment (Figure 4). Consequently, public health is threatened as hydrocarbon associated compound may develop and probably inhibit oxygen which becomes a threat to any aquatic body making the water not potable for human consumption.

Table 5:

Location	COD (mg/l)	Coliform (mg/l)	TPC (mg/l)
Bacteriological/Biological Parameters BH 1	4.40	0	0
BH 2	40.20	<0.005	ND
POND 1	55.20	0.2	ND
RIVER 1	30.10	0.04	15
RIVER 2	42.80	0.05	12
RIVER 3	50.10	0.05	8
RIVER 4	50.10	0.02	5
RIVER 5	50.00	0.04	10
RIVER 6	45.40	0.04	20
RIVER 7	26.80	0.02	50
RIVER 8	20.40	0.01	8
RIVER 9	10.80	0.01	15
RIVER 10	15.10	0.02	20
POND 2	12.50	0.10	0.05
POND 3	35.90	0.05	0.01
FEPA	N/S	N/S	N/S
SON	N/S	N/S	N/S
DPR	N/S	N/S	10
WHO	N/S	0	N/S

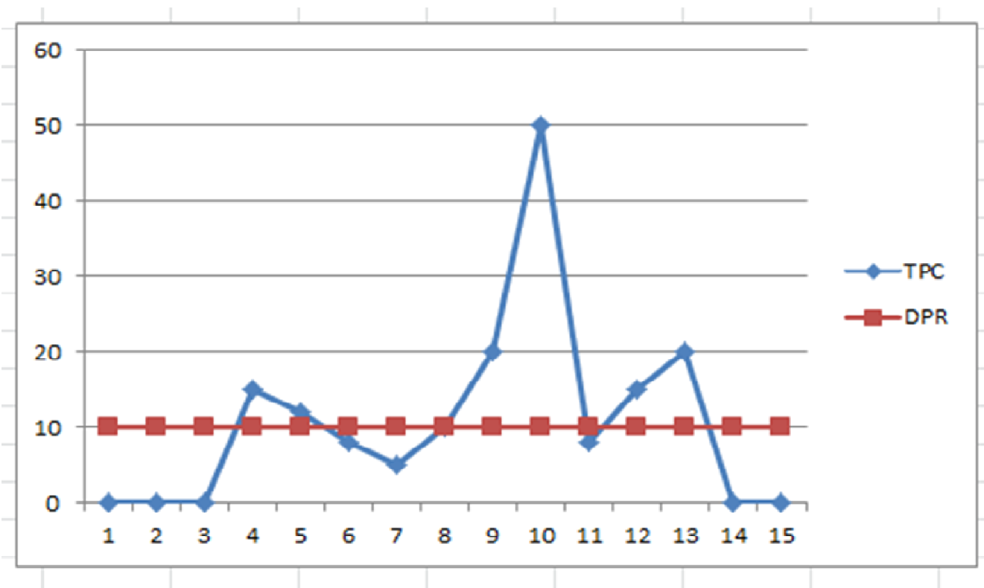

Fig. 4. Graphical Representation of TPC Against DPR

Table 6: Analytical Results for Heavy Metals

Location	Fe (mg/l)	Cu^{2+} (mg/l)	Pb^{2+} (mg/l)	Ni^{2+} (mg/l)	Cd^{2+} (mg/l)	Zn^{2+} (mg/l)	Cr^{6+} (mg/l)	Mn^{2+} (mg/l)	V^{2+} (mg/l)
BH 1	0.18	0.001	<0.001	ND	ND	0.002	0.002	0.001	ND
BH 2	0.21	0.062	<0.003	0.002	0.0001	0.35	0.018	0.176	ND
POND 1	0.41	0.08	0.002	0.034	0.011	0.0052	0.025	0.026	<0.001
RIVER 1	0.68	0.26	0.48	0.06	0.032	0.151	0.019	0.075	0.01
RIVER 2	0.42	0.49	0.069	0.01	0.013	0.062	0.005	0.040	0.03
RIVER 3	0.14	0.074	0.37	0.01	0.019	0.094	0.002	0.047	0.005
RIVER 4	0.42	0.057	<0.05	0.02	0.015	0.073	0.003	0.047	0.07
RIVER 5	0.37	0.059	0.024	0.02	0.013	0.062	0.042	0.036	0.002
RIVER 6	0.21	0.62	0.01	0.02	0.016	0.078	0.005	0.031	0.002
RIVER 7	0.12	0.41	0.01	0.04	0.013	0.062	0.005	0.039	0.01
RIVER 8	0.01	0.031	0.028	0.02	0.074	0.006	0.017	0.031	0.02
RIVER 9	0.09	0.042	0.029	0.01	0.0001	0.008	0.004	0.003	0.004
RIVER 10	0.38	0.52	0.19	0.02	0.009	0.047	0.011	0.026	0.007
POND 2	0.36	0.026	0.001	0.03	0.006	0.031	0.008	0.017	<0.008
POND 3	0.43	0.016	<0.05	0.001	0.004	0.021	0.016	0.012	<0.005
FEPA	0.3	1	0.05	N/S	N/S	5	N/S	0.1	N/S
SON	0.3	1	0.05	0.02	0.003	3	0.05	0.2	N/S
DPR	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S

The analytical results of the heavy metals in the water samples from the area of investigation are presented in Table 6. A detailed discussion on the concentration of heavy metals in surface water in Aguobiri Community will be provided separately in a different publication. However, the analytical results indicate that Pb^{2+}, Cd^{2+}, Fe^{2+} and Ni^{2+} are above recommended value for any drinking water in some of the locations.

In particular the concentration of lead (Pb^{2+}) in River 1, 2, 3, 5, 8, 9 and 10 are above the threshold value which is alarming. The aggravated lead concentration in the study area can be traceable to the high values of total hydrocarbon content (TPC) which is a reflection of the unsustainable illegal refinery waste products and the indiscriminate dumping of waste into the river. The river water in the area is polluted with lead.

Conclusion And Recommendation : The foregoing report shows that pH, TDS, TSS, Turbidity, Mg^{2+}, Na^+, Ca^{2+}, K^+, SO_4^{2-}, PO_4^{3-}, Cl^- determined in the water samples from Aguobiri Community are within permissible limit by comparison with FEPA (1991) and SON (2002) standards. However, the concentration of some heavy metals, Pb^{2+}, Cd^{2+}, Fe^{2+}, Hardness and TPC were above the threshold value. Traces of coliform were found in a number of the river and pond water samples indicating that the river and pond water were probably contaminated with feacal wastes. However, the borehole water samples did not show any coliform concentration. The river and pond water in the Aguobiri Community are not potable. The treatment of the water before drinking is strongly recommended for the area. Also holistic measures should be addressed to protect pipeline leakage as well as enact laws and guidelines at all levels of government to curb the menace of artisanal refineries and bunkers in the region.

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