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Concentration and Environmental Implication of Heavy Metals in Surface Water in Aguobiri Community, Southern Ijaw Local Government Area, Bayelsa State, Nigeria

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ABSTRACT: Geochemical analysis for Fe, Cu^{2+}, Pb^{2+}, Ni^{2+}, Cd^{2+}, Zn^{2+}, Cr^{6+}, Mn^{2+} and V^{2+} has been carried out on water samples collected from various location points in Aguobiri Community in Southern Ijaw Local Government Area of Bayelsa State. The analyses were done to determine the environmental status and suitability of the water in the area for drinking and domestic uses. Fifteen (15) water samples were collected from rivers, pond and boreholes located across the Aguobiri Community and analysed for heavy metals, bacteriological and physico-chemical parameters. The analytical results indicate the following ranges of concentrations for the heavy metals; Fe (0.01 – 0.68mg/l) Cu^{2+} (0.001 – 0.62mg/l) Pb^{2+} (<0.001 – 0.48mg/l) Ni^{2+} (0.001 – 0.06mg/l) Cr^{6+} (0.002 – 0.042mg/l), Mn^{2+} (0.001 – 0.176mg/l) and V^{2+} (0.002 – 0.07mg/l) When compared with standards recommended by the various regulatory bodies most of the values, particularly the river samples are above the permissible limits. Consequently most of the water in the Aguobiri Community of Bayelsa State are considered not potable. Hence there is a need for holistic and sustainable monitoring and treatment of water before drinking in the area. © JAS EM

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Metallic elements that have relatively high densities (0.4g/cm^3) and are toxic or poisonous at low concentrations; are termed heavy metals. Common examples include: Mercury (Hg) Cadmium (Cd) Lead (Pb), Zinc (Zn), Chromium (Cr), Copper (Cu) etc; (Njoku and Ayoka 2007).

These metals are natural components of the earth's crust and cannot be degraded or destroyed. Just like trace elements, some heavy metals (e.g Copper, Selenium, Zinc) are essential for maintaining the metabolism of human body; nevertheless, at higher concentrations, they can lead to poisoning. Heavy metal poisoning can result from drinking contaminated water e.g lead pipes. Heavy metals are dangerous because they tend to bioaccumulate and as the compounds accumulate in living things anytime they are taken up and stored faster than they are broken down (metabolized) or excreted.

The heavy metals can enter water supply through industrial and consumer waste or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers and groundwater, (Kronberg et. al; 1979) (Wong and Li, 2002). Over the years there has been increased public awareness of potential dangers of heavy metals to the ecosystem and in particular to human health (Meilor, 2001). Also special attention has been given to the great ecological significance of heavy metals due to their toxicity and accumulative behaviour, (Purves, 1985).

In this investigation geochemical analysis for Fe, Cu^{2+}, Pb^{2+}, Ni^{2+}, Cd^{2+}, Zn^{2+}, Cr^{6+}, Mn^{2+}, and V^{2+} has been carried out on water samples collected from various locations across Aguobiri in Southern Ijaw Local Government area of Bayelsa State. Aguobiri community is one of the pipeline communities in which Shell Petroleum Development Company (SPDC) laid their pipes in 1973 to serve as a conduit to transport crude oil from the flow station. The people of Aguobiri use the river water for drinking and other domestic purposes. Moreover, the occupation of Aguobiri people is predominantly itinerant fishing and peasant farming; hence they suffer from the damage that accompanied crude oil spillage which devastated the water bodies and endangered the biodiversity. Therefore, the geochemical analysis as well as the total petroleum hydrocarbon content (TPC) were done to determine the concentration of heavy metals as well as the environmental

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implication for surface water in the area of investigation.

MATERIALS AND METHOD

Water samples consisting of two (2) from a functional borehole, three(3) from surface pond water and ten(10) from surface flowing river were collected from different locations across Aguobiri Community in Southern Ijaw Local Government Area of Bayelsa State (Fig. 1). These samples were then taken to the laboratory for different analysis. Some physico-chemical and biological, parameters were determined within 48 hours using versatile standard methods. The heavy metals were determined using the atomic absorption spectrophotometer (AAS); the model used is SOLAAR969 UNICAM series Total hydrocarbon Content (THC) was determined through the following procedure; 250ml of water were filled with bourma bottles extracted with tetrachloro ethylene or xylene. A pitch of fuvin was added to 20ml, 30ml in the fraction for proper extraction. Separating fuel was used for filtering standards that were prepared in the range of 0, 100, 300, 400 and 500 from crude oil standard for calibration of the instrument. After filteration and addition of flovin to remove any possible biogenic oil; readings were taken with the instrument at wavelength with respect to equipment available at 550nm in gas chromatography and UV.

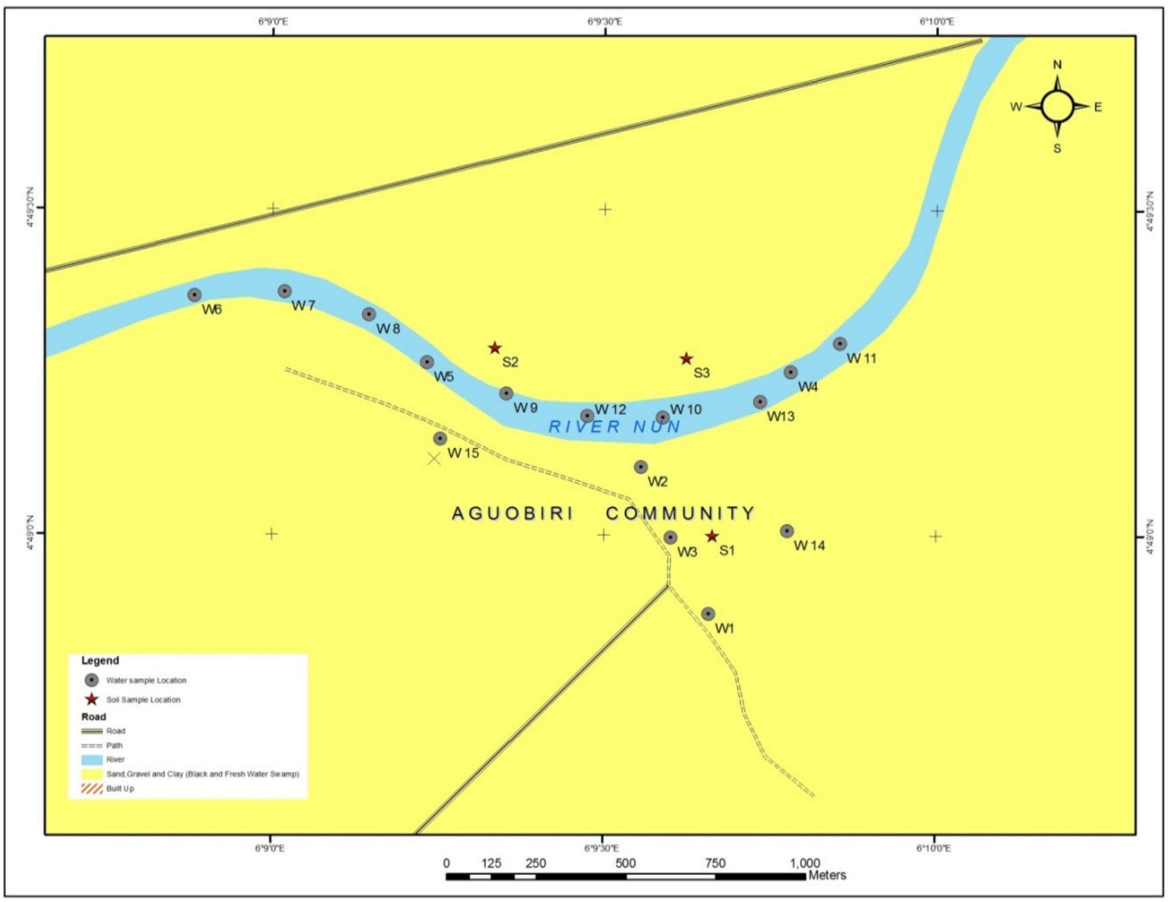

Fig. 1. Location Map showing the sampled points

RESULTS AND DISCUSSION

The results of the total hydrocarbon content (TPC) and the concentration of heavy metals in the water samples collected from the area of investigation are presented in Table 1in comparison with standards like FEPA (1991) WHO (2006), DPR and SON(2002)

TABLE 1: PRESENTATION OF TPC AND HEAVY METALS RESULT

.

Location	TPC(mg/l)	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	0.18	0.001	<0.001	ND	ND	0.002	0.002	0.001	ND
BH 2	ND	0.21	0.062	<0.003	0.002	0.0001	0.35	0.018	0.176	ND
POND 1	ND	0.41	0.08	0.002	0.034	0.011	0.0052	0.025	0.026	<0.001
RIVER 1	15	0.68	0.26	0.48	0.06	0.032	0.151	0.019	0.075	0.01
RIVER 2	12	0.42	0.49	0.069	0.01	0.013	0.062	0.005	0.040	0.03
RIVER 3	8	0.14	0.074	0.37	0.01	0.019	0.094	0.002	0.047	0.005
RIVER 4	5	0.42	0.057	<0.05	0.02	0.015	0.073	0.003	0.047	0.07
RIVER 5	10	0.37	0.059	0.024	0.02	0.013	0.062	0.042	0.036	0.002
RIVER 6	20	0.21	0.62	0.01	0.02	0.016	0.078	0.005	0.031	0.002
RIVER 7	50	0.12	0.41	0.01	0.04	0.013	0.062	0.005	0.039	0.01
RIVER 8	8	0.01	0.031	0.028	0.02	0.074	0.006	0.017	0.031	0.02
RIVER 9	15	0.09	0.042	0.029	0.01	0.0001	0.008	0.004	0.003	0.004
RIVER 10	20	0.38	0.52	0.19	0.02	0.009	0.047	0.011	0.026	0.007
POND 2	0.05	0.36	0.026	0.001	0.03	0.006	0.031	0.008	0.017	<0.008
POND 3	0.01	0.43	0.016	<0.05	0.001	0.004	0.021	0.016	0.012	<0.005
WHO		0.30	0.5	0.01	0.02	0.003	0.3	0.05	0.1	
FEPA		0.30	1.0				0.5		0.1	
DPR	10									
SON		0.30	1.0	0.01	0.02	0.003	3	0.05	0.05	0.01

DISCUSSION

Iron: While the recommended value for Iron (Fe) by SON (2002) and FEPA (1991) is 0.3mg/l, the iron (Fe) concentration in the study area ranges from 0.01 – 0.68mg/l. The values determined from River 1, 2, 4, 5, 10 and Pond 3 are either above or slightly above the threshold value. Iron is an essential element to the human body, hence higher iron concentration does not pose a threat to the human health. However, it stains laundry and induces incrustation, brownish and rusty colouration. The iron (Fe) can be derived from a marshy environment and also from acidic soils. A graphical representation of iron against FEPA and SON standards is shown in Fig 2.

*Copper:*The concentration of copper ranges from 0.001 to 0.62mg/l which is within the permissible limit of 1mg/l recommended by SON (2002) and FEPA (1991). The study area appears to be free of copper poisoning because higher copper concentration is injurious to human health as copper aggravates gastrointestinal disorder in man.

Lead: Lead (Pb) concentration in the area of investigation ranges from <0.01 to 0.48mg/l while the recommended value of lead (Pb) by SON (2002), WHO and FEPA (1991) is 0.01mg/l. Values of lead (Pb) concentration in the boreholes and two of the ponds are within the permissible limit but concentration of lead (Pb) in River 1, 2, 3, 5, 8, 9 and 10 are above the threshold. A graphical representation of lead against SON and FEPA standards is shown in Fig. 3.

The aggravated lead concentration in the study area can be traceable to the high values of the total hydrocarbon content (TPC) resulting from the illegal refineries waste product and the indiscriminate dumping of waste into the rivers.

Nickel: The concentration of Nickel in the study area ranges from 0.001 – 0.06mg/l whereas the recommended value by SON (2002) and WHO is 0.02mg/l. Invariably samples from River 1, 7 and Pond 1 and 2 exceeded the permissible level for any drinking water (ATSDR, 1998)**.**

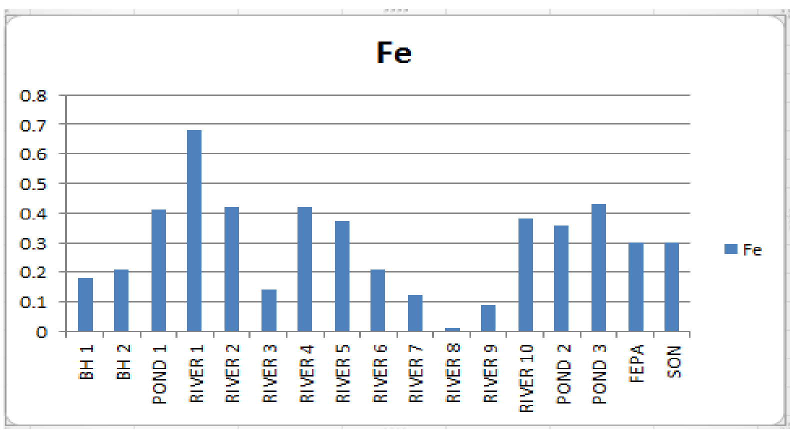

Fig. 2: A graphical representation of iron against FEPA and SON

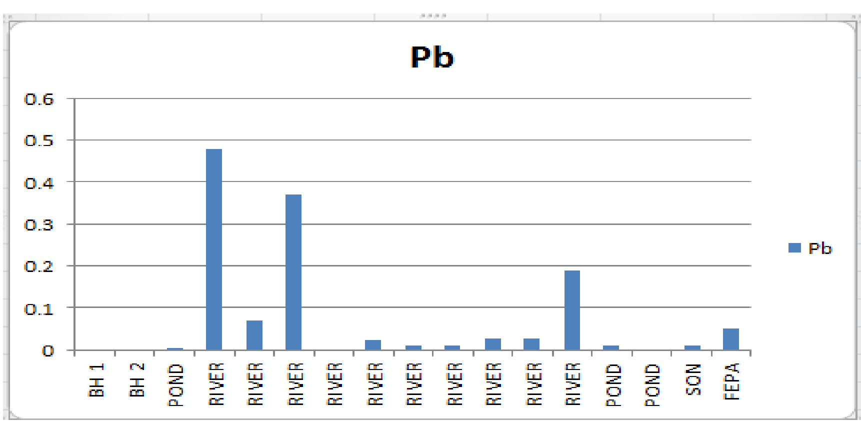

Fig. 3: A graphical representation of lead against FEPA and SON

Cadmium: The concentration of cadmium in the study area varied from 0.0001 to 0.074mg/l, whereas the maximum allowable limit recommended by SON (2002) for any dirking water is 0.003mg/l. This implies that the concentration of cadmium (Cd) in most of the rivers and ponds were above the limit. A graphical representation of cadmium concentration in comparison with SON standard is shown in Fig. 4. The higher concentration of cadmium in the rivers and ponds may be traceable to oil and grease from the engine boats. The major source of Cadmium to the environment is dry cell batteries but a high concentration of cadmium in the environment is toxic and can affect the kidney if taken.(Satarng et. al; 1984).

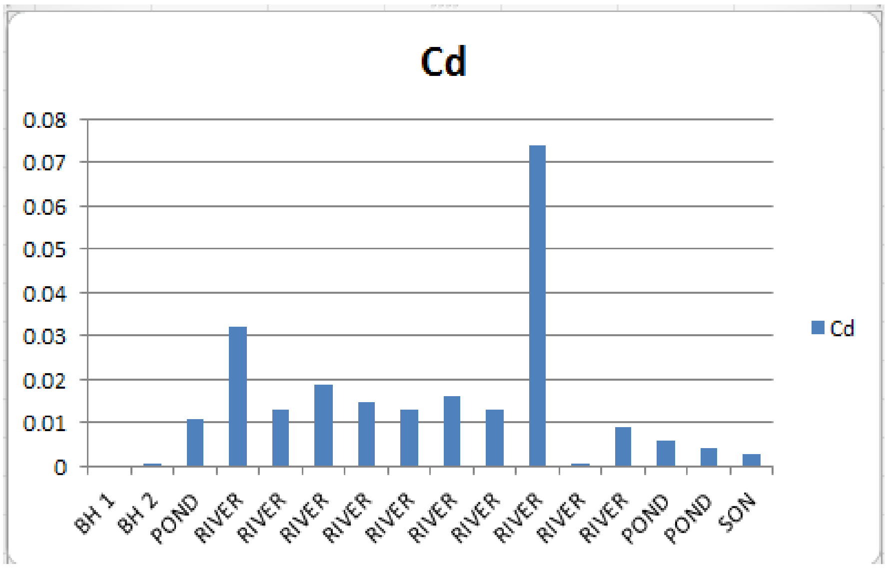

Fig. 4: A graphical representation of Cadmium against SON.

Zinc: The concentration of Zinc (Zn) in the area of investigation varies from 0.002 to 0.151mg/l which in comparison with SON (2002) and FEPA (1991) are below the permissible limit of 3mg/l and 5mg/l respectively. Zinc is an essential element for human reproduction especially for child bearing women, Gupta and Gupta (1998).

Chromium: Chromium (Cr) concentration in the study area ranges from 0.002 to 0.042mg/l which is within the permissible limit of 0.05mg/l for SON (2002). However, excessive concentration of chromium in the aquatic body tends to bioaccumulate in the fish. The fish will then become poisonous to the consumers which can aggravate complication in the human system (ATSDR, 1998).

Manganese **:** The concentration of Manganese (Mn) in the area of investigation varies from 0.001 to 0.176mg/l which is within the permissible limit of 0.2mg/l set by SON (2002) for any drinking water.

Vanadium **:** The concentration of Vanadium in the study area varies from <0.001 to 0.07mg/l (Table 1). While the concentration of Vanadium in water is a function of the geographical location, Vanadium is considered an essential element for certain green algae, Arnon and Wessel (1953). However, excessive concentration of Vanadium accumulate in the human lungs resulting in potent respiratory irritant, suggesting asthmatic risks (Miramand and Fowler 1998), (Letty et al; 2006).

Conclusion : The foregoing report has shown significantly high concentrations of some heavy metals in rivers and pond waters across Aguobiri Community in Southern Ijaw LGA, Bayelsa State.

When compared with standards stipulated by WHO, SON, FEPA and DPR the concentrations of Lead (Pb^{2+}), Iron (Fe^{2+}), Nickel (Ni^{2+}), Cadmium (Cd^{2+}) and Total Hydrocarbon Content (TPC) were above the permissible limits in the water samples obtained from the area of investigation. Traces of coliform and contamination of feacal wastes have earlier been reported in the rivers and ponds in this area (Egai et. al; 2013).

The high concentration of the heavy metals and total hydrocarbon content in most of the rivers and ponds in Aguobiri Community portrays that the surface water is not suitable for drinking and domestic purpose. In essence there is a threat to public health in the area as the water is unsafe and not potable.

Consequently there is an urgent need for proper monitoring and treatment of water before drinking. Moreover, the activities of the artisanal refiners and oil thieves that are probable sources of the contaminants should be checked by the appropriate government agencies.

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