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Assessment of Water Quality in Isaka, Okrika Nigeria

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Abstract:- Coastal communities have been heavily influenced by anthropogenic pollution. The environmental issues are the enrichment of water with organic matter leading to eutrophication and pollution by industrial chemicals and oils. This study assessed groundwater, surface water, sediment and soil. Samples were collected from two boreholes, one hand-dug well, river water, water sediment and top soil located in Isaka Town, Okrika Local Government Area, Rivers State, Nigeria, where the entire population rely only on groundwater from boreholes. Worst still, the lack of public power supply and the possible breakdown of generating sets used in pumping water from the borehole oftentimes make the people susceptible to the use of unprotected hand dug wells. Prescribed international procedures were used to measure physicochemical and microbiological parameters of each of the samples obtained, which include pH, EC, TDS, salinity, chlorine, Phosphate, Nitrate, DO, BOD, TPH, PAH and microbial plate counts. From the laboratory analysis measured, pH of boreholes, hand dug well sediment and soil values 6.44, 5.57, 5.84, 4.34 and 3.96 respectively were below the recommended limits of 6.5 - 8.5(WHO;NSDWQ;NESREA). Salinity for boreholes and hand dug well with values 66mg/I, 96mg/I and 76mg/s respectively were a bit high but within the limit of 200mg/l , meanwhile for surface water, EC, TDS and Salinity values of 45440, 24990 and 15840 respectively were high above the recommended limits by NESREA Chlorine and BOD of water samples were not within limits, EC, Sulphate, TPH and PAH contents of sediment and soil values were high. There were traces of Cadmium and Zinc metals in surface water, sediment and soil samples. For microbiological analysis, all samples recorded total fecal counts, therefore groundwater not fit for drinking. Water treatment plants should be put in place to secure the health of the inhabitants. High salinity could be attributed to industrial and degrading activities in the area, leading to saltwater intrusion. Appropriate methods of control should be put in place by regulatory authorities.

***Keywords*:-** *Water Quality, Salinity, Public Health, Water Treatment, Isaka, Okrika, Nigeria.*

I. INTRODUCTION

Water is life. Clean or potable water is crucial to human health. Groundwater is the only available natural resource for consumption in Isaka Town.

Salinization is a growing major global water quality challenge affecting water resources and the natural ecosystem (Nelson, et al, 2003., Caned- Arguelles et al., 2016).

Salinity is currently growing at a rate of 10% per year. It can be referred to as the concentrations of salts in water.

Studies have established that water salinity causes massive vulnerabilities in the environment. This destroys the ecosystem, degrades the soil productivity and creates challenging health problems among inhabitants. However, improving water quality is an important element of the United Nation's Sustainable Development Goals (SDGs). To reach associated water quality targets, data collection and sharing have been communicated as important steps (UN Environment, 2018; Transforming our World, 2017),

Consequently, salinization of water resources may arise from natural causes, from atmospheric deposition, saltwater intrusion and human activities liked industrial wastes disposal, waste mismanagement and dredging activities. Dredging causes physical disturbance and may result in redistribution of pollutants through release from the sediment.

In Nigeria, encountering freshwater in aquifers of over time due to the influx of saline water from the sea (Popoola et al., 2020).

It is a major problem where groundwater is the principal source of water. It will apparently result in the depletion of the water table and increase in salinity through sea intrusion. Increased groundwater salinity may be related to high concentrations of some elements like sodium, Sulphate boron (IAEA, 2000-2004), stored deep in soil.

In the Niger Delta region, a stumble potential effect of groundwater salinization could be either through saline intrusion by shifting saline/freshwater interface in dredged areas or infiltration from the placement of dredged marine sand (Abam and Oba, 2018). In a study carried out between 1995 and 1998 on the sodium chloride and chloride content of groundwater in coastal location of Port Harcourt showed average concentration of 250mgil in boreholes (Ujile, 2017).

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Also, significant increase in chloride levels in groundwater system was experienced at the Amadi- Ama axis after dredging activities of the Amadi Creek towards the end of 1997and early part of 1998. This have created fault zones, which are permeable, thereby enhance saltwater intrusion into the aquifers (Nwachukwu and Odjegba, 2001). Similar trends were observed in the Diobu and Moscow Road areas of Port Harcourt metropolis, capital of Rivers State, Nigeria, and other coastal towns and villages in the region especially around mangrove swamps, sandy islands and estuaries. In the same vein, excessive abstraction of groundwater could result in a decreased seaward flow of fresh groundwater allowing saline water to enter and penetrate the aquifer. This may progressively displace the freshwater thereby increasing the salinity depth (Ngah,2009).

Salinization of streams and rivers can threaten ecosystems and their constituent species. Many plants tolerate higher salinity for short periods but cannot survive long periods of inundation as well (Barrett-lennard, 2003).

Salinity intrusion and increased salinity in water and soil have serious negative impacts on humans like respiratory health as well as mental health thereby increasing various types of health risks among coastal people.

The effect of higher salinity on health are seen in low-income communities where water is in sufficiently treated or not treated at all. But exposure to high salinity can happen not only through drinking water but also through other indirect routes such as cooking, bathing and occupation (Vineis et al., 2011).

Many studies have reported a range of health problems due to increased salinity exposure among coastal populations that include hypertension and miscarriage among pregnant women, skin diseases, acute respiratory infection and diarrheal diseases. The causal link between salt consumption and rise in blood pressure (BP) is strongly evident from scientific research (He et al., 2013; Aburto et al., 2013).

Heavy salt intake increases the risk of coronary heart disease which is the single most important risk factor for stroke. Cardiovascular diseases is responsible for 62% of strokes and 49% of coronary heart disease (Baten and Titumir, 2016).

Additionally, densities of salinity-tolerant mosquitoes can increase by salt water intrusion and expansion of brackish water bodies in coastal zones. Recent findings suggest that malaria and dengue mosquito vectors possess the capacity to tolerate salinity variations and undergo preimaginal development in brackish waters (Ramasamy and Surendran,2012).These findings show that several health disturbances including mental, physical and reproductive health are highly prevalent.

It is however, more imperative to promote alternative drinking water sources with mass level awareness creation and community sensitization against bad practice of high table consumption. Based on the need for research on the quality of ground and surface within the coastal zone of Isaka Town, physicochemical and microbiological analysis on groundwater, surface water, sediment and soil were carried out to assess the quality of the water systems in the area and it's suitability for consumption and domestic purposes.
The strategic location of Isaka, being Sports Centre, proximity to industrial and economic activities has made this assessment important.

II. MATERIALS AND METHODS

- *Study Area*
- *Map of Study Area*

Fig. 1:- Aerial Map showing Isaka Town, Okrika Local Government Area with Sampling Location.

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S/No.	LOCATION CODES	LATITUDE	LONGITUDE	Town
1.	IS-WW	4°44'14.68"N	7° 0'4.36"E	Isaka Town
2.	IS-BW	4°44'14.60"N	7° 0'4.43"E	Isaka Town
3.	IS-GW	4°44'22.42"N	6°59'59.86"E	Isaka Town
4.	IS-RW	4°44'28.44"N	7° 0'8.70"E	Isaka Town
5.	IS-WS	4°44'27.39"N	7° 0'5.13"E	Isaka Town
6.	IS-TS	4°44'25.46"N	7° 0'3.76"E	Isaka Town

Table 1:- Coordinates of the Study Area (Isaka, Okrika Local Government)
.* IS-WW is Well water, IS-BN is Borehole water (1), IS-GW is Borehole water (Government), IS-RW is River water, IS-WS is Water Sediment, IS-TS is Top Soil

- *Description of Study Area*

Isaka Town is an island located in the northern part of Okrika Local Government Area of Rivers State,Niger Delta region,South-South Nigeria (Figure 1).The area is characterized by mangrove swamps and vegetation round the shoreline.Transportation to Isaka Town is only through boats and helicopter. Main occupation of the people is fishing and farming. The climate in Isaka is characterized majorly by two seasons-wet and dry.The wet season begins in March and ends in October with a peak in June and July.Try season begins in November and ends in February. Annual mean rainfall in the area is over 3000mm.Isaka is distinguished by its beautiful scenery and cool atmosphere from the effect of the sea breeze. Average annual temperature of the area is about 28°C.

Isaka developed as the first Tourist Beach in Rivers State in the early 1970's derives it water supplies from a federal government borehole sunk in 2014and linked to all houses in the study area and three unprotected hand - dug wells.

Host to the first Sports Institute in Rivers State, Isaka is bounded by the Bonny River and faced by oil terminals Macoba (producers of industrial chemicals, they channel their wastes into the sea), National Oil, Oando Oil, Ibeto Cement, which has stopped production few years back but contributed to wastes influx.

Residents in the study area practice open defecation into the water body. Domestic wastes is often dumped and burnt by the shore at the back of the community. Also, artisanal crude refining is on-going around the area.

III. DATA COLLECTION AND METHOD

The original aim of groundwater and surface water sampling was based on providing an analysis to investigate the current level of pollution for the aquifer system and the river water.

For this purpose, Six (6) samples from boreholes, hand-dug well and river water, sediment and soil were collected in the month of November, 2020 (wet season). Sampling locations are shown in figure 1. Location and sample point positions were gotten with the use of a hard held Global Positioning System (GPS) device. The water samples, sediment and soil were analyzed according to standard method of examination of water (APHA-AWWA-WPCF, 1995, 2005)? and reported in WHO standards for drinking water.

IV. RESULTS AND DISCUSSION

Parameters	Unit	BH-1	BH-2	H-D Well	Surface Water
pH		6.44	5.57	5.84	7.15
Temperature	0ºC	28.3	28.4	28.5	28.7
Ec	Us/cm	175	311	213	45440
Salinity	mg/l	66	96	76	15840
Turbidity	NTU	1	2	1	1
TDS	mg/l	96.25	171.1	117.2	24990
Chlorine	mg/l	20	29	23	4.798
Phosphate	mg/l	0.23	1.2	0.45	1.56
Nitrate	mg/l	0.5	1.5	0.8	2.4
DO	mg/l	7.9	9.2	8.8	8.3
BOD	mg/l	0.54	0.29	0.96	3.17
TPH	mg/l	0.41	0.25	0.49	0.64
PAH	mg/l	0.002	0.001	0.003	0.24

Table 2:- Bore Hole/Hand-Dug Well/Surface Water (Isaka, Okrika Local Government Area)

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EC is Electrical Conductivity, TDS is Total Dissolved Solids, DO is Dissolved Oxygen, BOD is Biochemical Oxygen Demand, TPH is Total Petroleum Hydrocarbon and PAH is Polycyclic Aromatic Hydrocarbon.

PARAMETERS	UNITS	SEDIMENT
Temperature	^{0}C	27.9
pH		4.34
Electrical Conductivity	ms/cm	15.850
Phosphate	mg/kg	2.43
Sulphate	mg/kg	650
Nitrate	mg/kg	1.04
Total Petroleum Hydrocarbon (TPH)	mg/kg	323.93
Polycyclic Aromatic Hydrocarbon (PAH)	mg/kg	1.388
Sand%		79.96
Silt %		4.44
Clay %		15.6
Textural Class		SCL

SCL: Sandy Clay Loam

Table 3:- Physicochemical Content In Sediment (Isaka, Okrika Local Government Area)

PARAMETERS	UNITS	SOIL
pH		3.96
Temperature	^{0}C	27.9
Electrical Conductivity	µs/cm	5.5
Phosphate	mg/kg	0.79
Sulphate	mg/kg	2
Nitrate	mg/kg	0.32
Total Petroleum Hydrocarbon (TPH)	mg/kg	91.17
Polycyclic Aromatic Hydrocarbon (PAH)	mg/kg	0.391
Porosity		0.407
Textural Class		SCL
Sand%		84.08
Silt %		1.32
Clay %		14.6

SL: Sandy Loam

Table 4:- Physicochemical Properties In Soil (Isaka, Okrika Local Government Area)

Heavy Metals mg/l, mg/kg	Bore Holes		Hand – Dug well	Surface water	Sediment	Soil
	BH -1	BH-2				
Lead	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.001	0.001	0.001	0.037	6.320	4.480
Cadmium	0.001	0.001	0.001	0.050	0.001	0.001

Table 5:- Heavy Metal Concentration Of Samples (Isaka, Okrika Local Government Area)

Plate counts	Bore Holes		Hand – Dug Well	Surface Water	Sediment	Soil
	BH- 1	BH-2				
THBC	$1.02X10^5$	$2.07X10^5$	$1.70X10^5$	$1.88X10^5$	$9.65X10^2$	$2.01X10^5$
TFC	$26.50X10^5$	$5.95X10^3$	$5.35X10^3$	$4.7X10^3$	$2.35X10^3$	$3.1X10^4$
TCC	O	$2.1X10^3$	$7.0X10^2$	$1.35X10^3$	O	$1.4X10^4$
TSSC	$3.5X10^2$	$4.95X10^3$	O	O	$4.6X10^3$	$4.5X10^3$
TVC	O	O	O	$5.00X10^2$	$6.2X10^3$	O

THBC is Total Heterotrophic Bacterial Count, TFC is Total Faecal Count, TCC is Total Coliform Count, TSSC is Total Salmonella-Shigella Count and TVC is Total Vibrio Count

Table 6:- Microbiological Content Of Samples (Isaka, Okrika Local Government Area)

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➢ *Water Analysis*

➢ *Temperature*

Water temperature is a physical property expressing how hot or cold water is. The mean value for the water samples is 28.5°c. Temperature is a major influence on biological activity and growth. It also has an effect on water chemistry and govern the kinds of organisms that live in water bodies (ÛSGS, 2021). Also, the rate of chemical reactions increases at higher temperatures.

➢ *pH*

It is used to express the intensity of acidic and alkaline condition of the water. Water from the two boreholes and hand-dug well are acidic with values 6.44, 5.57 and 5.84 respectively while surface water with value, 7.15 is alkaline. WHO has recommended maximum permissible limit of pH from 6.5 to 8.5 (WHO, 2017). Also, (NSDWQ, 2015). The pH of all four samples were in the range of 5.57-7.15. The boreholes and hand-dug well was found to be below the recommended limit, only the surface water was within the limit by WHO and NESREA.

➢ *Electrical Conductivity*

This is a measure of water capacity to convey the electric current in water. This signifies the total number of dissolved acids(Gold Mann and Horne,1983). The values of electrical conductivity were in the range of 175us/cm, 311us/cm, 213us/cm and 45440 for BH-1, BH-2, HD-W and S-W respectively. The boreholes and hand-dug well were within the recommended limit of 1000us/cm for WHO and 1500us/cm for NSDWQ except the surface water which had high values. This could be attributed to surface runoff, industrial discharges and sewage leakages.

➢ *Total Dissolved Solids (TDS)*

TDS indicates presence of dissolved solids in water and also the behavior of salinity in groundwater. TDS values ranged from 96.25NTU to 24990NTU. The boreholes and hand-dug well were within recommended limit of 600NTU(WHO) and 1000NTU(NSDWQ) except surface water with value, 2499NTU which is above the limit.

➢ *Chlorine*

High chlorine in drinking water may not hurt at first but may have long term health effects. WHO recommended limit for chlorine is 5mgil while NSDWQ is 0.1-0.2mg/l. All the values for chlorine is above the limits especially the boreholes and hand-dug well which were very high.

➢ *Salinity*

Drinking water salinity has been linked to risk of preeclampsia and gestational hypertension. Over extraction of groundwater and dredging may cause salinity in water.

Salinity values varied from 66mg/l to 15840mg/l in the boreholes, hand-dug well and surface water respectively. The boreholes and hand-dug well were within WHO's limit of 200mg/l but the surface water salinity value of 15840 which is very high.

- *Turbidity*

High Turbidity in water can provide hiding places for microorganisms and thereby shield them from disinfection process. Turbidity values for boreholes,hand-dug well and surface water were 1NTU,2NTU,1TNU and 1NTU respectively. These values are below the recommended limit of 5NTU,WHO(2017).

- *Phosphate*

Phosphate values for water samples were BH - 1(0.23mg/l);BH - 2(1.2mg/l), H - D well (0.45mg/l) and surface water (1.56mg/l). The allowable limit for phosphate in drinking water is 0.5mg/l (WHO,2017),with the results obtained, BH - 2 with value 1.2mg/l is unfit for drinking, H-D well is close to the limit. For surface water with limit 3.5mg/l (NESREA,2011) the surface water 1.56mg/l was within the limit .

- *Nitrate*

Nitrate values were 0.5mg/l,1.5mg/l,0.8mg/l and 2.4mg/l boreholes, hand-dug well and surface water respectively. The values are within WHO recommended limit of 50mg/l and NESREA limit of 9.1mg/l

- *Dissolved Oxygen*

Dissolved Oxygen values for boreholes,hand-dug well and surface water were 7.9mg/l, 9.2mg/l and 8.3mg/l respectively and are within limits of WHO (6mg/l).

- *Biochemical Oxygen Demand*

BOD values for boreholes,hand-dug well and surface water were 0.54mg/l, 0.29mg/l, 0.96mg/l and 3.17mg/l respectively. WHO limit for BOD is 0.002mg/l while NESREA(surface water)is 3.0. The results obtain show that BOD in the water samples is high, not within the limits.

➢ *Total Petroleum Hydrocarbon (TPH)*

TPH values for water samples were 0.41mg/l, 0.25mg/l, 0.49mg/l and 4.64mg/l respectively. This indicates traces of hydrocarbon in the water. However, pollution can be from industrial discharges, pipeline leakages, or artisanal oil refining in the area.

➢ *Polycyclic Aromatic Hydrocarbon (PAH)*

These enter the environment from a variety of combustion processes and are carcinogens of greater and lesser potency. PAH values recorded were 0.002mg/l, 0.001mg/l, 0.003mg/l and 0.24mg/l respectively for boreholes, hand-dug well and surface water. This indicate traces of pollution.

- *Sediment*

Temperature of sediment recorded 27.9°c. The pH of 4.34 denotes the high acidity level of sediment which can affect aquatic life. Electrical conductivity of 15850ms/cm was high, this could be due to industrial wastes. Phosphate value of 2.43mg/kg and nitrate value of 1.04mg/kg were within NESREA standards. Sulphate value was 650mg/kg, this is high and above recommended limits. TPH values at 323.93mg/kg is high indicating presence of toxic substances which can pollute the water body and aquatic life. PAH

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content of 1.388mg/kg was recorded, these adsorbs strongly to the organic fraction of sediments. Sediment is more of sandy nature and has textural class; Sandy clay loam.

- *Soil*

Soil was acidic in nature with value 3.96.Temp.27.9°c,EC value was 5.5ms/cm. Phosphate, sulphate and nitrate values were 0.79mg/kg,2mg/kg and 0.32mg/kg respectively. TPH and PAH values of 91.17mg/kg and 0.39mg/kg was recorded indicating presence of hydrocarbon in soil which can contaminate groundwater, surface water and agricultural produce, thereby may have negative effect to human and aquatic life. Porosity of soil was 0.407, Textural class; Sandy loam.

- *Heavy Metals*

Lead concentration values in all six samples recorded 0.001mg/l which is within limit. Zinc values recorded were 0.001mg/l in groundwater samples only surface water value was 0.037 which is above NESREA limit of 0.01mg/l for aquatic life. Sediment and soil recorded 6.320mg/kg and 4.480mg/kg respectively. Cadmium values recorded were 0.001 mg/l/kg in five samples except surface water which recorded 0.050 mg/l. NESREA limit of 0.005 mg/l and WHO 0.003 mg/l indicates contamination of surface water which may affect aquatic plants and animals and also human life.

- *Microbiology*

THBC was recorded in all six samples with the highest value in BH - 2 (2.08×10^5) TFC was also recorded in all six samples with the highest value in BH -1(26.50×10^5) TCC was recorded in BH - 2, Hand - dug well, surface water and soil. TSSC was recorded in four samples, BH - 1, BH - 2, Sediment and Soil. TVC was recorded in only surface water and sediment. The presence of fecal coliforms in drinking water indicates contamination with fecal matter and therefore not fit for drinking.

V. CONCLUSION

The results obtained from this study show that pH values for all samples (except surface water) were acidic and below the limits of WHO, NSDWQ and NESREA. EC, Salinity and TDS values of surface were high . Chlorine in boreholes and hand-dug wells were higher than limit of 5mg/l (WHO) the limit of 0.1 - 0.2 (NSDWQ). BOD was higher than the limit of 0.002mg/l. There were contamination of petroleum hydrocarbon and PAH in drinking water, sediment and soil.

Sulphate value in sediment was higher than the recommended limit of 100mg/kg (NESREA) Soil Textural class was sandy loam. Concentration of heavy metals in the samples analysed were in the order of high to low - Zn >Cd>Pb. Microbial contamination was high in samples analysed. Fecal contaminat of drinking water is a serious problem in the study area.

The study assessed water quality and salinity content in ground/ surface water in Isaka Town, Rivers State, Nigeria using physicochemical analysis of sampled ground and surface water. The study shows that the groundwater is acidic which could have negative health effects on residentsthe surface water is slightly basic.The study also shows that groundwater has elevated salinity concentrations.The surface water also recorded high salinity content, with indication of salt intrusion into the boreholes and well.Traces of petroleum hydrocarbons were recorded in the water system. The shallow groundwater table allows pollutants from surface and surface water into the groundwater system. There is need for government's intervention by the provision of water treatment plants to the town. Also enforcement of strict compliance to existing environmental laws and regulations by industries and constant monitoring of the water resources in the area must be mandatory. Education of the populace of the town on the salinity quality of the water they consume, so as to reduce their salt intake and to boil the water they consume because of microbial contamination.

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