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EVALUATION OF RADIONUCLIDE CONTENTS OF WATER IN NGO RIVER, ANDONI LOCAL GOVERNMENT AREA OF RIVERS STATE IN NIGERIA

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Abstract:

The research work covers the activity concentration of radionuclide contents of water in Ngo River, Andoni L.G.A of River State, Nigeria due to anthropological activities. The samples were collected at ten (10) different points in Ngo River, Andoni L.G.A, Rivers State. The collected samples were taken to laboratory for analysis and evaluations of the radionuclide concentration present, and ^{40}K, ^{226}Ra and ^{232}Th were found. The Gamma-Ray NaI(TI) Spectrometer was used to analyze and evaluate the activity concentration of radionuclide ^{40}K, ^{226}Ra and ^{232}Th in the samples. The mean activity concentration in water from the study area are 55.30 ± 4.26 Bql^{-1}, 22.80 ± 4.03 Bql^{-1} and 79.76 ± 9.17 Bql^{-1} which exceeded the world average values of 27.6 Bql^{-1}, 10 Bql^{-1} and 1 Bql^{-1} for water respectively. The high rate of activity concentration of radionuclide contents present has enhances serious threat to residents and the environment which could be attributed to the activities of oil companies, maritime activities and dumping of waste in the river. The result of the study indicates high level of health risk to the populace in the area.

Introduction

The exposure to radiation comes naturally from both the outer space and within the earth crust. The radiological activities from the oil and gas companies in the region have enhance the level of radiation and therefore pose serious threat to occupancies of the environment and entire people of the region.

The incessant death and health challenges in the area lead to this major research, to ascertain the significant level of radiation in the water. The exposure results come from both natural and artificial sources (Ajayi et al., 2012).

Naturally radionuclide depends wholly on the earth properties of the region and flow differently as from the upper stream of the river to the downstream of the river (UNSCEAR, 2000). The radionuclides are noted to be carried by serious flow of rain fall which wash them into the river Essiett et al, 2018).

However, the man-made activities has been noted as additional sources of radiation which enhanced level of the occurring radionuclide present in water in the region that has rich naturally radionuclide naturally (Adetutu *et al.,* 2018). This can occur when the anthropogenic activities, such as oil and gas exploration or exploitation takes place in the environment, oil spills in surface water, and most time, on the ground is washed away into the river.

These radionuclide which deposited in water, when taking into the body contained outrageous number of health hazards in the body. The recommended value for drinking water for save consumption is $1.0Bq^{-1}$ (WHO, 2004).

Activity concentration of ^{40}K, ^{226}Ra and ^{232}Th in water

The growing number of sources of anthropogenic radionuclides in the river was observed to include the atmospheric weapon test fallout, global nuclear test, discharges from nuclear installation dumping of radioactive material waste in the river and spills during maritime activities (Avwiri *et al.,* 2014).

The reason for evaluating the activity concentration content of ^{40}K, ^{226}Ra and ^{232}Th in the water, is to ensure the dose consumption (intake) of $0.1msy^{-1}$ is not exceeded by the occupancies of the region as recommended by the (ICRP, 1991) and (IAEA, 1996).

The objectives of this study is to determine and evaluate the activity concentration of radionuclide contents in Ngo River, Andoni L.G.A of Rivers State in Nigeria and to determine the radiological health hazards from the activity concentration of the radionuclide inorder to enlighten occupant with measures and guidelines in the environment.

Radium is a naturally occurring isotopes found in the earth's crust, a member of the uranium ^{238}U decay series. The predominant radium isotopes in water are ^{226}Ra, alpha emitter and beta emitter. In the study it was noted ^{226}Ra is an earthly alkaline element and most radium salt are soluble in water such which enriched river water (Onunugbo and Nwaka, 2017).

MATERIALS AND METHODS

2.1 Study Area

The Study Area is Ngo River. Ngo Town is the Headquarter of Andoni Local Government Area of Rivers State in Nigeria. The Ngo Rivers links with the Atlantic Ocean through Bonny Sea. It lies within geographical coordinates of $4^{o}29'02"N$ Longitude to $4^{o}30'43"N$ and $7^{o}24'31"E$ Latitude to $7^{o}28'30"E$. The sea water is being used extensively by the Andoni People for different purposes which include birthing, washing, cooking and drinking. The major means of transportation of the people in this area is through water; and as such engine boats are used which spills oils /fuels on the water. Oil and gas activities are ongoing in the area by multinational companies such shell plc, Amni oil plc, Chiveron, Green Energy Plc, etc. Most of these company's boats when capsize with goods enhance the radiological concentration of the water in the area. In addition illegal bunkeries and incessant dumping of waste from oil and gas companies in the river including abandon dredges and old pipes also contributed. Fig 1.1 shows the map of the area.

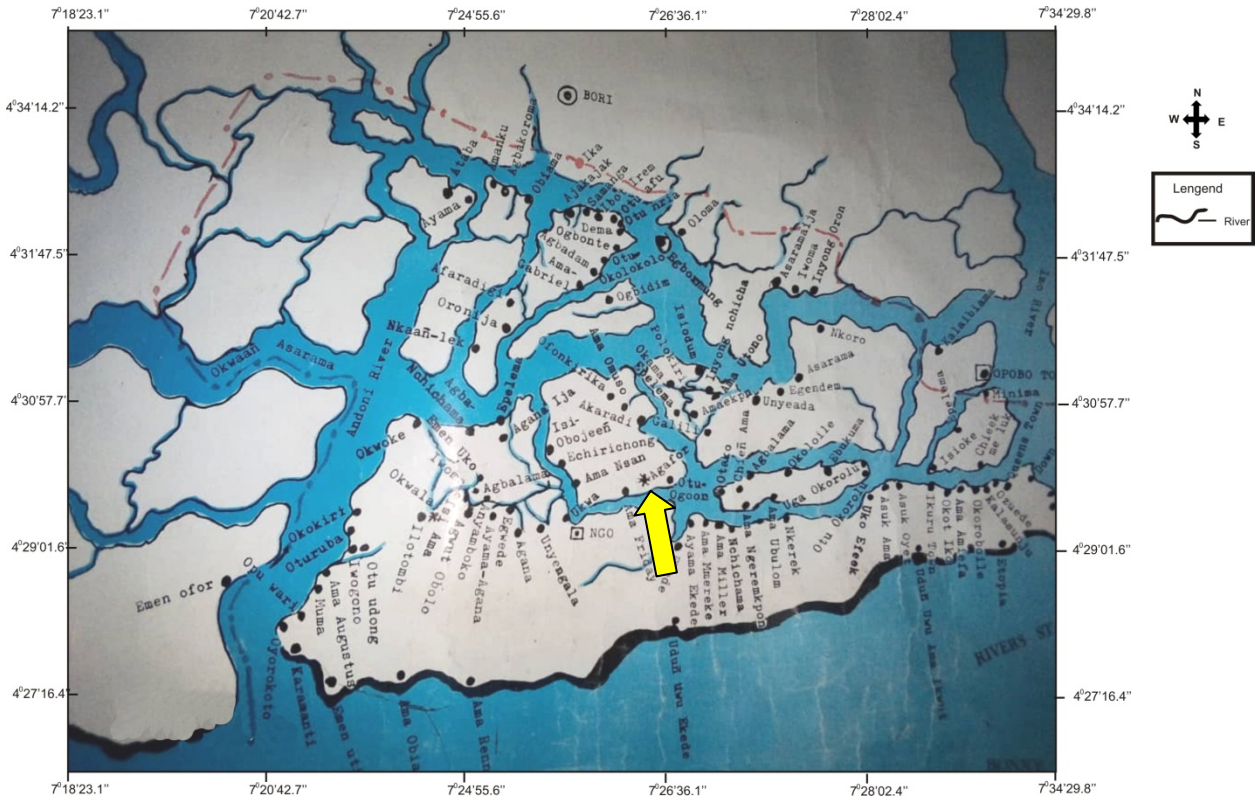

Fig 1 Map of Study Area

2.2 Sample collection and Sample preparation

Inorder to evaluate the activity concentration of radionuclide contents of the water in Ngo River, a total of ten (10) water samples were collected from different spots along the river. These cut across 5 (five) communities which include Ngo, Ekede, Ama – Frdiay, Otako and Agbalama. The water samples were collected using plastic bottle containers that contain 2 litres of water, which was cleans with nitrate acid to avoid clippings of radionuclides on the walls of the plastic container and also to prevent microbial activities. Then the samples were taken to the laboratory for analysis of the radionuclides contents and activity concentration for 4 weeks which cover 28 days of secular equilibrium (Avwiri et al., 2007). The temperature of about 70^{o} was used for gradual evaporation of the water in the oven to ascertain the level of activity concentration of

radionuclide content. The element ^{40}K,(Potassium) ^{226}Ra (Radium) and ^{232}Th (Thorium) were found present in the sample.

2.3 Experimental:

The instrument known as gamma ray spectrometer was used to analyses the water samples. This opt research and analysis was done in Nuclear Institute of Radiation Protection and Research (NIRPR), University of Ibadan, Nigeria.

The HPGe detector used in the analysis was proficient with the high energy resolution with duly 80% efficiency. The calibration of the instrument was of standard mostly recommended by multi Gamma Ray Standard (MGS6M315) (Andrew and Len, 1993).

In quest for identifying the various radionuclide contents that may be present in the water samples, the samples were observed as they emit energies and the detector performed, through standard source of well-defined energies. Samples were both determined by the activities decay of their product and measuring of 14608Kev gamma rays emitted during the decay of ^{40}K.

The radionuclide contents present are ^{40}K, ^{226}Ra and ^{232}Th in the water samples respectively, which was counted in the HPGe detector for 36000 seconds. Thereafter, the empty plastic container was counted to verify the background for 10 hours (Ononugbo *et al.*, 2013). The number of counts of activity concentration of radionuclide in the water samples is given by the below formula Bql^{-1}.

$$A\ (Bq^{-1}) = \frac{C_n}{\in_y P_y t_c V} \qquad (1)$$

Where C_n is the net peak area at gamma ray energy ϵ_y is the efficiency of the detector. P_y is the emission probability of the radionuclide of interest, t_c is the total count time(s) and V is the sample volume in litres.

2.4 Risk and Hazard Evaluation

The risks and indices such as Annual Effective dose, Absorbed dose and Excess lifetime cancer risk was calculated from the activity concentrations of ^{40}K, ^{226}Ra and ^{232}Th in the water samples using standard dose equation (USA-EPA, 2012).

2.5 Statistical Analysis

A bar chart and Histogram chart of ^{40}K, ^{226}Ra and ^{232}Th activities concentration are compared with their standard (WHO) standard to verify their regulatory limits.

RESULT AND DISCUSSION

The result of activity concentration of radionuclides ^{40}K, ^{226}Ra and ^{232}Th are presented in Table 1 while the comparison with the radiation indices parameters are presented in Table 2.

Fig 1 to Fig 3 shows the statistical comparison of the absorbed dose, annual effective dose equivalent and excess life cancer risk compared with the World average values while Fig 5 to Fig 7 shows the statistical comparison of radiological Indices of the activity concentration of ^{40}K, ^{226}Ra and ^{232}Th in water with the standard.

The mean result values obtained from sea water of ^{40}K, ^{226}Ra and ^{232}Th are 55.304 ± 4.26 Bql^{-1}, 22.803 ± 4.03 Bql^{-1} and 79.76 ± 9.17 Bql^{-1} respectively. When compared with World average values for ^{40}K, ^{226}Ra and ^{232}Th, it was observed that the value exceeds the world average values of 27.6 Bq/l^{-1}, 10 Bq/l^{-1} and 1 Bq/l^{-1} for ^{40}K, ^{226}Ra and ^{232}Th respectively as shown in table 1.

However, when the various collection points where compared generally with the world average value of 27.6 bq^{-1} for ^{40}K, it was observed that two points out of ten points only were below the average weight value. The point AFW8 and AGW10 is accepted to be within the limit value. The points when compared with standard for ^{226}Ra (Bq/l) and ^{232}Th (Bq/l) were all higher than the standard value, and such clear infection of water as an increase in concentration was observed.

The mean activity concentration exceeding the world average values could be attributed to industrial exploration and exploitation activities both on onshore and offshore, Boat Capsizing with materials, incessant sea pirate, Pipeline vandalism, unconditional spilling of fuel from engine boat and flying boat, unconditional dumping of waste in the sea.

The radiological hazard indices presented in table 2, shows that the absorbed dose rate ranged from 44.06 $nGyhr^{-1}$ to 88.70 $nGyhr^{-1}$ with mean value of 63.11 $nGyhr^{-1}$, annual effective dose ranged from 0.05 $mSvy^{-1}$ to 0.11 $mSvy^{-1}$ with mean value of 0.08 $mSvy^{-1}$, annual gonnadal effective dose ranged from 296.55 $mSvy^{-1}$ to 598.58 $mSvy^{-1}$ with mean as 426.14 $mSvy^{-1}$ and excess lifetime cancer risk ranged from 0.19 x 10^{-3} to 0.38 x 10^{-3} with mean value of 0.27 x 10^{-3} . When the result is compared with the world average values of 57$nGyh^{-1}$, 1 $mSvy^{-1}$, 300 $mSvy^{-1}$ and 0.29 for absorbed dose rate, annual effective dose, annual gonnadal effective dose and excess lifetime cancer risk it was observed that the result is higher than the world average value for absorbed dose rate and annual gonnaldal effective dose but annual effective dose and excess lifetime cancer risk were below the world average values.

Thus this high dose intake may be attributed to flowing and washing of industrial waste in the river, constant spilling of fuel during transportation as the major means of movement in the area and industrial and anthropological activities in the area.

Table 1 Activity Concentration Results in Water

S/N	Samples location	ACTIVITY CONCENTRATION		
		^{40}K (Bq/l)	^{226}Ra (Bq/l)	^{232}Th (Bq/l)
1	NGW 1	33.40 ± 3.00	30.54 ± 4.85	84.07 ± 7.31
2	NGW 2	61.93± 4.09	27.08± 3.76	118.53± 8.33
3	NGW 3	113.90 ± 3.46	20.93 ± 4.49	51.95 ± 10.11

4	NGW 4	88.76 ± 4.00	15.16 ± 3.99	101.30 ± 14.14
5	NGW 5	71.60 ± 4.69	17.55 ± 3.73	100.52 ± 7.95
6	ECW 6	40.17 ± 5.92	28.62 ± 3.22	59.78 ± 12.63
7	AFW 7	34.85 ± 4.74	32.84 ± 4.92	80.15 ± 6.80
8	AFW 8	23.01 ± 5.00	24.00 ± 4.47	86.42 ± 7.52
9	OTW 9	67.73 ± 3.16	15.93 ± 4.52	68.40 ± 7.73
10	AGW 10	17.69 ± 4.53	31.31 ± 2.37	46.47 ± 9.15
	MEAN VALUE	**55.304±4.26**	**22.803 ± 4.03**	**79.76 ± 9.17**
	WHO (2004)	**27.6**	**10**	**1**

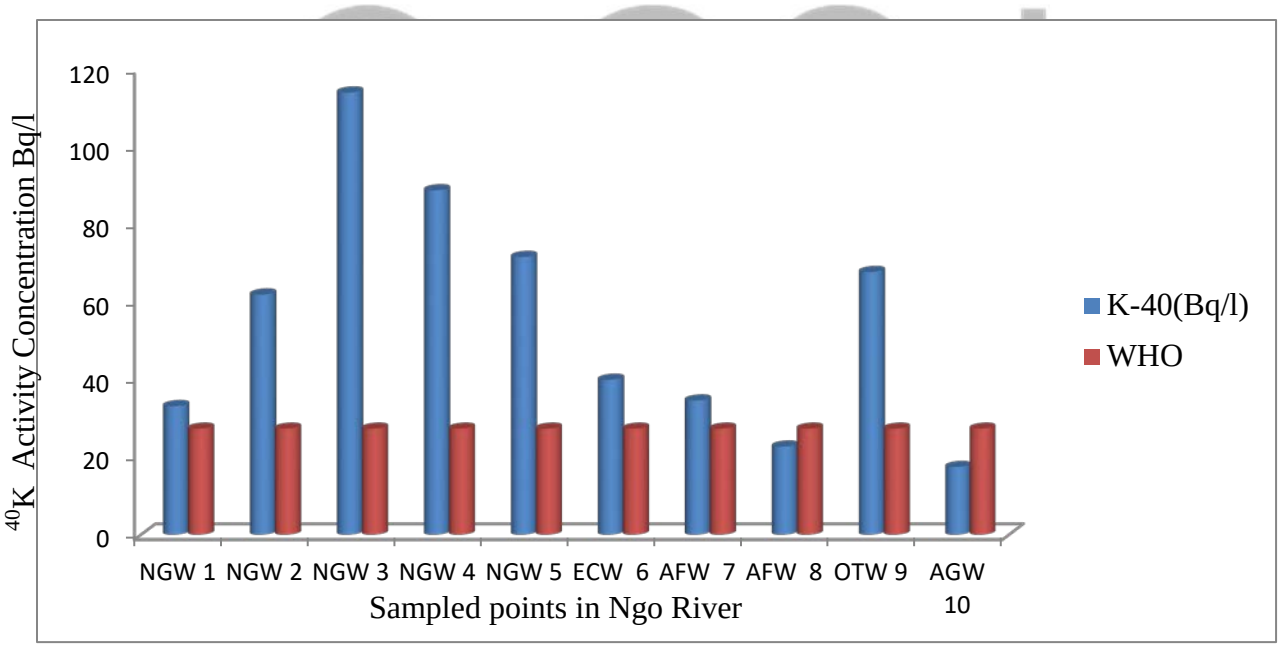

Fig 2: Comparison of ^{40}K activity concentration (Bq/l) in Sea Water with WHO standard from Ngo River, Andoni

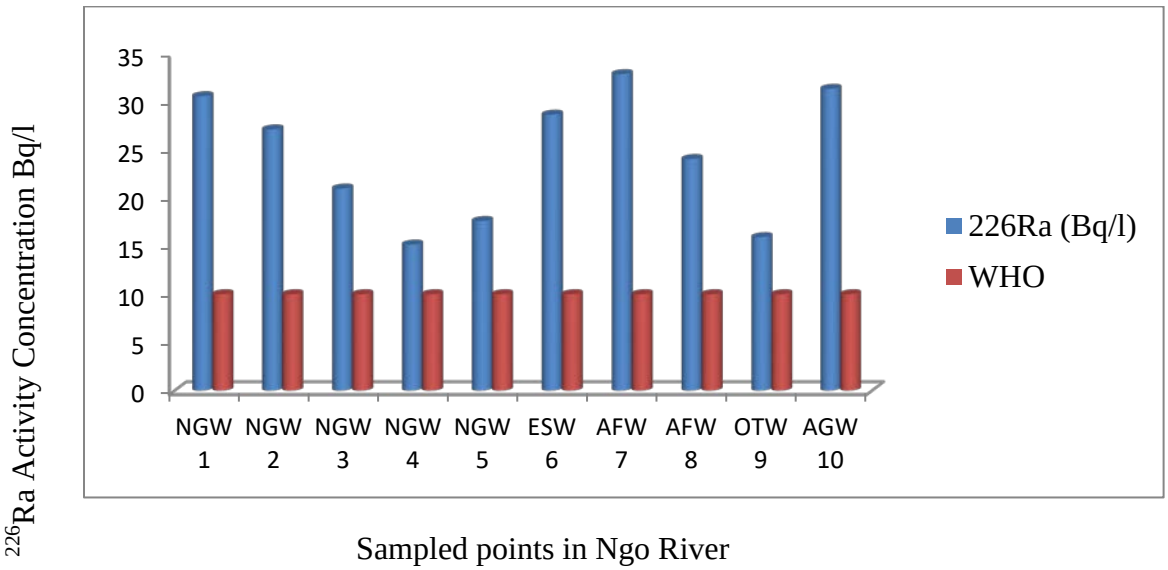

Fig 3: Comparison of ^{226}Ra activity concentration (Bq/l) in Sea water with WHO standard from Ngo River, Andoni.

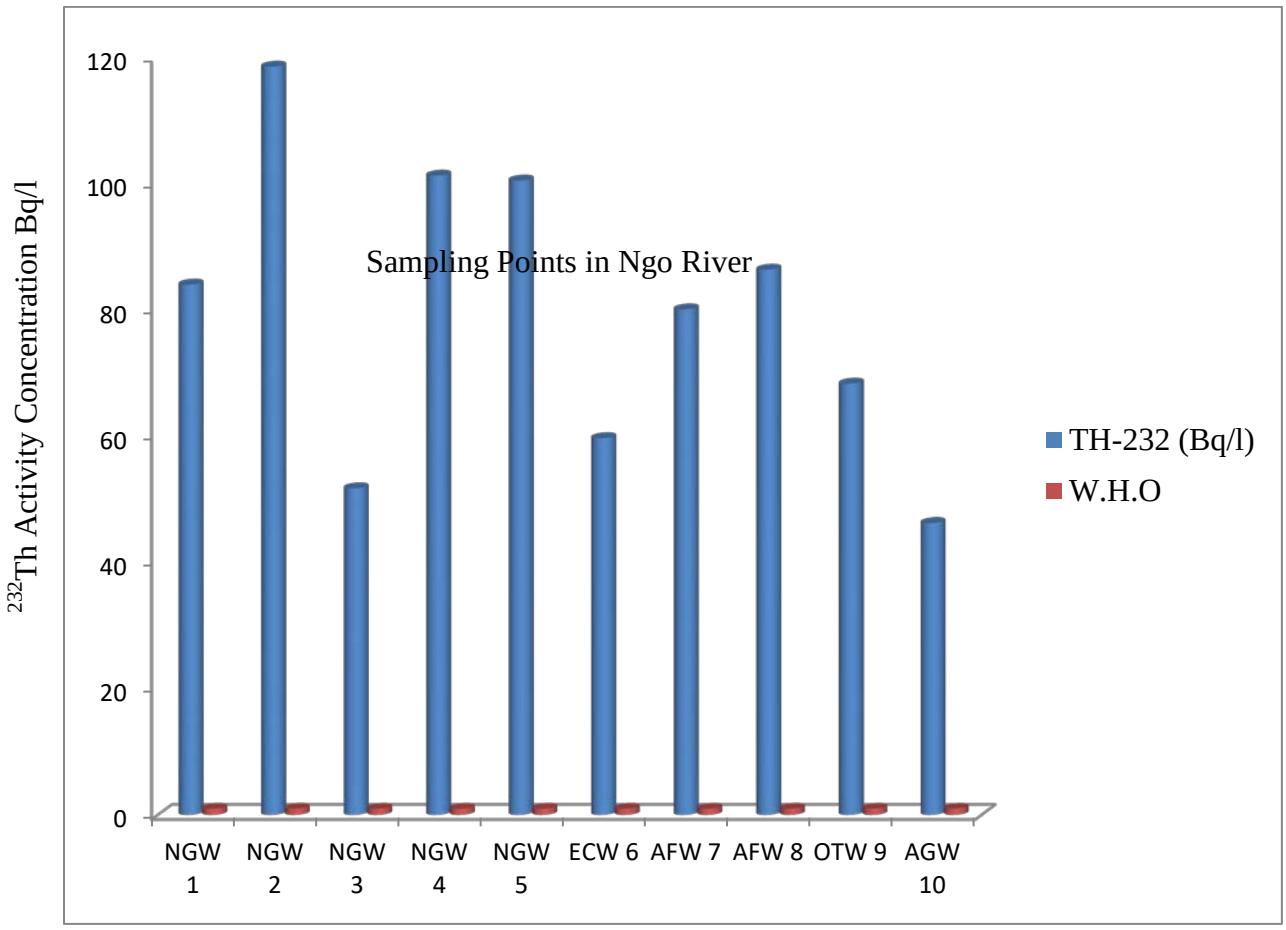

Fig 4: Comparison of ^{232}Th activity concentration (Bq/l) in Sea Water with WHO standard from Ngo River, Andoni

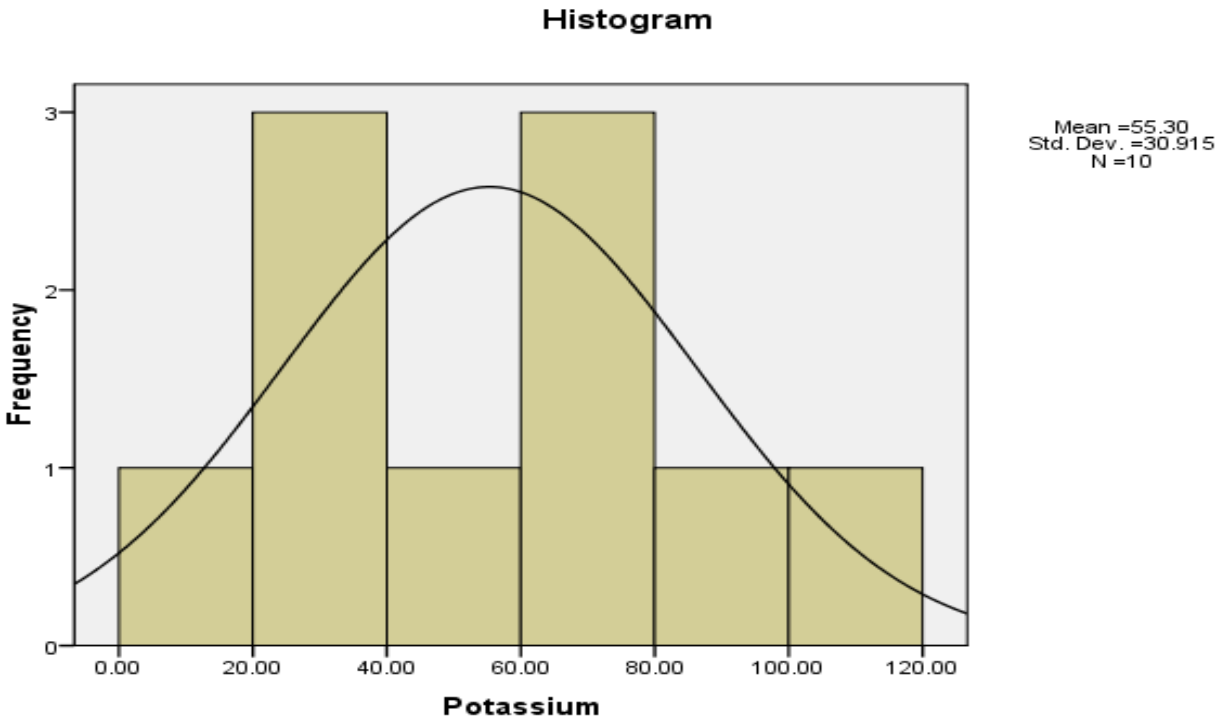

Fig 5. Chart of Activity Concentration of ^{40}K in water

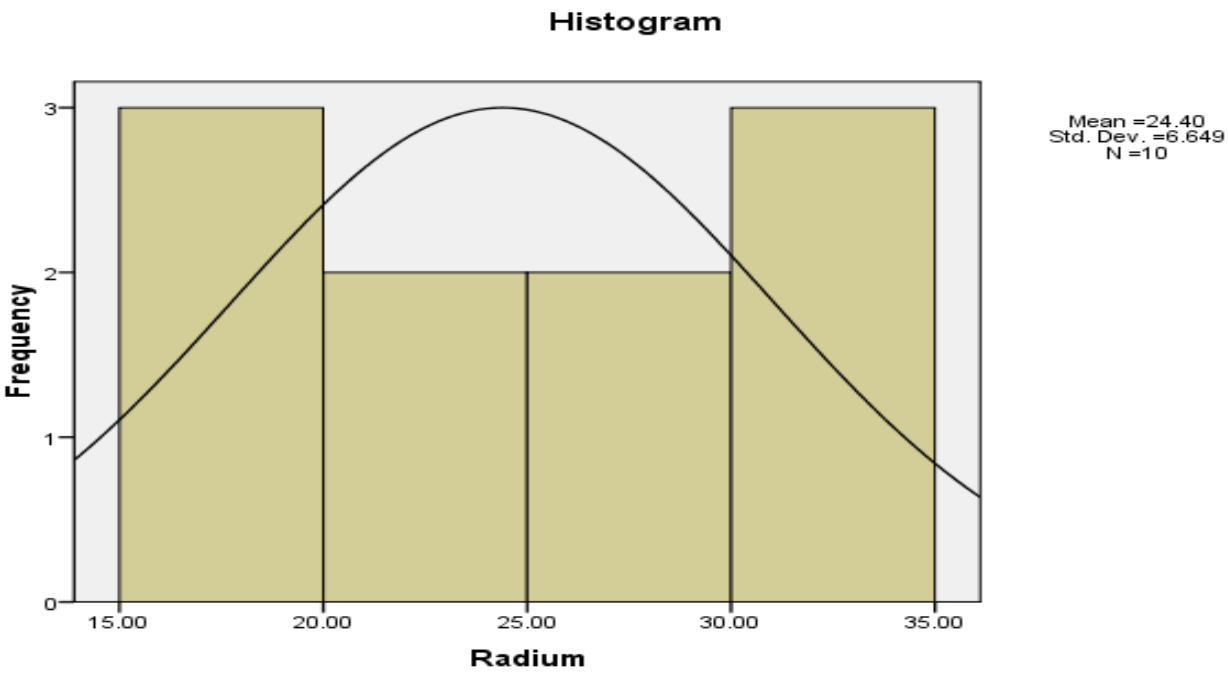

Fig 6. Chart of Activity Concentration of ^{226}Ra in water

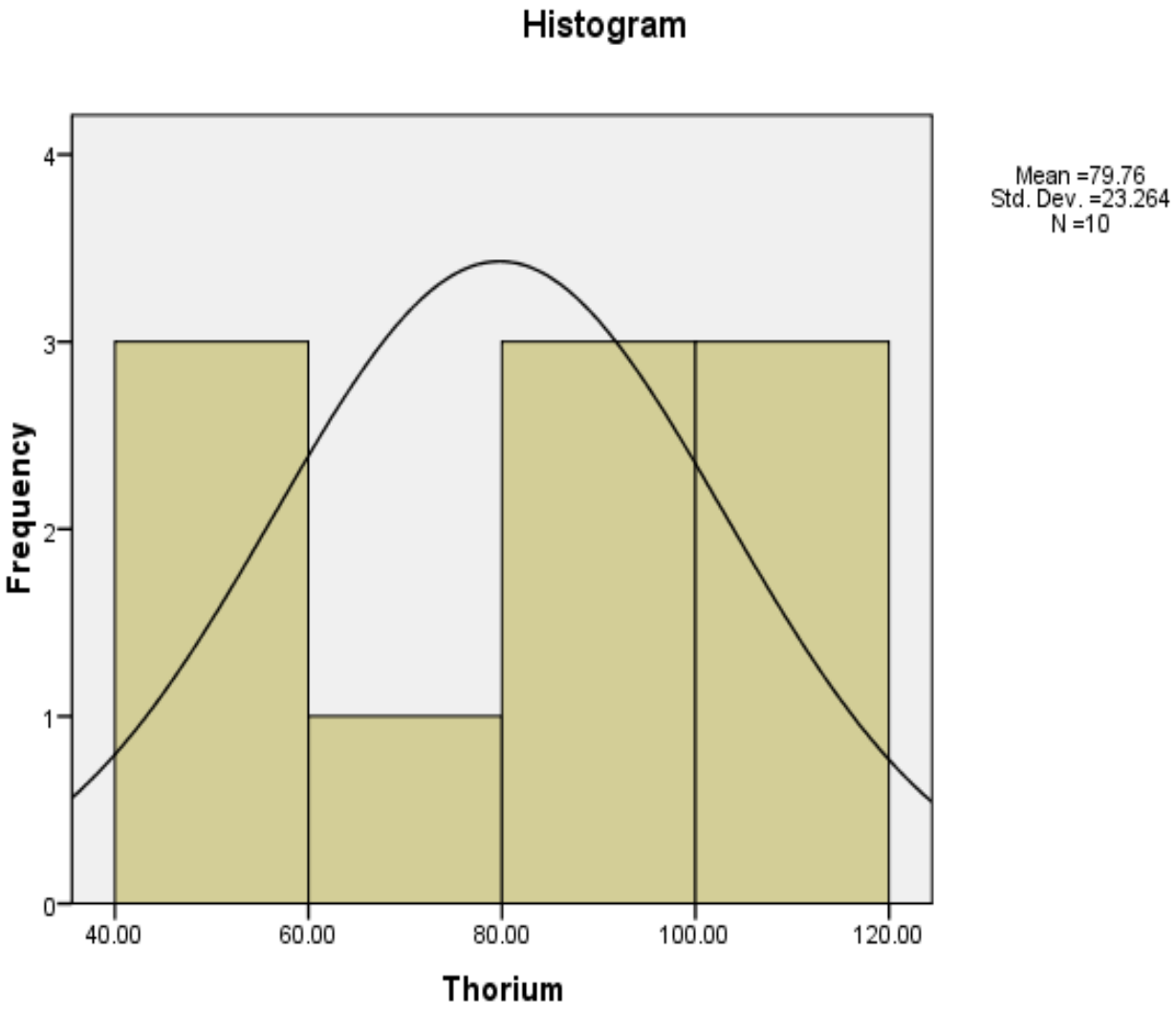

Fig 7. Chart of Activity Concentration of ^{232}Th in water

Table 2 Radiation Hazard Indices in Sea Water

S/N	Location	Raeq (Bq/l)	Hex (mSvy^{-1})	Hin (mSvy^{-1})	D (nGyh^{-1})	AED (mSvy^{-1})	AGED (mSvy^{-1})	ELCR x 10^{-3}

1	NGW 1	153.33	0.414	0.497	67.71	0.08	456.27	0.29
2	NGW 2	201.35	0.544	0.617	88.70	0.11	598.58	0.38
3	NGW 3	103.99	0.281	0.337	46.68	0.06	317.59	0.20
4	NGW 4	166.85	0.451	0.492	73.61	0.09	498.15	0.32
5	NGW 5	166.81	0.450	0.498	73.52	0.09	496.89	0.32
6	ECW 6	117.20	0.317	0.394	52.02	0.06	350.93	0.22
7	AFW 7	150.14	0.406	0.494	66.40	0.08	447.45	0.29
8	AFW 8	149.35	0.403	0.468	65.71	0.08	442.62	0.28
9	OTW 9	118.96	0.321	0.364	52.66	0.07	356.40	0.23
10	AGW 10	99.12	0.268	0.352	44.06	0.05	296.55	0.19
	MEAN VALUE	**142.71**	**0.385**	**0.451**	**63.11**	**0.08**	**426.14**	**0.27**
	UNSCEAR 2000	**370**	**1**	**1**	**57**	**1**	**300**	**0.29**

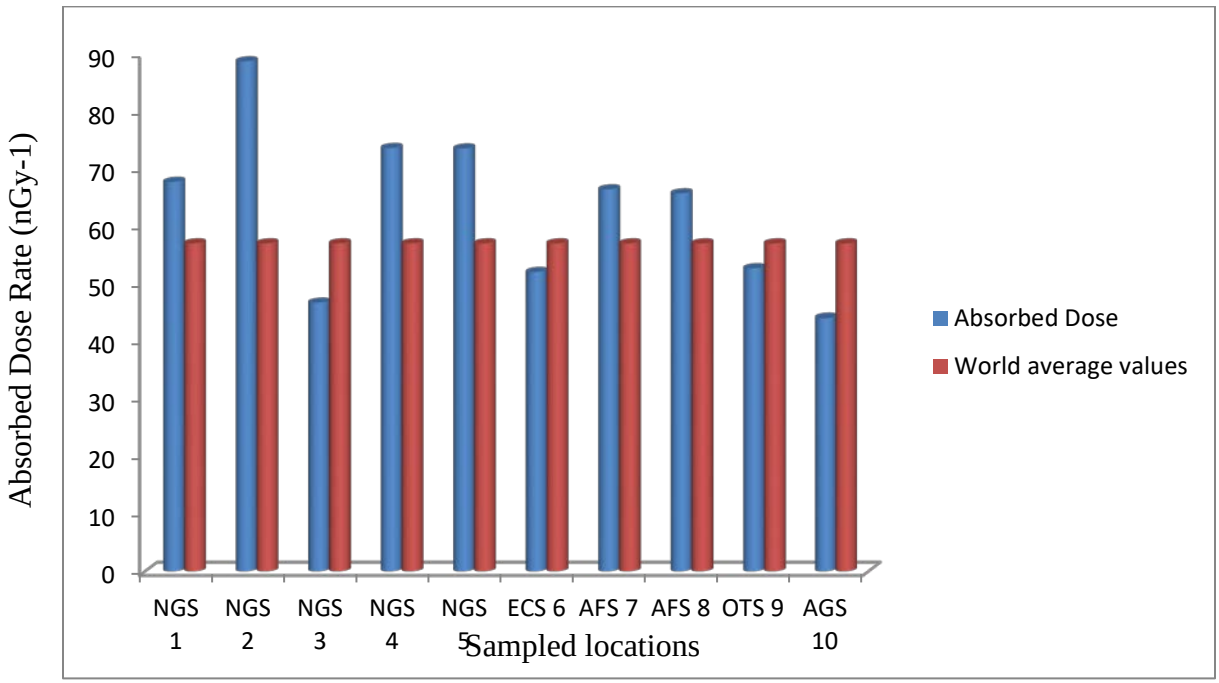

Fig 8. Comparison of Absorbed Dose in sea water with World average values in all the locations

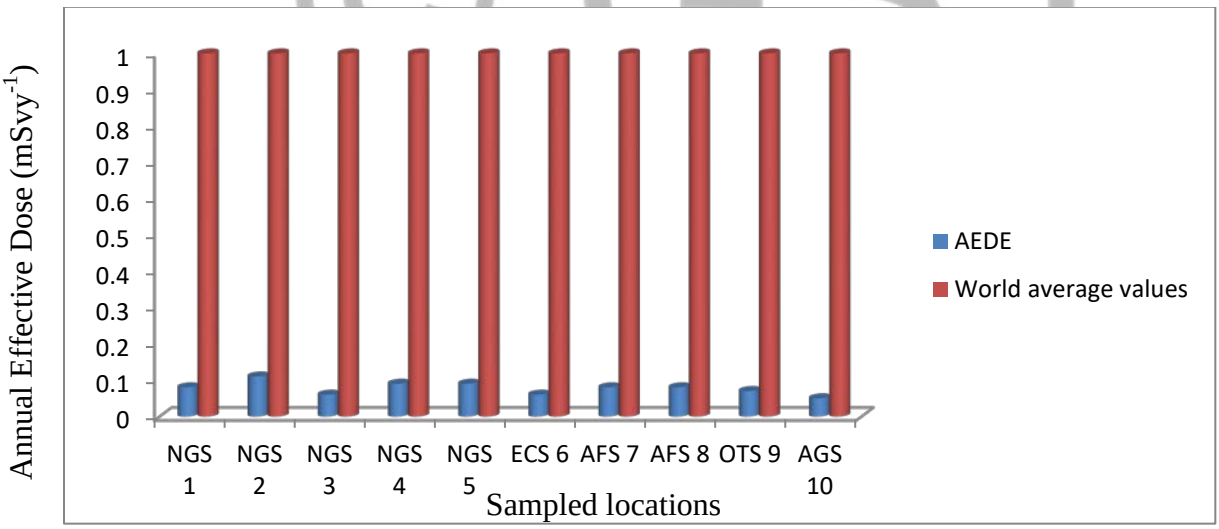

Fig 9. Comparison of Annual Effective Dose in sea water with World average values in all the locations

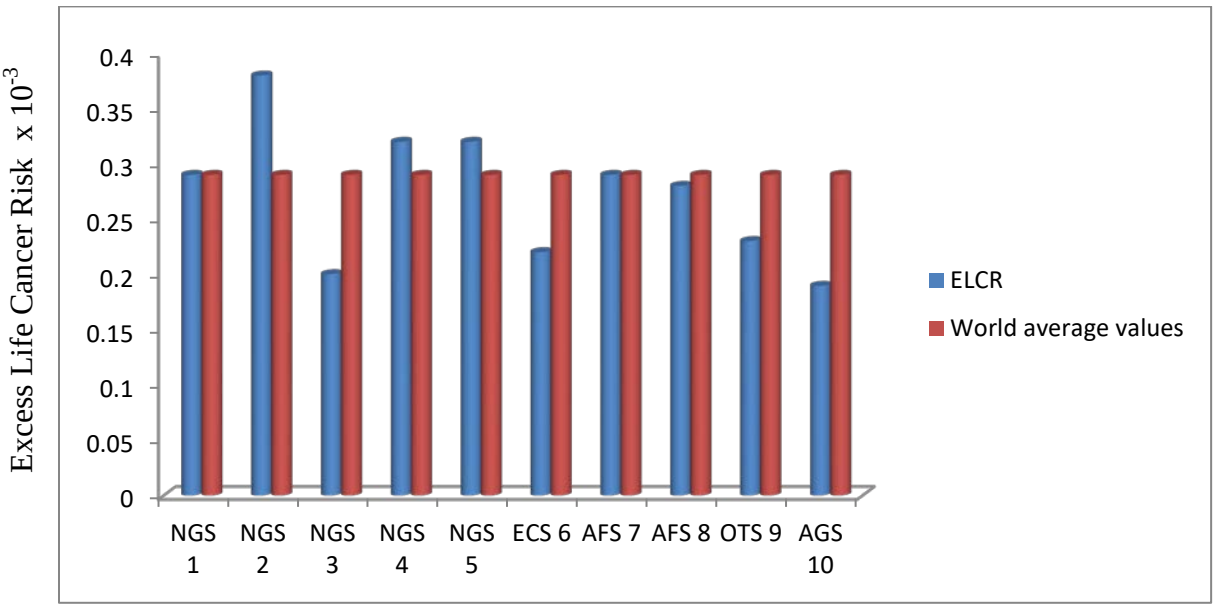

Fig 10. Comparison of Excess Life Cancer Risk in sea water with World average value in all the locations

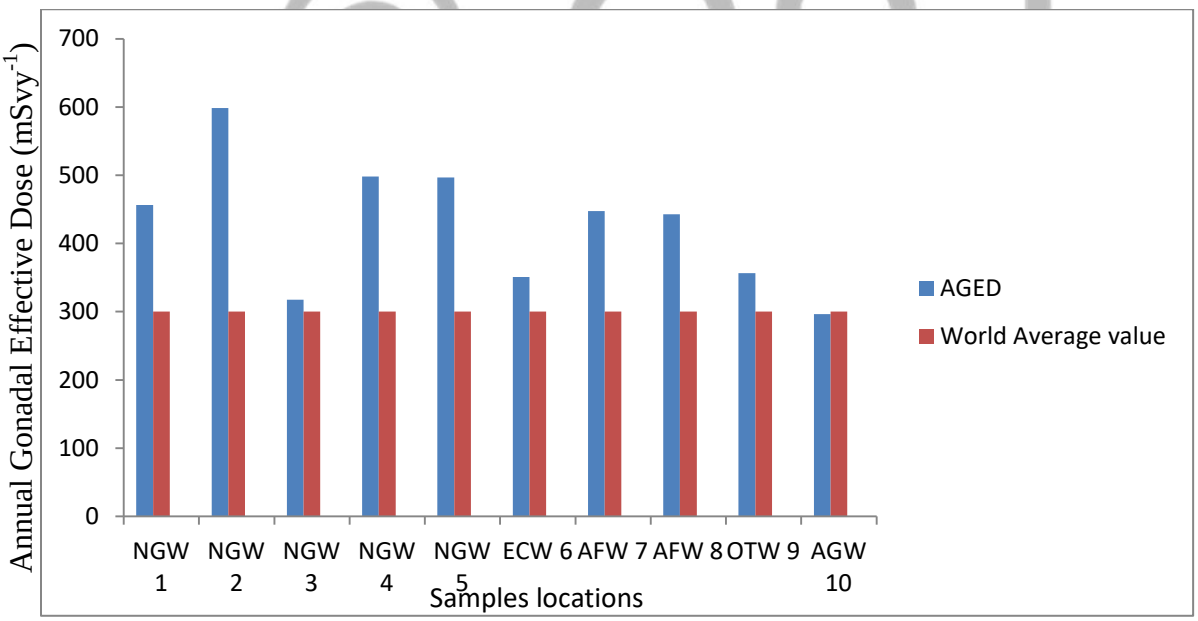

Fig 11. Comparison of Annual Gonnadal Effective Dose in sea water with world average value in all the locations

CONCLUSION:

The evaluation of radionuclides contents in water of Ngo River, Andoni LGA of Rivers State, Nigeria has been investigated. It was observed that the value also exceeds the UNSCEAR, (2000) value of 27.6 Bq/l^{-1}, 10 Bq/l^{-1} and 1 Bq/l^{-1} for ^{40}K, ^{226}Ra and ^{232}Th in water, except AFW8 and AGW10 where the value gotten is below the world average value of 27.6 Bq/l^{-1} for ^{40}K.

The mean activity concentration exceeding the world standard values could be attributed to industrial exploration and exploitation activities both on onshore and offshore, Boat Capsizing with materials, incessant sea pirate, Pipeline vandalism, unconditional spilling of fuel from engine boat and flying boat, unconditional dumping of waste in the sea in the area. All the anthropological activities and naturally occurring radioactive materials had enhanced the radioactivity of the area and may pose serious health risk to the populace and the environment.

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