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Research Article

Determination of Effective Dose of Radionuclides in Water Samples on Infants from Communities along the Banks of New Calabar River, Rivers State, Nigeria

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ABSTRACT

The determination of annual effective dose of radionuclides (^{40}K, ^{232}Th and ^{232}U) in water samples from communities along the banks of New Calabar River for infants was carried out. Twenty-eight (28) water samples were collected and treated with 1 M HNO_3 to allow for homogeneity and to avoid precipitation and adsorption of radionuclides on the walls of the containers. Activity concentrations of these radionuclides in the samples were first measured, using NaI spectrometer detector. The annual effective dose for infants due to the intake of the river water was determined by using the activity concentrations of the radionuclides with their ingested dose conversion factor. Results of the mean activity concentration (BqL^{-1}) for ^{40}K, ^{232}Th and ^{232}U are: 62.43±3.26, 4.18±0.24 and 9.37±1.19 respectively. The mean annual effective dose ($mSv\ yr^{-1}$) for infants 0-1yr and 1–2yrs are: 0.63±0.037 and 0.957±0.05 for ^{40}K; 3.548±0.203 and 0.687±0.039 for ^{232}Th; 8.041±1.023 and 3.285±0.403 for ^{232}U respectively. The mean total annual effective doses for infants of 0–1 yr and 1–2 yrs old are: 12.247±1.258 and 4.929±0.496 respectively. The results showed that the mean activity concentration of ^{40}K, ^{232}Th and ^{232}U (BqL^{-1}) in all the water samples exceeded the WHO and UNSCEAR recommended safe limits of 10.0, 0.10 and 10.0 respectively. The mean total annual effective dose ($mSv\ yr^{-1}$) of ^{40}K, ^{232}Th and ^{232}U for infants also exceeded the WHO and UNSCEAR recommended safe limits of 0.26. The water supplies under investigation have been found to be radiologically polluted and unsafe for human consumption. It is recommended that alternative safe sources of water supply be provided by Government, Non-Governmental Organizations and/or private individuals for the inhabitants of the study area.

Keywords: New Calabar River, Radionuclides, radiological hazards, infants, effective dose.

Introduction

Water plays very important role in survival of plants and animals including humans of all ages such as infants, children and adults (Chifu *et al.*, 2016). Surface water from streams, creeks and rivers are used for domestic purposes such as cooking, drinking, and bathing; agricultural purposes such as fishing and for recreational purposes such as swimming. Degradation of water quality is determined by the concentration of biological, chemical and physical contaminants. Biological contaminants consist of microorganisms and human and animal wastes; chemical contaminants result from surface water runoff from industrial processes and agricultural practices such as application of fertilizers and pesticides, and the physical contaminants are due to disposal of solid wastes (Akinloye, 2008). Drinking water standard is determined by the assessment of physiochemical parameters (taste, odour, colour, turbidity, dissolved oxygen, biochemical oxygen demand, pH) and the presence of heavy metals and radionuclides (Oyebanjo and Magbagbeola, 2015).
The presence of radioactivity in surface water is mainly due to radionuclides of the natural decay chains of ^{40}K,

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^{232}Th and ^{232}U are found in soil, and run-offs from industrial wastes, effluents discharges and other maritime activities (Ononugbo and Anyalebechi, 2017). Other sources may be due to some activities such as improper household wastes disposal, discharge of wastes from oil and gas industries (Ononugbo *et al.*, 2013). Naturally occurring radioactive materials (NORMs) enter human body either via inhalation of radioactive gases such as dust particles and Radon or through direct pathways such as water or indirectly through consumption or ingestion of ^{40}K, ^{232}Th and ^{232}U (Ajayi and Adesida, 2009). Associated health effects are lung, pancreas, hepatic, bone, skin, and kidney cancers; cataracts, sterility, brain tumor, skin burn, atrophy of the kidney and leukaemia (Taskin *et al.*, 2009).

The New Calabar River and its tributaries (Fig.1) are all located in Rivers State. The region is situated at approximately $5^{0}10'N; 6^{0}50'E$and flows southward for roughly 150 km before its discharge into the Atlantic Ocean at approximately $4^{0}20'N; 7^{0}00'E$ (Francis and Elenwo, 2012). The river is subjected to effluent discharges from industries located along its banks, surface run off due to soil erosion, lumbering activities, forestry operations, dredging activities and discharge from bunkering and illegal petroleum product refining activities, which contributed to a wide scale contamination of the river. The river is the major source of water for domestic (cooking, drinking, washing, and bathing) purposes for inhabitants of the communities along its banks.

Several studies have been conducted on radioactivity in water samples from underground (borehole and hand-dug well) and surface water (creeks, streams and river) from some cities and communities in the Niger Delta region of Nigeria (Agbalagba *et al*,.2013; Ononugbo and Anyalebechi, 2017; Avwiri *et al.*, 2014; Avwiri, 2005; and Ononugbo *et al.,2013*). However, no such data exist for cities and communities along the banks of the New Calabar River which necessitated this research.

This research study assessed the radiological hazard indices such as Annual Effective Dose due to ingestion of the water samples by infants (0-1 and 1-2 years) and total annual effective dose in infants in some randomly selected water samples from communities along banks of the New Calabar River, Rivers State.

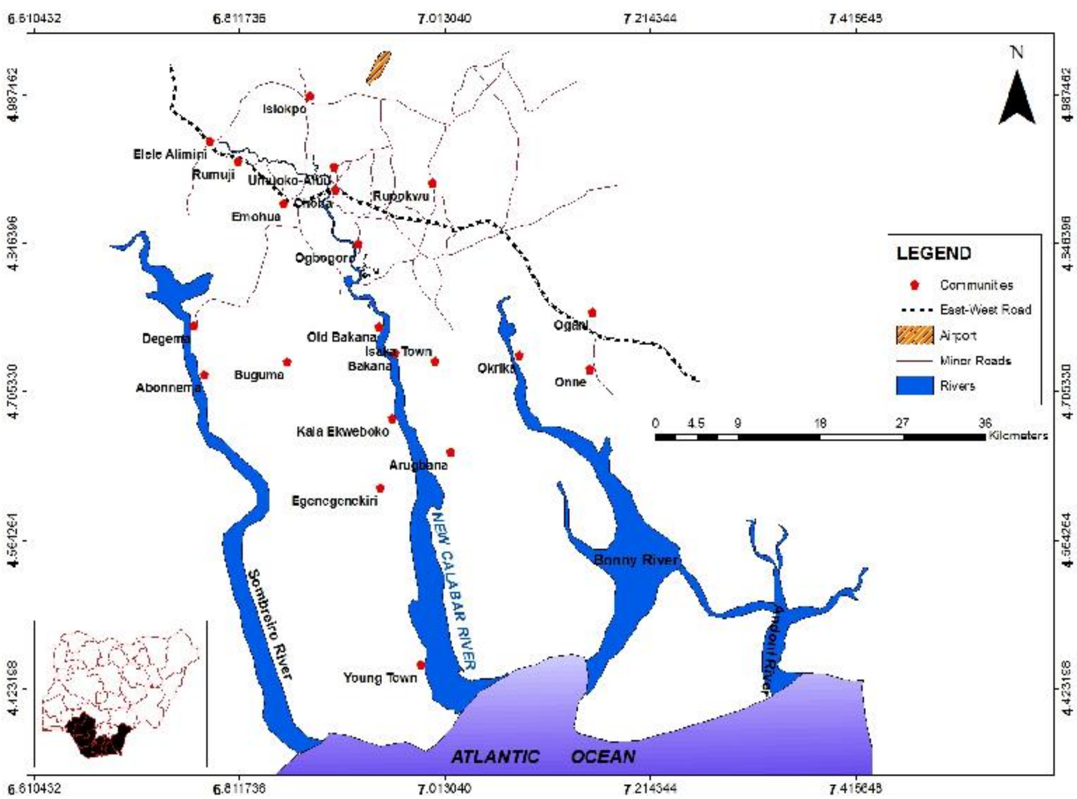

Fig. 1: Map of Lower Niger Delta showing the New Calabar River drainage system and the communities through which it traverses (Source: Francis and Elenwo, 2012).

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Materials and Methods

A global positioning system (GPS) (Garmine-Trex) was used to measure the co-ordinates of the sample locations. A total of twenty-eight (28) water samples were randomly collected from fourteen (14) sample locations in duplicates from nine communities along the bank of the New Calabar River. All water samples were collected during the wet season (July, 2022) into 0.75 L sterile plastic containers using the aid of grab sampling technique. About 16 ml of 1 M of HNO_3(Nitric acid) solution was injected into each water sample container to reduce the pH to less than 2 as to allow for homogeneity, avoid precipitation and adsorption of radionuclides by the walls of the container. The samples were appropriately labelled, well packaged and ice-cooled for a maximum of 24 hours before being transported to the National Institute of Radiation Protection and Research (NIRPR) laboratory, Nigeria Nuclear Radiation Authority (NNRA), University of Ibadan, Ibadan, Oyo State, Nigeria, where they were analysed using a Thallium activated 3” x 3”Sodium Iodide (NaI) (TI) detector with its accessories to obtain the Activity Concentrations (BqL^{-1}) of ^{40}K, ^{232}Th and ^{232}U.

Equations for Calculating Effective Dose

(a). The Annual Effective Dose (AED)

The annual effective dose (AED) $(mSvyr^{-1})$ from the radionuclides due to intake of water samples was calculated from the mean Activity Concentration of each natural radionuclide, using Eq. (1) (Agbalagba *et al*., 2013; Ononugbo *et al*., 2013):

$$AED = IAC \times 365 \qquad (1)$$

where: I = Daily water consumption (in Ld^{-1})

A = Activity Concentration (BqL^{-1}) of the radionuclide in the water sample.

C = Dose conversion factor $(mSvBq^{-1})$ which varies with age of individuals and the radionuclide present in the water sample. Its values were extracted from (ICRP, 1997; IAEA, 2003; US EPA, 2000).

(b). Total Annual Effective Dose (TAED)

The total annual effective dose, TAED (in *mSvy*$^{-1}$) to an individual due to ingestion of water samples was obtained by adding contributions of the three radionuclides $(^{40}K, ^{232}Th$ and $^{232}U)$ present in the water samples using eq. (2) (Ajayi and Adesida, 2009; Ononugbo and Anyalebechi, 2017)

$$\text{AED (mSvy}^{-1}) = \sum A_c I_A C_F \qquad (2)$$

where:

A_c = Activity concentration (BqL^{-1}) of the radionuclide in the water sample.

I_A = Daily water consumption (Ld^{-1}).

C_F = Dose conversion factor $(mSvBq^{-1})$

The age group was: infants (0 - 1 and 1– 2yrs).

Results

The Activity Concentrations (BqL^{-1}) of ^{40}K, ^{232}Th and ^{232}U in water samples collected from some communities along the bank of New Calabar River during the wet season (July, 2022) are displayed on Table 1 below. The annual effective dose $(mSvyr^{-1})$ of ^{40}K, ^{232}Th and ^{232}U for infant population with ages: 0 – 1 yr and 1–2 yrs are as displayed in Table 2 below.

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Table 1: Activity concentrations (BqL^{-1}) of ^{40}K, ^{232}Th and ^{232}U present in the New Calabar River water samples collected during wet season (July, 2022)

Sample Location	Sample Points	LOCATTION		ACTIVITY CONCENTRATIONS (BqL^{-1})			pH
		LATITUDE	LONGITUDE	^{40}K	^{232}Th	^{232}U	
Iwofe Jetty Water Front (L1)	P1	N 4º 48'36.86''	E 6º 55'44.94''	40.05±2.12	4.54±0.27	5.70±0.84	7.30
	P2	N 4º 48'33.06''	E 6º 55'42.01''	36.07±1.91	3.90±0.23	11.04±1.56	
Ogbogoro Water Front (L2)	P1	N 4º 50'55.09''	E 6º 55'24.42''	14.89±0.78	2.07±0.12	4.52±0.60	7.20
	P2	N 4º 48'52.07''	E 6º 55'50.71''	28.31±1.49	2.81±0.17	12.05±1.62	
Rumuokparali Water Front (L3)	P1	N 4º 52'16.76''	E 6º 54'15.47	99.40±5.23	5.39±0.32	79±0.97	7.10
	P2	N 4º 52'30.92''	E 6º 54'13.33''	66.52±3.37	1.74±0.10	6.53±0.64	
Choba Market Water Front (L4)	P1	N 4º 53'48.24''	E 6º 55'13.17''	31.69±1.60	4.21±0.24	6.34±0.64	7.10
	P2	N 4º 53'50.88''	E 6º 53'54.26''	55.99±2.96	2.76±0.17	10.15±1.39	
Omuihuechi Aluu Water Front 1, (L5)	P1	N 4º 53'29.03''	E 6º 54'97.69''	40.37±2.13	3.17±0.19	10.76±1.50	6.90
	P2	N4º 53'28.63'	E 6º 54'08.24''	137.04±7.20	3.55±0.21	9.54±1.37	
Omuihuechi Aluu Water Front 2 (Behind Man O' War) (L6)	P1	N 4º 54'46.18''	E 6º 53'52.96''	63.43±3.35	6.43±0.38	6.31±0.88	6.80
	P2	N 4º54'40.19''	E6º 53'51.45''	95.31±5.00	1.03±0.06	25.29±3.03	
Choba Bridge Water Front (L7)	P1	N 4º 53'48.24''	E 6º 55'13.17''	24.62±1.25	4.74±0.27	8.20±0.82	6.90
	P2	N 4º 53'50.88''	E6º 53'54.26''	93.00±4.89	4.99±0.30	15.09±2.04	
Mini Onuah Creek, Elele Alimini (L8)	P1	N 5º 04'31.36''	E 6º 41'53.26''	13.38±0.68	5.85±0.34	12.53±1.25	6.40
	P2	N 5º 04'24.30''	E 6º 44'10.33''	70.77±3.73	6.01±0.36	5.50±0.77	
Mini Ezi Creek, Elele Alimini (L9)	P1	N 5º 03'29.30''	E 6º44'23.25''	266.11±13.99	4.87±0.29	13.71±2.04	6.70
	P2	N 5º 02'29.20''	E 6º 44'07.86''	76.65±4.06	4.95±0.29	0.48±0.07	
Rumuji/Ibaa Bridge Water Front (L10)	P1	N 4º 56'44.87''	E 6º 47'42.40''	72.64±3.68	3.83±0.22	14.07±1.38	6.80
	P2	N 4º 56'40.33''	E 6º 47'41.05''	10.38±0.54	5.89±0.35	4.61±0.63	
Alimini Water Front, Oduoha Emohua (L11)	P1	N 4º 55'29.27''	E 6º50'02.94''	40.37±2.13	4.55±0.27	9.22±1.20	6.90
	P2	N 4º55'45.99''	E 6º49'58.90''	94.99±4.99	3.98±0.24	23.67±3.11	
Ogbodo Water Front Oduoha Emohua (L12)	P1	N 4º55'25.36''	E 6º 50'24.69	19.92±1.05	7.04±0.42	0.72±0.11	6.80
	P2	N 4º 55'25.75''	E 6º 50'23.66''	59.95±3.04	4.95±0.28	1.20±0.12	
CAC Water Front, Ogbodo, Oduoha Emohua (L13)	P1	N 4º 55'19.59''	E 6º 50'21.70''	22.12±1.12	2.51±0.15	1.82±0.18	6.90
	P2	N 4º 55'08.25''	E 6º 50'13.62''	79.83±4.04	1.53±0.09	9.87±0.97	
Mgbuitanwo Emohua Water	P1	N 4º 52'55.02''	E 6º 53'35.78''	11.01±0.58	4.36±0.09	12.54±1.74	6.80

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….Table 1 continued Front (L14)	P2	N 4º 52'56.37''	E 6º 53'34.90''	83.36±4.39	5.47±0.33	14.24±1.93	
Min.				10.38±0.54	1.03±0.06	0.48±0.07	6.40
Max.				266.11±13.99	7.04±0.42	25.29±3.03	7.30
Mean				62.43±3.26	4.18±0.24	9.37±1.19	6.88
WAV				10.0	0.10	10.0	N/A

Table 2: Annual Effective Dose ($mSv\ y^{-1}$) for ^{40}K, ^{232}Th and ^{232}U for infant age groups (0-1 and 1-2yrs) in water samples collected during wet season (July, 2022)

Sample Code	^{40}K Infants		^{232}Th Infants		^{232}U Infants	
	(0 – 1) yr	(1 – 2) yr	(0 – 1)	(1 – 2) yr	(0 – 1) yr	(1 – 2) yr
L1P1	0.453±0.024	0.614±0.032	3.811±0.227	0.746±0.044	4.889±0.720	1.997±0.294
L1P2	0.048±0.022	0.553±0.029	3.274±0.193	0.641±0.038	9.470±1.338	3.868±0.547
L2P1	0.168±0.009	0.228±0.012	1.738±0.101	0.340±0.020	3.877±0.515	1.584 ±0.210
L2P2	0.320±0.017	0.434±0.023	2.359±0.143	0.461±0.028	10.336±1.390	4.222±0.568
L3P1	1.125±0.059	1.524±0.080	4.525±0.269	0.885±0.053	5.824±0.832	2.379±0.340
L3P2	0.753±0.038	1.020±0.052	1.461±0.084	0.286±0.016	5.601±0.549	2.288±0.224
L4P1	0.359±0.018	0.486±0.024	3.534±0.201	0.691±0.039	5.438±0.549	2.221±0.224
L4P2	0.633±0.033	0.858±0.045	2.317±0.160	0.453±0.028	8.706±1.192	3.557±0.487
L5P1	0.457±0.024	0.619±0.033	2.661±0.159	0.521±0.031	9.229±1.287	3.770±0.526
L5P2	1.551±0.081	2.101±0.110	2.980±0.176	0.583±0.034	8.183±1.175	3.343±0.480
L6P1	0.718±0.038	0.972±0.051	5.398±0.319	1.056±0.062	5.412±0.755	2.211±0.308
L6P2	1.078±0.057	1.461±0.077	0.865±0.050	0.169±0.010	21.692±2.599	8.862±1.062
L7P1	0.279±0.014	0.377±0.020	3.979±0.227	0.778±0.044	7.034±0.703	2.873±0.287
L7P2	1.052±0.055	1.426±0.075	4.189±0.252	0.820±0.049	12.943±1.750	5.287±0.715
L8P1	0.151±0.008	0.205±0.010	4.911±0.285	0.961±0.056	10.748±1.072	4.390±0.438
L8P2	0.801±0.042	1.085±0.057	5.045±0.302	0.987±0.059	4.718±0.660	1.927±0.270
L9P1	3.011±0.158	4.079±0.214	4.088±0.243	0.800±0.048	11.760±1.750	4.804±0.715
L9P2	0.867±0.046	1.175±0.062	4.156±0.243	0.813±0.048	0.412±0.060	0.168±0.024
L10P1	0.822±0.042	1.114±0.056	3.232±0.185	0.632±0.036	12.069±1.184	4.930±0.484
L10P2	0.117±0.006	0.159±0.008	4.945±0.294	0.967±0.057	3.954±0.540	1.615±0.221
L11P1	0.457±0.024	0.619±0.033	3.820±0.227	0.747±0.044	7.908±1.029	3.231±0.420
L11P2	1.075±0.056	1.456±0.076	3.341±0.201	0.654±0.039	20.303±2.668	8.294±1.090
L12P1	0.225±0.012	0.305±0.016	5.910±0.353	1.156±0.069	0.618±0.094	0.252±0.039
L12P2	0.678±0.034	0.919±0.047	4.156±0.235	0.813±0.046	1.029±0.103	0.420±0.042
L13P1	0.250±0.013	0.339±0.017	2.107±0.126	0.412±0.025	1.561±0.154	0.638±0.063
L13P2	0.903±0.046	1.224±0.062	1.284±0.076	0.251±0.015	8.466±0.832	3.458±0.340
L14P1	0.125±0.007	0.169±0.009	3.660±0.076	0.720±0.015	10.756±1.492	4.394±0.610
L14P2	0.943±0.050	1.278±0.067	4.592±0.277	0.898±0.054	12.214±1.655	4.990±0.676
Min.	0.048±0.022	0.159±0.008	0.865±0.050	0.251±0.015	0.412±0.060	0.168±0.024
Max.	3.011±0.158	4.079±0.214	5.910±0.353	1.156±0.069	21.692±2.599	8.862±1.062
Mean	0.63±0.037	0.957±0.050	3.548±0.203	0.687±0.039	8.041±1.023	3.285±0.403
WAV	0.12		0.17		0.17	

The variation of total annual effective dose for infants (0-1 and 1-2) yrs due to ingestion of water samples as well as their comparison with WHO and UNSCEAR recommended safe limits are displayed in Figures 2 and 3 respectively.

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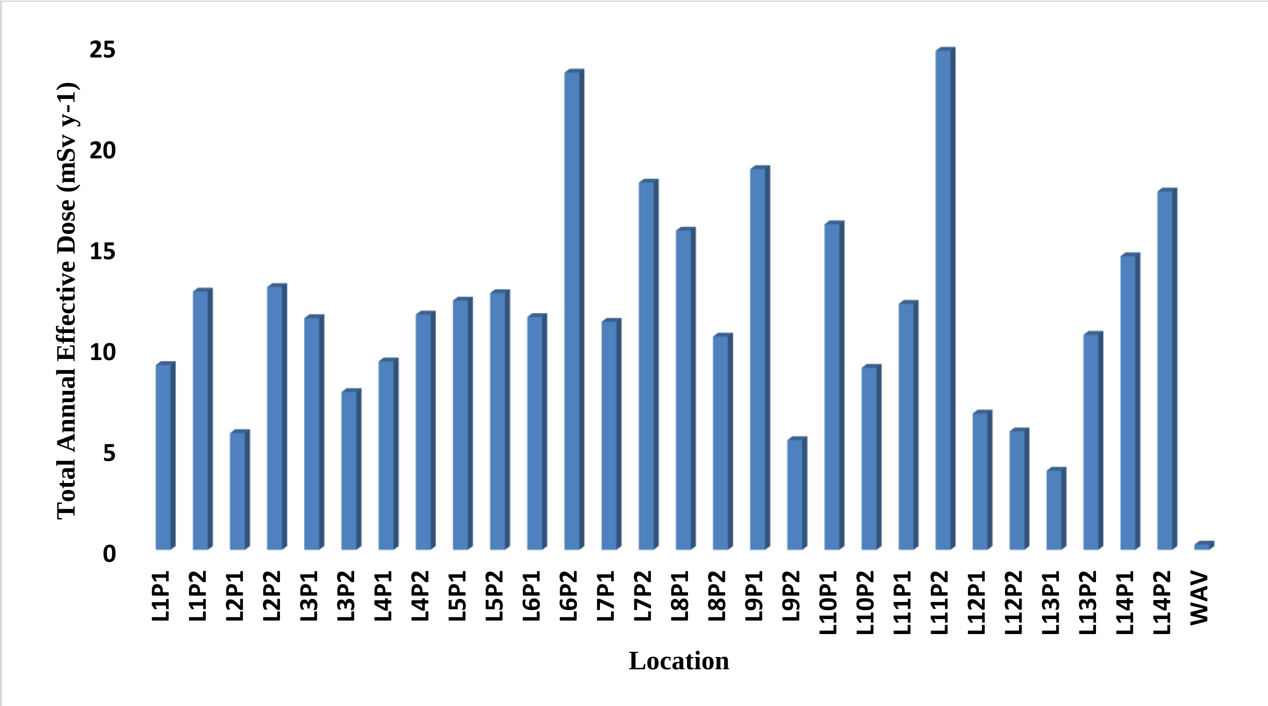

Fig. 2: Variation of total annual effective dose (*mSv y^{-1}*) of ^{40}K, ^{232}Th and ^{232}U for infant population (0-1 yr) in Water Samples Collected from New Calabar River during Wet Season (July, 2022)

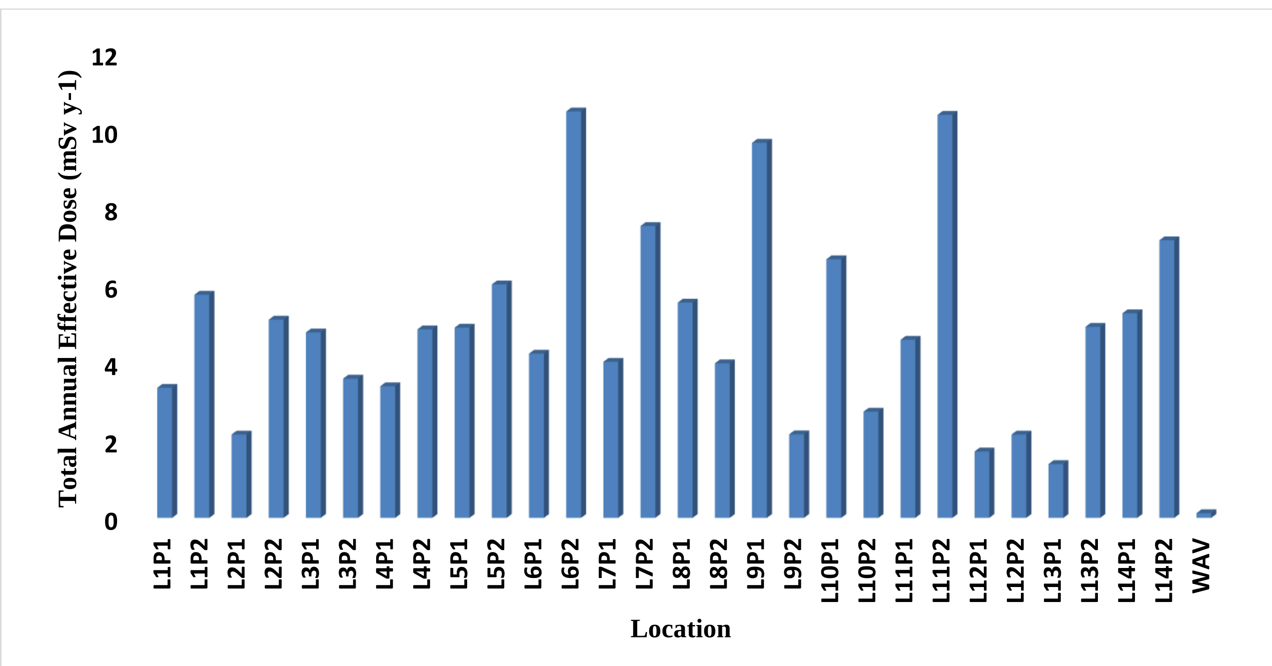

Fig. 3: Variation of total annual effective dose (*mSv y^{-1}*) of ^{40}K, ^{232}Th and ^{232}U for infant population (1-2) yr in Water Samples Collected During Wet Season (July, 2022).

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Discussion

This present study has revealed the Activity concentrations (BqL^{-1}) of of Radionuclides (^{40}K, ^{232}Th and ^{232}U) present in the water samples collected from Communities along the Banks of New Calabar River, Rivers State, Nigeria. during wet season of July, 2022. The study also revealed the Annual Effective Dose ($mSv\ y^{-1}$) of ^{40}K, ^{232}Th and ^{232}U for infants age groups (0-1 and 1-2) in water samples.

Results in Table 1 indicated that the activity concentration (BqL^{-1}) of ^{40}K ranged from 10.38±0.58 to 266.11±13.99 with a mean value of 62.43±3.26. The highest activity concentration was recorded in water samples collected from Mini Ezi creek (L9P1) and the least at Rumuji/Ibaa Bridge (L10P2). This high activity concentration of ^{40}K in all the water samples collected from the communities may be because ^{40}K is a naturally occurring radionuclide largely present in the earth's crust (ICRP, 1984). It might also be due to the use of N-P-K fertilizer during agricultural practices and as a result of other organic components rich in potassium in the study location. The minimum activity concentration of ^{40}K may be due to high drift velocity of surface water which is capable of transporting the potassium to other locations. The activity concentration of ^{232}Th in the water samples ranged from 1.03±0.06 to 7.04±0.42, with a mean value of 4.18±0.24. The highest activity concentration of ^{232}Th was recorded at Ogbodo water front (L12P1) and the lowest at Omuihuechi Aluu, Behind Man O' War Camp (L6P2). The high activity concentration of ^{232}Th might be due to effluent discharge from illegal refining of petroleum products and bunkering as well as maritime activities into the river of the study location (Ononugbo and Anyalebechi, 2017). The activity concentration of ^{232}U ranges from 0.48±0.07 to 25.29±3.03, with a mean value of 9.37±1.19.The maximum activity concentration of ^{232}U occurred at Umuihuechi Aluu, behind Man O' War Camp (L6P2) and the least at Mini Ezi creek (L9P2).

The mean activity concentration of ^{232}U was relatively higher than that of ^{232}Th. This is because ^{232}U is more mobile than ^{232}Th (Tchokossa *et al*., 2011).This might also be due to the presence of Uranium source rocks and processes that might lead to Uranium leaching into the river water at the study location. The relatively high activity concentration of ^{232}U than ^{232}Th in the study location might also be due to proximity of oil and gas to Uranium source, oxidation states of the water and concentration of suitable complexing agents which is capable of increasing the solubility of Uranium in the sample location (Tchokossa *et al*., 2011). Comparison of the activity concentration of the three radionuclides present in the water samples indicated that the activity concentration of ^{40}K was the prevalent radionuclide in all the water samples collected while the activity concentrations of ^{232}Th and ^{232}U were relatively low. Thus ^{40}K contributed the largest activity concentration in the water sample followed with that of ^{232}U while ^{232}Th contributed the least activity concentration. The results further revealed that the mean activity concentrations of ^{40}K and ^{232}Th in the water samples from the nine communities of the study area exceeded the WHO and UNSCEAR recommended safe limit of 10.0 Bq l^{-1} and 0.10 Bq l^{-1}respectively while that of ^{232}U is below the recommended safe limit of 10.0 Bql^{-1} (WHO 2008).

The annual effective doses ($mSv\ y^{-1}$) of ^{40}K, ^{232}U and ^{232}Th in the water samples were calculated using eq. (1) with the activity concentration of the radionuclides obtained from Table 1. The dose conversion factor for the infant age groups (0-1 and 1-2) yrs was obtained from: (IAEA, 2003; US EPA, 2000; ICRP, 2012). Results in Table 2 indicated that the annual effective dose of ^{40}K in infants age group (0-1 and 1-2) yrs ranged from 0.048±0.022 to 3.011±0.158 and 0.159±0.008 to 4.079±0.214 respectively. Their mean annual effective dose are: 0.630±0.037 for (0–1) yr and 0.957±0.050 for (1-2) yrs respectively. The annual effective dose of ^{232}Th in infants age group ranged from 0.865±0.050 to 5.910±0.353 for (0-1) yr and 0.251±0.015 to 1.156±0.069 for (1-2) yrs respectively. The mean annual effective dose of ^{232}Th in infants age groups are 3.548±0.203 and 0.6687±0.039 for (0-1 and 1-2) yrs respectively. The annual effective dose of ^{232}U in infant age groups ranged from 0.412±0.060 to 21.692 for (0–1) yr and 0.168±0.024 to 8.862±1.062 for (1-2) yrs. The mean annual effective dose of ^{232}U in infant age groups are 8.041±1.023 and 3.285±0.403 for (0–1) yr and (1–2) yrs respectively. The high effective dose of ^{40}K, ^{232}Th and ^{232}U in infant population of the inhabitants of the study area were recorded in water samples collected from locations: Mini Ezi creek (L9P1), Ogbodo water front (L12P1) and Omuihuechi Aluu, behind Man O' War camp (L6P2) respectively. The mean annual effective dose (mSv y^{-1}) of ^{40}K, ^{232}Th and ^{232}U are all above the WHO and UNSCEAR

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recommended safe limits of 0.12, 0.17 and 0.17 respectively.

The total annual effective dose of ^{40}K, ^{232}Th and ^{232}U was calculated using eq. (2) and was obtained by addition of annual effective doses of all the three radionuclides in the water samples. The total annual effective doses (*mSv* y^{-1}) in infants due to ingestion of the water samples ranged from 3.918±0.293 to 24.719±2.925 for 0-1 yr olds and 1.389±0.105 to 10.492±1.149 for 1-2 yrs olds. The mean total annual effective doses (mSvy–1) in infants are: 12.282±1.258 and 4.929±0.496 in 0-1 yr and 1-2 yrs respectively. The results revealed that the highest total annual effective dose in infants (0-1 and 1-2) yrs were recorded in Alimini water front (L11P2) while the minimum was recorded in CAC water front (L13P2). The variation of total annual effective dose in infants due to ingestion of water samples as well as their comparison with the WHO (2008) and UNSCEAR (2000) recommended safe limits are displayed in figures 2 and 3. Results of the comparison showed that the mean total annual effective dose of the radionuclides in infant age groups are above the WHO and UNSCEAR recommended safe limit of 0.26 (WHO, 2008; UNSCEAR, 2008). This means that the water sample under investigation is radiologically polluted and unfit for domestic purposes.

Conclusion

The study on the determination of effective doses in water samples from communities along the banks of New Calabar River was carried out. The activity concentration of ^{40}K, ^{232}Th and ^{232}U in the water samples were measured using NaI gamma spectrometer detector. Their mean activity concentrations (Bql^{-1}) are: 62.43±3.26, 4.18±0.24 and 9.37±1.19 respectively. These mean activity concentrations (Bql^{-1}) exceeded the WHO and UNSCEAR recommended safe limits of 10.0, 0.10 and 10.0 for ^{40}K, ^{232}Th and ^{232}U respectively. The mean annual effective dose ($mSvy^{-1}$) of ^{40}K, ^{232}Th and ^{232}U in infants are: 0.630±0.037 for 0-1 yr and 0.957±0.050 for 1-2 yr; 3.548±0.203 for 0-1 yr and 0.687±0.039 and, 8.041±1.023 for 0-1 yr and 3.285±0.403 for 1-2 yr olds respectively. The mean total annual effective dose ($mSvy^{-1}$) of ^{40}K, ^{232}Th and ^{232}U due to ingestion of the water samples for infants (0-1) and (1-2) yr are: 12.247±1.258 and 4.929±0.496 for 0-1yr and 1-2 yrs respectively. These values also exceeded the WHO and UNSCEAR recommended safe limit of 0.26 ($mSvy^{-1}$) for infants (UNSCEAR 2000; Tchokossa *et al*., 2011). The results showed that all the radiological parameters determined from the water samples in this study are above the WHO and UNSCEAR recommended safe limits. The water supplies under investigation from the New Calabar River are found to be radiologically polluted and unsafe for human consumption, especially among the infants population. It is recommended that alternative source of water supplies be provided for inhabitants of these communities. Furthermore research studies on the effective dose in children and adults populations of the study area, as well other radiological hazards in water samples from the remaining communities not captured in this study, should be carried out.

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