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EVALUATION OF NATURAL RADIONUCLIDE CONTENT IN SURFACE AND GROUND WATER AND EXCESS LIFETIME CANCER RISK DUE TO GAMMA RADIOACTIVITY

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ABSTRACT

The objective of this study is to evaluate the radionuclide content of the surface and ground water around oilfields and their host communities and finally assess the excess lifetime cancer risk associated with them. A total of thirty-six water samples were each taken from Tap water, Well Water and River Water in and around twelve oilfields and their host communities of Ogba, Egbema and Ndoni Local Government Area of Rivers State, Nigeria. The radionuclide concentrations in all water samples were measured using gamma spectroscopy method. The average values of ^{226}Ra, ^{228}Ra and ^{40}K obtained is 9.22±0.82, 8.46±0.61 and 44.27±2.34Bq/l respectively for well water, 4.20±0.12, 4.44±0.14 and 37.85±2.15Bq/l respectively for Tap water and 6.57±0.24, 6.88±0.36 and 29.48±1.98Bq/l respectively for river water. The committed effective dose and excess lifetime cancer risk was calculated for four age brackets. The average committed effective dose for adults that take tap, well and river water ranged from 1.61 to 3.44mSv/yr and that for teenagers, children and babies ranged from 6.03 to 11.76, 8.97 to 19.09 and 10.63 to 14.73mSv/yr respectively. The excess lifetime cancer risk in adult that drank tap, well and river water ranged from 11.50 x 10^{-3} to 16.26 x 10^{-3}. And that for teenagers, children and babies ranged from 21.24 to 41.16 x 10^{-3}, 31.42 to 66.83 x 10^{-3} and 25.53 to 51.57 x 10^{-3} respectively. These results when compared with their corresponding world permissible values were found to be above the standard limit for such environment and as such long term radiation exposure to workers and residents of the study areas could pose health threat.

Keywords: Radioactivity, lifetime cancer, Committed Effective dose, health hazard

INTRODUCTION

Many people are increasingly concerned about a variety of contaminants in drinking water especially those which affect human health. The presence of radionuclide in drinking water can be attributed to a variety of sources including the improper disposal of household products, cleaning solvents, leaking landfills and underground storage tanks, discharge from oil and gas industry and increased use of pesticides. The primary purpose of the World Health Organization guidelines for drinking water quality is the protection of public health. Water is essential to sustain life and a satisfactory (adequate, safe and accessible) supply must be available to all. Improving access to safe drinking water can result in tangible benefits to human health (WHO, 2008).

The occurrence of natural radionuclides in drinking water poses a problem of health hazard, when these radionuclides are taken to the body by ingestion. Radionuclide in drinking water causes human internal exposure, caused by the decay of radionuclides taken into the body by ingestion and inhalation indirectly when they are incorporated as part of the human food chain (Uosif et. al., 2012). Several naturally occurring alpha and beta emitting radionuclides

such as ^{238}U, ^{226}Ra, ^{216}Pb, ^{228}Ra and others are frequently dissolved in ground water supplies and their concentrations vary over an extremely wide range, mainly depending upon the amount of radioelement present in bedrock and soil with which the water comes in contact (Agbalagba et al., 2013).

In most of the industrial areas and their host communities in Rivers State, availability of clean and safe drinking water has been a critical issue to tackle. This is because in the oil reservoirs, crude oil co-exists with underground water usually called formation water and as the reservoir pressure falls over time, the water is co-produced with the crude oil. This produced water contains some level of naturally occurring radionuclide (Ajayi et al., 2009). In some cases, various amounts of radio-isotopes are injected with the secondary recovery flooding fluid to facilitate oil flow. The wastes originated from these activities in addition to the produced water are released into nearby rivers, lakes and open environment and through filtration and absorption, these radionuclides find their way into the underground aquifers thus contaminating the underground water bodies. Utilization of tap water drilled from such aquifer and surface water (rivers) supplies in these areas has raised some health concern since the long term exposure to these naturally occurring radionuclide through ingestion has several health effects as chronic lung diseases, cancer, leukemia, cataracts and other radiation induced diseases (EPA, 2012; Avwiri et al, 2007).

However, Environmental Protection Agency EPA reported that the general cancer risk associated with waterborne radon is higher than any other drinking water contaminants. EPA (2012) estimated that lifetime risk of developing cancer from water containing high level of radon is approximately one chance in 10,000. Completely removing radon from drinking water probably will reduce the average cancer risk by only a few percent because most radon enters the air in a home directly from soil and rocks. Excessive exposure to radon is known to cause bone cancer and other adverse health effects.

Knowledge of the naturally occurring radionuclide present in drinking water enables one to assess any possible radiological hazard to humans by the use of such water. Hence the objective of this study is to evaluate the radioactivity concentration of these naturally occurring radionuclides in drinking water sources, determine the committed effective doses of the radiation from each of the water sources and finally evaluate the excess lifetime cancer risk associated with gamma radiation determined. This study will help to ascertain the safety of drinking both surface and ground water source from Onelga oil fields and their host communities and also serve as a radiological base line data of the area.

MATERIALS AND METHODS

Description of the Study Area

Ogba/Egbema/Ndoni Local Government Area of Rivers State is an oil producing community in the Niger Delta Region of Nigeria. They play host to two multinational oil and gas companies with their subsidiaries. The thirteen oil and gas fields of the study are in the onshore portion of the Niger Delta operated by Nigerian Agipoil Company (NAOC) and Total Fina Elf Plc respectively. Twelve oil fields were strategically selected out of thirteen oil fields in the area. They lie within latitude 5˚13' N and 5˚ 68'N and longitude 6˚ 38'E and 6˚ 42'E western Niger Delta region of Nigeria.

The geology of the study area has been reported earlier (Avwiri and Ononugbo, 2012). The lithological log correction showed that the top soil layer, which is composed of plastic clay, has a thickness ranging from 9.1 to 10.7m which is capable of protecting the underlain aquifer unit from being contaminated by surface toxic discharge (Agbalagba et al., 2012). A

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silty sand or sandy layer directly underlies this which forms the aquifer unit of the study area and the ground water table ranges between 2.4 and 3.1m (Taiwo and Akalia, 2009). The natural water system of the area depends on the location and depth with two extremes of fresh water and salt water and an intermediary of blackish water (Agbalagba et al., 2012).

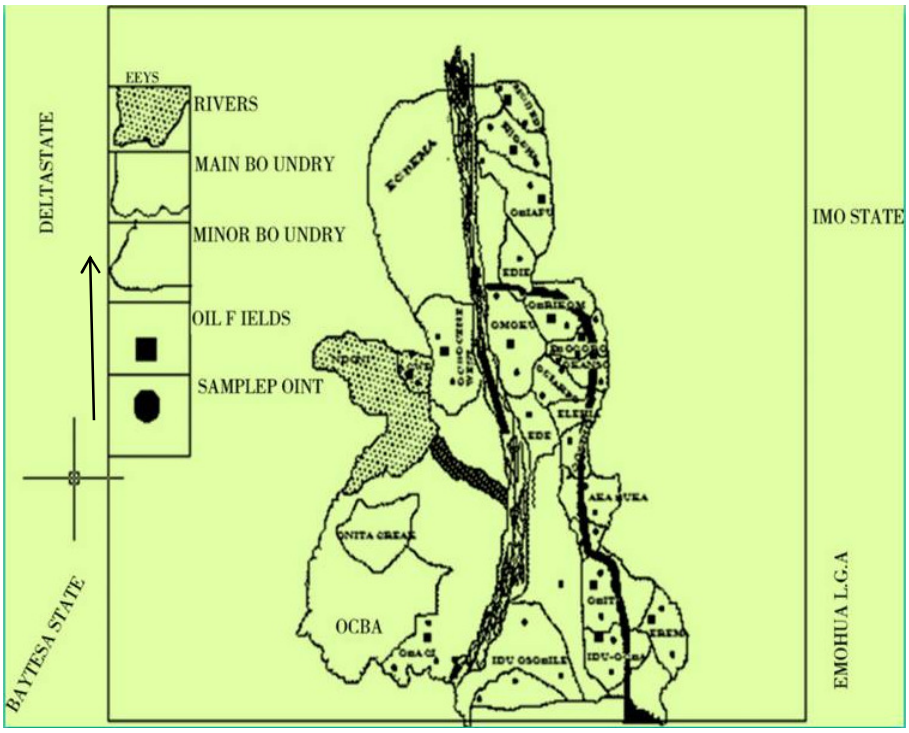

Figure 1. Sketch of the ONELGA Oil Fields Showing Sampling Areas

Sample Collection and Preparation

Thirty –six water samples were collected from the twelve oil fields nearby rivers/ streams and the host communities' public water supply (taps and hand dug wells) and for comparison purpose, another three samples of one each from a hand dug well. A bore hole and river were taken as controls from community with no history of oil and gas exploration and production activities but with geographical features similar to the study areas. At each sampling point, 1.5litres plastic containers were used for the collection of sample from each source with about 1% air space of the container left for thermal expansion. Sample containers were rinsed three times with sample water being collected to minimize contamination from the original content of the sample container. Hand dug shallow well water samples were collected at the early hours of the day from host community wells of varying depth (5-10m). The water samples were collected directly from wells by dropping a clean container on a rope long enough to reach the water level in the well. The tap water (borehole water) before samples were collected, the taps were first turn to its capacity for a few minutes to purge the plumbing system (Tchokossa et al., 1999). The taps were turned down to reduce turbulent flow and to reduce radon loss before collection. The samples of river /streams waters were collected from the host community domestic water fetching spot in the early hours of the day using the grab sampling method as reported by (Vesterbacka, 2007).

The original PH value of all the water samples was measured and nitric acid (HNO_3) added in other to retain the element in the water from missing or being deficient. Then the water was taken to the laboratory and processed through evaporation until 0.5 litres. To obtain equilibrium state for gamma spectroscopy, the samples were kept in Marinelli beaker sealed

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for one month. Due to smaller lifetime of the daughter radionuclides in the decay series of ^{233}Th and ^{238}U, the ^{232}Th activity was determined from the average activities of ^{208}Ti at 583Kev and ^{226}Ac at 911Kev in the samples and that of ^{238}U was determined from the average activities of the decay product ^{214}Pb at 352Kev and ^{214}Bi at 609Kev. The activity of ^{40}K was based on 1460Kev peak.

Experiment

Gamma Counting

The experiments for radioactivity measurement of the drinking water (ground and surface water) were carried out at the Ahmadu Bello University, Center for Energy Research and Training using Thalium activated 3″× 3″ Sodium Iodide (NaI(TI)) detector connected to ORTEC 456 amplifier. The detector enclosed in a 100mm thick lead shield, was connected to a computer program MAESTRO window that matched gamma energies to a library of possible isotopes.

Background measurement and efficiency calibration of the system was made using ^{137}Cs and ^{60}Co standard sources from IAEA, Vienna. Spectrum were accumulated for background for 29,000s at 900V to produce strong peaks at gamma emitting energies of 1460KeV for ^{40}K, 609KeV of ^{214}Bi and 911KeV of ^{228}Ac, which were used to estimate the concentration of ^{226}Ra and ^{228}Ra respectively. The activities of the standards at the time of calibration were 25.37kBq for ^{137}Cs and 4.84kBq for ^{60}Co. The background spectra measured under the same conditions for both the standard and sample measurements were used to correct the calculated sample activity concentrations in accordance with (Yussuf et al., 2012).

Concentrations of ^{226}Ra, ^{228}Ra and ^{40}K

The activity concentration (C) in Bql^{-1} of the radionuclides in the samples was calculated after subtracting decay correction using the expression;

$$C_s(Bqkg^{-1}) = \frac{C_a}{\varepsilon_\gamma \times M_s \times t_c \times P_\gamma} \qquad \text{----------} \quad 1$$

Where C_s = Sample concentration, C_a= net peak area of a peak at energy, ε_γ = Efficiency of the detector for a γ-energy of interest, M_s = Sample mass, t_c= total counting time, P_γ = abundance of the γ-line in a radionuclide. Radiation health hazard indices calculation was also carried for radium equivalent (Ra_{eq}) and committed effective dose to ascertain the radiation health impact associated with drinking the different sources of water available in the area.

Estimation of Committed Effective Dose

The committed effective dose to an individual due to intake of natural radionuclides from all the water samples is estimated using the relation

$$E = IAC \times 365 \qquad \text{----------} \quad 2$$

Where I is the daily water consumption in l/day, A is the activity/l, C is a dose conversion factor in mSv/Bq. Dose conversion factors were extracted from (IAEA, 2003) while the committed effective dose is the arithmetic summation of the effective dose of the three radionuclide measured.

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Table 1. Committed effective dose conversion factor (Sv/Bq) for members of the public (ICRP, 1997; WHO, 2003 and Ismail et al., 2009)

S/N	*Radioisotope*	*Infant ≤ 1yr*	*Children*	*Teenagers*	*Adult > 17 yrs*
		1-12yrs	12- 17 yrs		
1	^{226}Ra	4.7 E-06	6.2 E-07	1.5E-06	2.8E-07
2	^{228}Ra	3.0 E-05	3.4 E-06	5.3 E-06	6.2 E-07
3	^{40}K	6.2 E-08	2.1 E-08	7.6 E-09	6.2 E-09
Volume of water		0.5 l/day	1.0 l/day	2.0 l/day	2.0 l/day

Excess Lifetime Cancer Risk (ELCR)

This deals with the probability of developing cancer over a lifetime at a given exposure level. It is presented as a value representing the number of cancers expected in a given number of people on exposure to a carcinogen at a given dose.

It is worth noting that an increase in the ELCR causes a proportionate increase in the rate at which an individual can get cancer of the breast, prostate or even blood.

Excess Lifetime cancer risk (ELCR) is given as (Taskin et. al., 2009)

$$ELCR = AEDE \times DL \times RF \quad \text{----------} \quad 3$$

Where, AEDE is the annual committed effective dose, DL is the average duration of life (estimated to 70 years), and RF is the Risk Factor (Sv^{-1}), i.e. fatal cancer risk per Sievert. For stochastic effects, ICRP uses RF as 0.05 for public (Taskin et. al., 2009). The range of ELCR are 1.78 x 10^{-3} to 16.26 x 10^{-3} with an average of 16.26 x 10^{-3} ,5.95 to 19.07 x 10^{-3} with mean value of 11.50 x 10^{-3}, 5.30 to 40.75 x 10^{-3} for adults that drink tap, well and river water respectively. Also the range of ELCR for teenagers (13-17years) that drink tap, well and river water are 4.37 to 38.47 x 10^{-3}, 22.31 to 70.23 x10^{-3} and 14.02 to 62.18 x 10^{-3} respectively and that of babies (< 1yr) ranges are 7.09 to 51.79 x 10^{-3}, 29.84 to 82.78 x 10^{-3} and 22.19 to 71.79 x 10^{-3} respectively.

RESULTS AND DISCUSSION

Table 2 presents the summary of the result of the radionuclide activity concentrations along with the counting uncertainties. The result shows relatively high activity concentrations in all sources of water supplies in the oil fields and their host communities, as average activity concentrations were well above the WHO recommended permissible level for drinking water of 1.0,0.1 and 10.0Bql^{-1} for ^{226}Ra, ^{228}Ra and ^{40}K respectively (WHO, 2008). This may be attributed to the incessant gas flare activity and its precipitation into the environment, frequent oil spill into the surface water bodyand arable land and its consequential leaching into underground water within these oil fields in recent times. This was especially evident in the observed relatively high activity concentrations in the Obrikom, Odugiri and Agwe oil fields that are within 1km radius of oil and gas facilities where sampled water sources are very close to gas flare stacks and oil spilled areas with high soil porosity.

A comparison of the activity concentrations of the three radionuclides in the three sources of water with the control samples revealed that all concentrations were higher than the values of the corresponding control values which suggest that the water samples from these oilfields

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have been contaminated radiologically and it is possible that this may be attributed to the activities of the oil production companies as no other major industry is in the study area.

The estimated committed effective dose due to water intake by different age groups was calculated using equation 2 and presented in Tables 3 to Table 6. On the average, babies are considered to consume 0.5liter of water per a day, children 1liter per day, teenagers and adults 2liters per a day. These reference water intakes are conservatively low for summer in Nigeria. The values in Tables 3 to Table 6 are well above the allowed dose contribution from water which is estimated to be $0.1mSvy^{-1}$ (WHO, 2008; Agbalagba et al., 2013). The results revealed that children and teenagers are most susceptible to high dose related disease through intake of these waters.

Average excess lifetime cancer risk (ELCR) for all water samples as contained in Tables 3 to Tables 6 were above the world average value of 10^{-4} (EPA, 2012). This implies that the chances of having cancer by the oil workers and the general populace are significant. Therefore all the sources of drinking water in this area of study must be treated before consumption to avert the likely health implications.

Table 3. Committed Effective Dose and Excess Lifetime Cancer Risk in Adults (17 years and above)

Oil Fields	*Sample Type*					
	TAP H_2O ($mSvy^{-1}$)	*WELL H_2O ($mSvy^{-1}$)*	*RIVER H_2O ($mSvy^{-1}$)*	*TAP H_2O ELCR x 10^{-3}*	*WELL H_2O ELCR x 10^{-3}*	*RIVER H_2O ELCR x 10^{-3}*
EBOCHA	0.569	2.316	1.593	2.311	8.105	5.575
MGBEDE	1.420	2.614	1.669	4.971	9.148	5.842
OBIAFU	4.688	2.794	8.334	16.409	9.779	29.167
OBRIKOM	3.432	5.459	2.700	12.012	19.106	9.451
EBEGORO	0.494	1.701	1.514	1.729	5.955	5.301
OMOKU	1.351	2.756	3.010	4.728	9.647	10.535
EREMA	1.819	2.993	2.062	6.367	10.476	7.218
IDU-OGBA	0.707	2.026	11.644	2.474	7.089	40.752
OBAGI	1.617	3.079	2.316	5.659	10.777	8.104
OGBOGENE	0.453	4.047	2.991	1.585	14.164	10.470
ODUGIRI	2.406	5.449	4.793	8.421	19.070	16.774
AGWE	2.415	4.208	2.941	8.453	14.728	10.292
Mean	1.608	3.445	2.502	16.260	11.504	13.290

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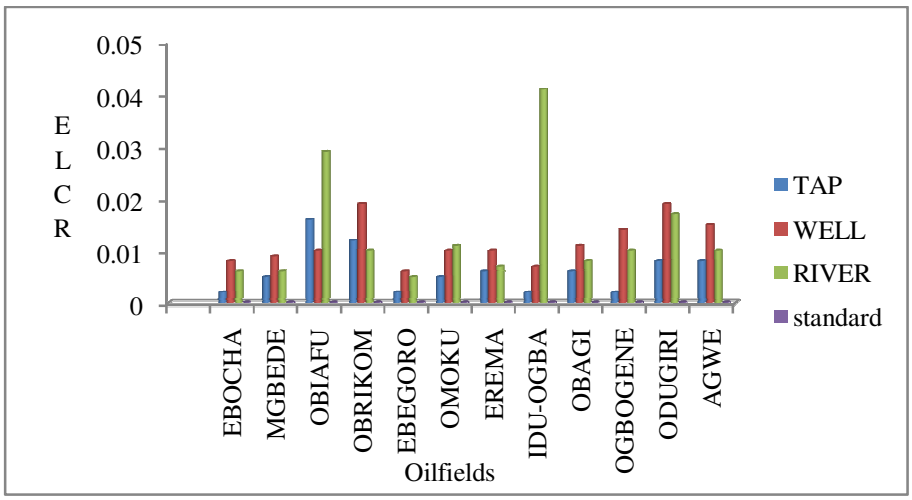

Figure 2. Comparison Excess Lifetime Risks for Adults (17yrs and above) in the Tap, Well and River Water with EPA 2012 standard

Table 4. Committed Effective Dose and Excess Lifetime Cancer Risk in Teenagers (13-17 YEARS)

Oil Fields	*Sample Type*					
	TAP H_2O ($mSvy^{-1}$)	*WELL H_2O ($mSvy^{-1}$)*	*RIVER H_2O ($mSvy^{-1}$)*	*TAP H_2O ELCR x 10^{-3}*	*WELL H_2O ELCR x 10^{-3}*	*RIVER H_2O ELCR x 10^{-3}*
EBOCHA	1.872	7.441	4.005	7.601	26.044	14.016
MGBEDE	4.922	8.180	5.228	17.225	28.630	18.296
OBIAFU	8.334	14.125	7.788	29.169	49.437	27.257
OBRIKOM	10.992	17.795	11.143	38.470	62.284	38.999
EBEGORO	1.256	6.376	5.775	4.395	22.314	20.211
OMOKU	3.577	10.695	9.206	12.518	37.432	32.222
EREMA	4.878	8.909	6.214	17.074	31.183	21.749
IDU-OGBA	2.930	6.962	5.785	10.253	24.366	20.246
OBAGI	6.308	10.532	9.287	22.078	36.863	32.505
OGBOGENE	10.612	14.221	10.475	37.141	49.774	36.662
ODUGIRI	8.232	20.065	17.765	28.813	70.229	62.179
AGWE	8.899	15.830	10.837	31.146	55.405	37.929
MEAN	6.026	11.761	8.626	21.236	41.163	30.189

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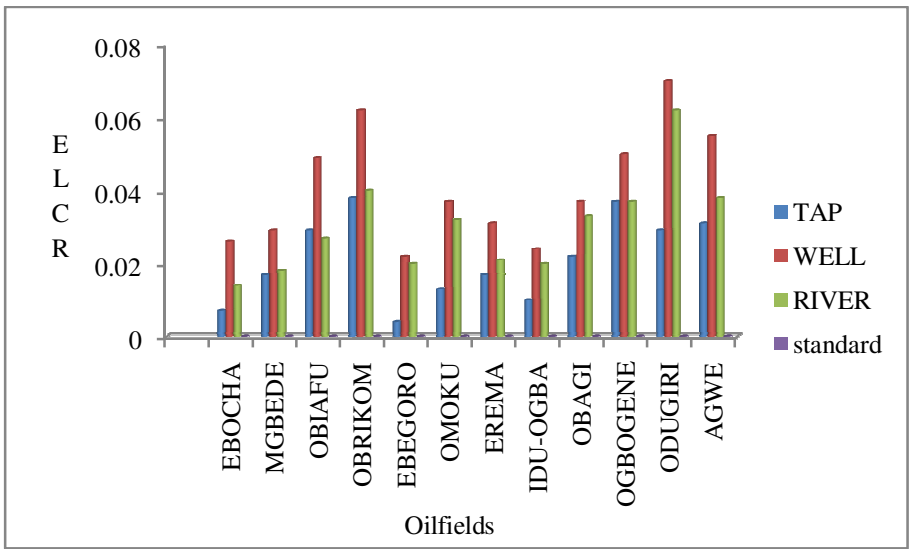

Figure 3. Comparison Excess Lifetime Risks for Teenagers (13-17 yrs) in the Tap, Well and River Water withEPA 2012 standard

Table 5. Committed effective dose and excess lifetime cancer risk in children (1-13 years)

Oil Fields	*Sample Type*					
	TAP H_2O ($mSvy^{-1}$)	*WELL H_2O ($mSvy^{-1}$)*	*RIVER H_2O ($mSvy^{-1}$)*	*TAP H_2O ELCR x 10^{-3}*	*WELL H_2O ELCR x 10^{-3}*	*RIVER H_2O ELCR x 10^{-3}*
EBOCHA	0.794	2.703	1.804	3.224	9.462	6.314
MGBEDE	1.691	3.017	1.961	5.919	10.561	6.863
OBIAFU	3.108	5.085	3.033	10.876	17.797	10.615
OBRIKOM	3.857	6.172	3.407	13.498	21.602	11.924
EBEGORO	0.592	2.153	1.924	2.073	7.537	6.734
OMOKU	1.546	26.342	20.899	5.412	92.198	73.147
EREMA	10.622	20.252	14.179	37.176	70.882	49.628
IDU-OGBA	7.403	16.642	13.935	25.911	58.247	48.773
OBAGI	15.539	25.140	22.771	54.387	87.990	79.700
OGBOGENE	21.160	34.048	25.073	74.058	119.167	87.757
ODUGIRI	19.622	48.876	43.220	68.677	171.066	151.269
AGWE	21.647	38.693	26.326	75.763	135.427	92.140
Mean	8.965	19.094	14.878	31.415	66.828	52.072

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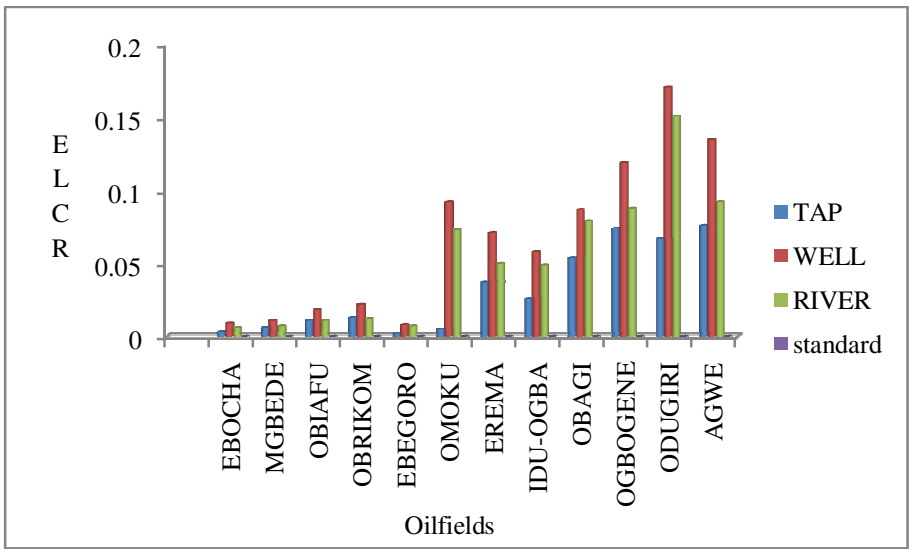

Figure 4. Comparison Excess Lifetime Risks for Children (1-13 yrs) for the Tap, Well and River Water with EPA 2012 standard

Table 6. Committed Effective Dose and Excess Lifetime Cancer Risk in BABIES (<1 YEAR)

Oil Fields	*Sample Type*					
	TAP H_2O ($mSvy^{-1}$)	*WELL H_2O ($mSvy^{-1}$)*	*RIVER H_2O ($mSvy^{-1}$)*	*TAP H_2O ELCR x 10^{-3}*	*WELL H_2O ELCR x 10^{-3}*	*RIVER H_2O ELCR x 10^{-3}*
EBOCHA	2.214	9.870	6.704	8.988	34.546	23.464
MGBEDE	6.044	11.163	7.071	21.153	39.072	24.750
OBIAFU	11.004	20.490	12.110	38.515	71.715	42.384
OBRIKOM	14.797	23.651	11.477	51.791	82.778	40.168
EBEGORO	2.026	7.144	6.339	7.090	25.004	22.186
OMOKU	5.686	11.851	13.370	19.903	41.479	46.794
EREMA	7.974	12.920	8.918	27.907	45.219	31.214
IDU-OGBA	2.790	8.524	6.865	9.765	29.835	24.029
OBAGI	6.937	12.954	10.375	24.28	45.341	36.313
OGBOGENE	7.498	17.135	15.860	26.241	59.973	55.511
ODUGIRI	10.211	23.040	20.511	35.738	80.642	71.790
AGWE	10.334	18.065	12.577	36.170	63.229	44.020
Mean	10.634	11.0148	14.734	25.525	51.569	38.552

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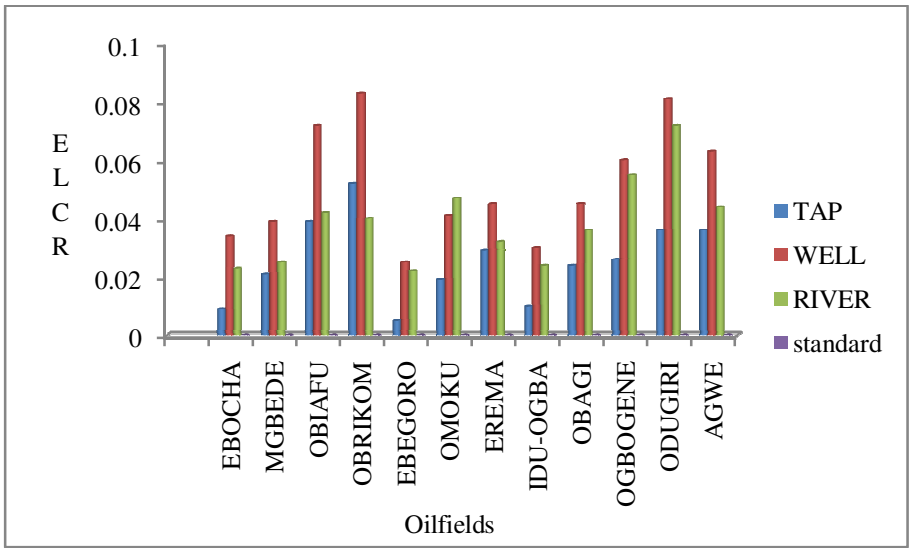

Figure 5. Comparison Excess Lifetime Risks for Babies (< 1yr) in the Tap, Well and River Water with EPA 2012 standard

CONCLUSION

The concentrations of natural radionuclides varied widely within the oil fields and from one oil field to another in the twelve oilfields. The relatively high radionuclide activity concentrations were probably attributed to the impact of oil and gas exploration and exploitation activities on the environment. This could result from contamination of aquifers, precipitation of radon daughters from radon released into the atmosphere by oil and gas exploitation activities and effluent discharged at various magnitudes in the oil fields. The estimated committed effective dose to the local population are well above the permissible limits and well above nearby control sites. Therefore, the sources of water in these oil fields have been contaminated. The excess lifetime cancer risk calculated also was higher than the world acceptable value in all the age brackets. Though immediate health implication for the public users may not be observed at the present level, but long term accumulative health side effects are highly probable in the host communities. It is therefore recommended that all the drinking water from surface or groundwater sources must be treated either through reverse osmosis or ion exchange method which can help remove radium from the water. This work has established baseline information on the natural radioactivity status of hand dug wells, boreholes (tap) and river water in the studied area and any typical oil and gas onshore environment of Niger Delta which will serve as reference for future studies.

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APPENDIX

Table 2. Activity concentrations of ^{226}Ra, ^{228}Ra and ^{40}K (Bql^{-1}) in well, tap and river water samples from twelve oil fields environment

Oil Fields	*Water Sample Activity concentration (Bql^{-1})*								
	Host comm. Hand dug well			*Host comm. Borehole water*			*Field river water*		
	^{226}Ra	^{228}Ra	^{40}K	^{226}Ra	^{228}Ra	^{40}K	^{226}Ra	^{228}Ra	^{40}K
EBOCHA	5.66±0.82	6.11±0.82	39.21±4.14	1.42±0.07	0.86±0.04	31.14±3.61	2.61±0.52	5.24±0.72	8.11±4.32
MGBEDE	6.14±1.02	7.21±1.30	44.36±4.33	3.88±0.35	3.31±0.29	21.12±3.00	3.92±0.42	4.44±0.51	34.18±2.21
OBIAFU	10.42±1.65	14.87±1.60	37.63±2.78	6.31±1.42	9.26±1.14	56.42±4.11	5.52±0.82	5.52±0.82	39.42±3.20
OBRIKOM	13.67±1.12	15.18±1.72	50.11±3.88	7.79±2.00	10.14±0.9	46.68±5.02	9.42±1.81	4.21±0.54	21.78±1.23
EBEGORO	5.18±0.54	3.12±0.30	32.37±2.45	0.82±0.07	1.46±0.08	20.32±2.94	4.73±0.36	2.64±0.20	27.73±1.12
OMOKU	8.84±1.03	5.13±0.62	27.73±2.16	2.42±0.38	4.24±0.80	38.72±3.67	6.71±0.70	9.42±1.14	49.99±2.23
EREMA	6.52±1.0	9.42±1.14	41.82±2.53	3.36±0.54	6.52±0.42	26.36±2.79	4.58±0.38	6.27±0.81	18.82±1.06
IDU-OGBA	5.46±0.65	4.52±0.42	40.56±1.24	2.46±0.08	0.49±0.06	36.71±3.60	4.58±0.61	3.37±0.42	27.68±2.02
OBAGI	8.24±1.02	6.92±0.47	62.64±4.25	7.62±0.91	4.72±0.23	27.16±3.02	5.23±0.23	3.12±0.32	10.31±0.96
OGBOGENE	11.23±0.61	9.01±1.41	67.25±3.82	0.65±0.02	1.48±0.03	18.19±1.11	8.31±0.76	7.22±0.76	29.43±0.89
ODUGIRI	16.32±0.89	11.25±1.04	55.16±1.03	6.45±0.86	5.65±0.74	39.83±3.36	14.43±1.66	10.17±1.26	46.34±1.62
AGWE	12.94±1.12	8.82±1.04	32.40±0.62	7.21±0.74	5.18±0.53	24.21±2.04	8.78±0.92	6.29±0.76	30.02±1.94
Mean	*9.22±0.82*	*8.46±0.61*	*44.27±2.34*	*4.20±0.12*	*4.44±0.14*	*37.85±2.15*	*6.57±0.24*	*6.88±0.36*	*29.48±1.98*