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Studies on the Radiological Impact of Oil and Gas Activities in Oil Mineral Lease 30 (Oml30) Oil Fields in Delta State, Nigeria

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Abstract

A preliminary studies on the radiological impact of oil and gas exploration activities in the oil and gas production land area of Delta State has been carried out *insitu,* using two radiation meters (Digilert 50 and 100) synchronized and calibrated and a geographical positioning system (GPS). Readings were taken in nine different facilities in each of the oil and gas fields and one sample each in their host communities. Measured radiation values in the oil field facilities ranged from 0.011 ± 0.003 mRh^{-1} in Evwreni campsite to 0.031 ± 0.01 mRh^{-1} at the Otorogu gas plant. Mean field exposure rates/equivalent dose rates in the oil fields ranged from 0.016 ± 0.006 mRh^{-1} (1.4 ± 0.5 $mSvy^{-1}$) to 0.0213 ± 0.008 mRh^{-1} (1.8 ± 0.7 $mSvy^{-1}$). While in the host communities values ranged from 0.011 ± 0.003 mRh^{-1} (0.9 ± 0.3 $mSvy^{-1}$) in Evwreni community to 0.021 ± 0.007 mRh^{-1} (1.8 ± 0.7 $mSvy^{-1}$) in Otujeremi town and the control study area value been 0.009 ± 0.002 mRh^{-1} (0.8 ± 0.06 $mSvy^{-1}$). The results show that all the oil and gas fields and host communities except Evwreni community yearly radiation dose rate exceeded the 1$mSvy^{-1}$ maximum permissible limit recommend for the public and non-nuclear industrial environment by International Council on Radiological Protection [1]. All the oil fields and host community except Ughelli East and Evwreni community radiation levels exceeded the normal world average BIR level of 0.013 mRh^{-1} and other reported values in similar environment. This shows that the oil fields environment and the host communities have been impacted radiologically. However, these results obtained may not have immediate health hazard, but will pose some long-term health side effects on the staff working in the facilities and residents of the host communities. Interim proactive measures are recommended while further and a detail study is ongoing.

Keywords: Radiological impact; Oil and Gas facilities; OML30; Delta state

Introduction

Radiation plays an important and sometimes vital role in our everyday lives. Every day each of us is exposed to naturally occurring quantities of radiation. We are exposed to these radioactive materials through the air we breathe, the soil on which we walk, the water we drink, the food we eat and even within our bodies [2]. Monitoring for radioactive materials is of primary importance for environmental protection, but rapid and accurate methods for the assay of radioactivity are essential [3].

Crude oil and other petroleum related products is a naturally occurring liquid mineral deposited beneath the earth surface. Its occurrence is sometimes accompanied with the existence of natural gas. The oil, gas and associated gas are contaminated generally with radionuclide in the earth crust and drilling material. All these provide the source of radiation such as α, β and γ radiation often found in the petroleum matrix [4].

Gamma rays are known to be highly penetrating and are part products of the radioactive materials containing radon that may be ingested or inhaled into the human body, during repairs and maintenance of oil facilities. If inhaled the dust particles and aerosols containing radon may attach themselves to the lungs where gamma rays emitted in the decay may pose increase risk of lung cancer, eye cataracts and mental imbalances to personnel and host communities [4].

In recent time, researchers have found a strong correlation between radiation exposure and health hazard on workers in this environment eco-system [5] which are attributed to the industries input raw materials, effluents discharged as in gas flare and output products.

Elena and Gracea [6] conduct environmental monitoring of radioactivity in the surroundings of six oil fields in Bacau and Braila districts and reported that from radiological point of view, the situation does not pose any immediate concern. However, the high radium-226 content of oil field formation waters could lead to environmental pollution. Laogun et al. [4] studied the variation in well-Heads gamma radiation levels at an oil field in Ologbo, Edo state and reported that the values obtained are fairly higher than the normal background level but are in agreement with the International Atomic Energy Agency's standard on background ionizing radiation level for such environment. Also, the Rail Road Commission of Texas [7] reported that naturally occurring radioactive materials (NORMS) associated with oil and gas production originated in subsurface and contain radioactive materials like Uranium and Thorium and their daughter progenies (Ra-226 and Ra-228).

Avwiri et al. [5] studied the terrestrial radiation around oil and gas facilities in Ughelli region of Nigeria and reported an average value range of 12.00 ± 0.10 μRh^{-1} (5.33 ± 0.35 μSv/wk) to 22.00 ± 2.1 μRh^{-1}(9.79 ± 0.16 μSv/wk) in the oil fields and 09.00 ± 1.0 μRh^{-1} to 11.00

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± 0.5μRh^{-1} in the host communities. They concluded that though the radiation values are within international standard and are in consonant with other reported values in the country, the BIR levels exceeded the normal background level.

EPA [8] on environmental, health and safety online, stated that the more radiation dose from oil and gas installation on a person or worker receives, the greater the chance of developing cancer, leukemia, eye cataracts, erythema, hematological depression and incidence of chromosome aberrations. This may not appear until many years after the radiation dose is received (typically, 10-40 years).

Through temperature and pressure changes that occur in the course of oil and gas production operations, radium-226 and radium-228 found in produced waters may co-precipitate with barium sulfate scale in well tubules and surface equipment. Concentrations of radium-226 and radium-228 may also occur in sludge that accumulates in oil field pits and tanks. These solids become sources of hydrocarbon NORM waste [9]. In gas processing activities, NORM generally occurs as radon gas in the natural gas stream. Radon decay elements occur as a film on the inner surface of inlet lines, treating units, pumps and valves principally associated with propylene, ethane and propane processing streams. Production and processing equipment may contain residual quantities of NORM- contaminated water, scale or sludge that can cause disposal and exposure problems when the equipment is taken-off line for maintenance, repair or replacement. Workers employed in the area of cutting and reaming oil field pipe, removing solids from tanks, pits and refurbishing gas processing equipment may be exposed to particles containing levels of alpha and or beta emitting radionuclide that could pose health risks if inhaled or ingested [10].

The objective of this study is therefore to assess the radiological impact on the environment and population of the oil/gas industry that is non-nuclear industry. This study will also give precise and accurate information on the background ionizing radiation (BIR) levels of these flow stations and their host communities in the Niger Delta State and add to the data on background radiation levels in oil facilities in the region. The health implications of the obtained results on the fields' workers and residents of the host communities were examined.

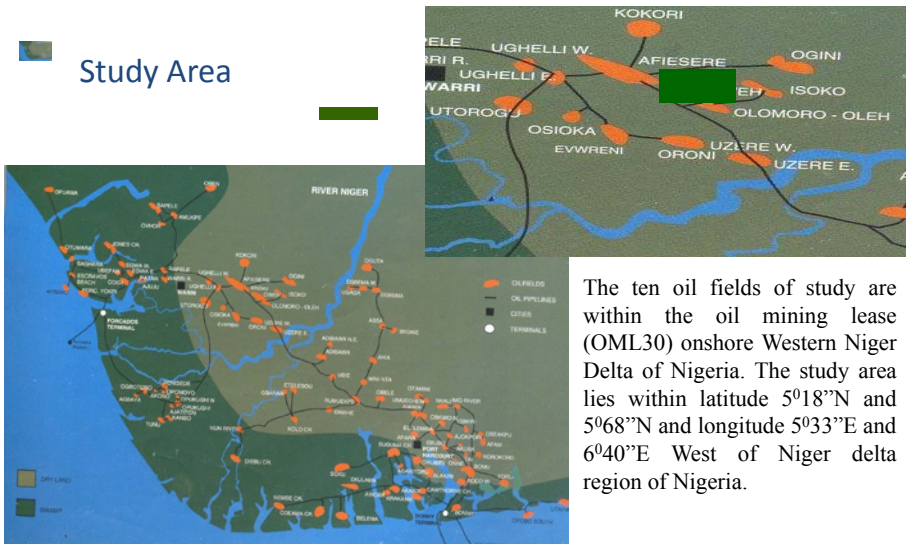
Experimental Method

The studied oil fields are within the Oil Mining Lease 30 (OML 30) of the production land area of Niger Delta Shown in figure 1. An *insitu* approach of the background radiation levels measurement was preferred to enable samples maintain their original environmental characteristics. Two radiation meters, Digilert 50 and 100 nuclear radiation monitors (S.E International Inc. Summer Town, USA), which contain a Geiger Muller tube, each capable of detecting; α, β, γ and x-rays within the temperature range of -10 to 50°C were used.

Prior to use, the two meters were synchronize by resetting them. Readings were taken on each operational scale at the time of the calibrations with check sources and repeated every 5 minutes. The standard errors detected were ± 8% and ± 5% for digilert 50 and 100 respectively. During field measurements, the tube of the radiation meters were held at a standard height of 1.0 m above the ground and placed at about 2.0 m away from the facilities. The windows of the radiation meters were first oriented vertically downward and then toward the oil/gas facility [4,5]. The geographical positioning system (GPS) reading for the particular facility location was recorded.

For optimum meter responds and results, measurements were carried out between 1300 to 1600 hours each day, since the radiation meters have maximum response to environmental radiation within these hours [11]. At each facility, three readings were obtained simultaneously at 300 secs each facility and their average values computed. In a field, nine different facilities radiation levels were taken to ensure adequate coverage of the oil field facilities. Also one radiation level measurement was obtained outside in each oil field host communities.

To estimate the whole body equivalent dose rate, the researcher used the National Council of Radiation Protection and Measurements (NCRP, 1993) recommendation which stipulates that



The ten oil fields of study are within the oil mining lease (OML30) onshore Western Niger Delta of Nigeria. The study area lies within latitude $5^{0}18$"N and $5^{0}68$"N and longitude $5^{0}33$"E and $6^{0}40$"E West of Niger delta region of Nigeria.

A map showing network of pipes of oil fields in onshore of the Niger Delta.

Figure 1: Isolation of plant DNA.

$$1mRh^{-1} = \left(\text{üüüüx} \quad x \quad {}^{/}_{100}\right) mSvy^{-1}$$

Results and Discussion

Tables 1–10 show the results of the *in situ* measurement carried out in the nine studied oil and gas fields and one host community. The facilities exposure rate in the oil fields ranged from 0.011 ± 0.03 mRh^{-1} at the campsite in Evwreni oil fields to 0.031 ± 0.010 mRh^{-1} at the Otorogu gas plant in Otorogu oil and gas field. The high values obtained at the Otorogu gas plant may be attributed to the high concentration of randon accompanying natural gas, which is in abundance in this environment.

The mean exposure rates/equivalent dose rates in the oil fields ranged from 0.016 ± 0.006 mRh^{-1} (1.350 ± 0.50 $mSvy^{-1}$) in Evwreni field to 0.021 ± 0.008 mRh^{-1} (1.79 ± 0.70 $mSvy^{-1}$) in Otorogu oil and gas field (Figure 1). The low level obtained at Evwreni oil and gas field could be attributed to the shutdown in operations at the oil field. While the high radiation level recorded at some of the oil and gas field especially at Otorogu field may be as a result of the ongoing development of new oil wells and the turnaround maintenance going on in some major facilities within these oil and gas fields. The mean field radiation values obtained from the oil and gas field show that, Ughelli East, Kokori, Eriemu, Evwreni, Oweh, Olomoro-Oleh oil and gas fields are still within the 1.0 $mSvy^{-1}$ maximum permissible limit for non-nuclear work environment and the general public, recommended by European Council for Nuclear Research [12] and International Council on

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Crude Flow Pipe	NO5 32.297' E005 53.780'	0.019	0.018	0.019±0.004	1.6±0.3
2	Natural Gas Compressor	NO5 26.021' E005 52.940	0.025'	0.019	0.022±0.008	1.9±0.7
3	Flow station entrance	NO5 26..057' E005 52.926'	0.017	0.018	0.018±0.007	1.5±0.6
4	Well 7	NO5 25.918' E005 53.014'	0.021	0.024	0.223±0.009	1.9±0.8
5	Pegging Manifold	N05 26.062' E005 52.901''	0.019	0.021	0.020±0.008	1.7±0.6
6	Well 10	N05 25.671' E005 52.930'	0.016	0.018	0.017±0.006	1.4±0.5
7	Flare Stack Site	N05 26.141 E005 52.653	0.024	0.025	0.025±0.011	2.1±0.8
8	Well 5	NO5 25.701' E005 52.608'	0.018	0.020	0.019±0.009	1.6±0.7
9	Olorogu Gas Plant	NO5 25.701' E005 52.608'	0.028	0.034	0.031±0.010	2.6±0.8
10	***Otujeremi Town***	***NO5 25.865' E005 52.567'***	***0.022***	***0.020***	***0.021±0.007***	***1.8±0.6***
	MEAN FIELD LEVELS				**0.021±0.008**	**1.8±0.7**

Table 1: Otorogu Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Crude Flow Pipe	NO5 32.297' E005 53.780'	0.019	0.018	0.019±0.003	1.6±0.3
2.	Flow station entrance	NO5 32..303' E005 53.782'	0.029	0.024	0.027±0.008	2.2±0.7
3	Well 7	NO5 32.338' E005 53.7954'	0.024	0.018	0.021±0.006	1.8±0.5
4	Limer & Serier (L&S) Tango piple	N05 32.279' E005 53.771'	0.023	0.020	0.022±0.006	1.9±0.5
5	Crude oil control	N05 32.275' E005 53.759	0.016	0.018	0.017±0.005	1.4±0.4
6	Flare knockout vessel	N05 32.282' E005 53.720'	0.015	0.018	0.017±0.006	1.4±0.5
7	Flare control valve	N05 32.295' E005 53.685	0.018	0.014	0.016±0.005	1.4±0.4
8	Flare stack point	N05 32.307' E005 53.678	0.016	0.015	0.016±0.005	1.3±0.4
9	Well 2	N05 32.112' E005 53.802'	0.018	0.020	0.019±0.007	1.6±0.6
10	***Ekakpamre community***	***N05 31.071 E005 54.170***	***0.021***	***0.017***	***0.019±0.008***	***1.6±0.7***
	MEAN FIELD				**0.019±0.005**	**1.6±0.4**

Table 2: Ughelli West Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Flow station entrance	NO5 30.850' E005 56.233'	0.021	0.019	0.020±0.008	1.7±0.7
2.	Control station (UNC)	NO5 30.856' E005 56.229'	0.019	0.015	0.017±0.006	1.4±0.5
3	L & S tango crude pipe	NO5 30.860' E005 56.210'	0.018	0.018	0.018±0.007	1.5±0.6
4	Crude and Gas control valve	N05 30.864' E005 56.117	0.015	0.017	0.016±0.005	1.3±0.4
5	UPS Manifold	N05 30.750' E005 56.272	0.017	0.020	0.019±0.007	1.6±0.6
6	Flare site	N05 30.984' E005 56.271'	0.016	0.04	0.015± 0.005	1.3±0.4
7	Ughelli East Buster station	N05 31.004' E005 55.910'	0.018	0.018	0.018±0.004	1.5±0.3
8	Well 5	N05 30.783' E005 56.310	0.016	0.014	0.015±0.007	1.3±0.6
9	NGC station	N05 30.860' E005 56.199'	0.019	0.020	0.019±0.008	1.6±0.7
	Eruemukohwara community	***N05 31.598' E005 56.409'***	***0.011***	***0.014***	***0.012±0.004***	***1.1±0.3***
	MEAN FIELD LEVEL				**0.017±0.007**	**1.5±0.6**

Table 3: Ughelli East Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Flow and compressor station gate	NO5' 32.888' E006 00.898'	0.017	0.020	0.019±0.008	1.6±0.7
2.	Manifold	NO5' 3 2.871' E006' 00.892'	0.030	0.028	0.029±0.009	2.4±0.7
3	Flare control valve	NO5' 32.899' E006' 00.808'	0.018	0.020	0.019±0.007	1.6±0.6
4	L & S Tango flow crude pipe	N05' 32.903' E005 56.117	0.014	0.015	0.015±0.007	1.2±0.5
5	Natural gas compressor (NGC) station	N05' 32.652' E006. 01.138	0.021	0.019	0.021±0.008	1.7±0.7
6	Flare knockout vessel	N05' 32.801' E006 00.776'	0.016	0.015	0.016± 0.006	1.3±0.5
7	Flare site	N05 32.906' E005 00.801'	0.023	0.020	0.022±0.009	1.8±0.8
8	Well 27	N05" 32.863' E005 00.982	0.018	0.017	0.018±0.008	1.5±0.6
9	Well 13	N05" 32.783' E005 01.035'	0.022	0.025	0.024±0.008	2.0±0.7
10	***Emeragha community***	***N05 32.582' E005 01.530'***	***0.019***	***0.018***	***0.019±0.006***	***1.6±0.5***
	MEAN FIELD LEVEL				**0.020±0.008**	**1.7±0.6**

Table 4: Afiesere Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Manifold	NO5' 38.624' E006 04.321'	0.017	0.025	0.021±0.008	1.8±0.7
2.	Flow station Gate	NO5' 38.641' E006' 04'224'	0.018	0.020	0.019±0.009	1.06±0.8
3	Natural Gas compressor (NGC) station	NO5' 38.638' E006' 04.215'	0.018	0.022	0.021±0.010	1.7±0.8
4	L & S Tangle flow crude pipe	N05' 38.601' E006 04.226'	0.016	0.014	0.015±0.007	1.3±0.6
5	Control valve (crude)	N05' 39.012' E006. 04.171	0.018	0.020	0.019±0.007	1.6±0.6
6	Flare knockout drum	N05' 39.016' E006 0466'	0.017	0.020	0.019± 0.006	1.6±0.5
7	Flare stock site	N05' 39.108' E005 00.801'	0.017	0.015	0.016±0.006	1.4±0.5
8	Well 13, 34 & 35	N05" 38.844' E006" 04.030'	0.020	0.023	0.022±0.011	1.8±0.9
9	Flare control valve	N05" 39.112' E006 04.192'	0.016	0.014	0.015±0.008	1.3±0.7
10	***Erhioke Community***	***N05 38.602' E006" 04.227'***	***0.014***	***0.013***	***0.014±0.004***	***1.2±0.3***
	MEAN FIELD LEVEL				**0.018±0.007**	**1.50.6**

Table 5: Kokori Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Field logistic base (FCB)	NO5' 32.770' E006 02.716'	0.022	0.016	0.019±0.009	1.6±0.8
2.	Well 3	NO5' 31.264' E006' 03 501	0.014	0.019	0.017± 0.007	1.4±0.6
3	Pegging manifold	NO5' 31.550' E006' 03.430'	0.016	0.013	0.015±0.004	1.2±0.3
4	N.G.C Station	N05' 31.211' E006 03.428'	0.019	0.017	0.018±0.008	1.5±0.7
5	Flow station Gate	N05' 31.218' E006. 03.488'	0.012	0.014	0.013±0.005	1.1±0.4
6	Gas Vent (knockout drum)	N05' 31.488' E006 03.498'	0.017	0.018	0.015± 0.007	1.3±0.6
7	Flare stack site	N05' 31.305' E006 03.519'	0.013	0.019	0.016±0.006	1.4±0.5
8	L & S Tango Crude flow pipe	N05" 31.246' E006" 03.473'	0.013	0.016	0.015±0.005	1.2±0.4
9	Well 13 & 19	N05" 32 .181' E006' 02.251'	0.018	0.020	0.019±0.007	1.6±0.6
10	***Gana Agbarh-otor community***	***N05 38.578' E006" 03.75'***	***0.017***	***0.014***	***0.016±0.007***	***1.3±0.6***
	MEAN FIELD LEVEL				**0.016±0.006**	**1.4±0.5**

Table 6: Eriemu Oil and Gas Field Background Radiation Level.

Radiological Protection [1]. However, Otorogu, Ughelli West, Afiesere and Uzere West and East oil and gas fields exceeded this maximum value of 1.0 $mSvy^{-1}$ [1]. This calls for a concern and detailed studies of the oil fields to ascertain the level of radiological impact of these fields' workers, host communities and the immediate environment.

The exposure rates obtained in the host communities ranged from 0.011 ± 0.003 mRh^{-1} (0.925 ± 0.300 $mSvy^{-1}$) in Evwreni community to 0.021 ± 0.007 mRh^{-1} (1.770 ± 0.670 $mSvy^{-1}$) in Otujeremi town. It was generally observed that the closer the facilities to the host community the higher the impact level, thus proximity plays an important role in the radiation impact and distribution. These results obtained in the host communities show that all communities equivalent dose rate exceeded the [1] 1.0 $mSvy^{-1}$ maximum (Table 11) permissible limit recommended, for the public, which may result in some health hazard in this environment. Shows the comparison of the studied oil fields and host communities radiation data. The percentage deviation is least at Ughelli West oil and gas field with a percentage difference of 0.30 and maximum at Ughelli East oil and gas field with a percentage difference of 39.10. This could also be attributed to the proximity of the oil and gas facilities to the host communities. The result obtained from the control site (a non-oil bearing community with the same geological, hydrological and geomorphologic features with studied fields) is 0.009 ± 0.002 mRh^{-1} (0.756 ± 0.17 $mSvy^{-1}$), which show a great difference with the host communities BIR levels and dose value is below the [1] 1.0 $mSvy^{-1}$ maximum permissible limit recommended, for the public.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Camp site	NO5' 22.720' E006 02.962'	0.011	0.011	0.011±0.003	0.9±0.2
2.	Well 13	NO5' 22.615' E006' 02 640'	0.015	0.014	0.015± 0.005	1.2±0.4
3	Manifold	NO5' 22.405' E006' 02.405'	0.019	0.013	0.016±0.006	1.4±0.5
4	Well 1	N05' 22.327' E006' 02.410'	0.017	0.014	0.016±0.005	1.3±0.4
5	Flow station Gate	N05' 22.445' E006. 02.470'	0.015	0.016	0.016±0.006	1.3±0.5
6	L & S Tanga crude flow pipe	N05' 22.428' E006" 02 500'	0.015	0.014	0.015± 0.005	1.2±0.4
7	Gas vent (knockout drum)	N05' 22.432' E006 22.482'	0.020	0.022	0.021±0.009	1.8±0.8
8	Flare stock site	N05" 22.361' E006" 02.451'	0.021	0.018	0.020±0.008	1.6±0.7
9	Well 11	N05" 22 .394' E006' 02.439'	0.014	0.014	0.014±0.005	1.2±0.4
10	***Evwreni Community***	***N05' 24.243' E006" 03.451'***	***0.017***	***0.014***	***0.011±0.003***	***0.9±0.3***
	MEAN FIELD LEVEL				**0.016±0.006**	**1.4±0.5**

Table 7: Evwreni Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Flow Station Gate	NO5' 29.271' E006 08.101'	0.016	0.012	0.014±0.005	1.2±0.4
2.	Crude oil control valve	NO5' 08.101' E006' 08'	0.019	0.019	0.019± 0.007	1.6±0.6
3	Gas vent (knockout drum)	NO5' 29.289' E006' 08.201'	0.017	0.016	0.017±0.006	1.4±0.5
4	Flare stack site	N05' 29.304' E006' 08.244'	0.016	0.018	0.017±0.005	1.4±0.4
5	NGC Station	N05' 29.216' E006. 08.132'	0.022	0.020	0.021±0.008	1.8±0.7
6	L & S tango Crude flow pipe	N05' 29.285' E006" 28 185'	0.016	0.014	0.015± 0.006	1.3±0.5
7	Manifold	N05' 28.185' E006 07.720'	0.019	0.018	0.019±0.008	1.6±0.7
8	Well 12	N05" 29.666' E006" 06.567'	0.020	0.018	0.019±0.007	1.6±0.6
9	Well 2	N05" 29 .219' E006' 08.128'	0.018	0.023	0.020±0.010	1.7±0.8
10	***Otor-Oweh community***	***N05' 29.614' E006" 06.248'***	***0.012***	***0.014***	***0.013±0.005***	***1.1±0.4***
	MEAN FIELD LEVEL				**0.018±0.007**	**1.50.6**

Table 8: Oweh Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD. VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Well 14	NO5' 27.984' E006 09.856 '	0.021	0.015	0.018±0.007	1.5±0.6
2.	Well 20	NO5' 27.441' E006' 10.470''	0.015	0.021	0.018± 0.006	1.5±0.5
3	Flow station Gate	NO5' 27.410' E006' 10.736'	0.015	0.021	0.015±0.007	1.3±0.6
4	L & S Tango crude flow pipe	N05' 27.422' E006' 10.778'	0.016	0.019	0.018±0.006	1.5±0.5
5	Gas vent (knockout drum)	N05' 27.521' E006. 10.811'	0.026	0.022	0.024±0.010	2.0±0.8
6	Flare stock site	N05' 27.541' E006" 10 826'	0.020	0.024	0.022± 0.009	1.9±0.8
7	NGC	N05' 27.303' E006 10.781'	0.017	0.020	0.019±0.008	1.6±0.7
8	Manifold	N05" 27.226' E006" 10.702'	0.014	0.015	0.015±0.006	1.2±0.5
9	Field logistic base (FLB)	N05" 27 .256' E006' 10.985'	0.008	0.610	0.009±0.002	0.8±0.2
10	***Olomoro Community***	***N05' 26.989' E006" 11.820'***	***0.017***	***0.018***	***0.018±0.005***	***1.5±0.4***
	MEAN FIELD LEVEL				**0.018±0.007**	**1.5±0.6**

Table 9: Olomoro-Oleh Oil and Gas Field Background Radiation Level.

S/N	SAMPLED AREA	GEOGRAPHICAL LOCATION	RADIATION LEVEL mRh^{-1}		AVE. RAD VALUE mRh^{-1}	EQ. DOSE $mSvy^{-1}$
			RAD 50	RAD 100		
1	Manifold	NO5' 20.080' E006 14.865 '	0.016	0.015	0.016±0.006	1.3±0.5
2.	Buster station	NO5' 20.162' E006' 14 .781''	0.017	0.014	0.016± 0.005	1.3±0.4
3	NGC Station	NO5' 19.751' E006' 14.762'	0.016	0.019	0.018±0.006	1.5±0.5
4	Flow station Gate	N05' 19.627' E006' 14.655'	0.027	0.028	0.028±0.013	2.3±1.1
5	L & S Tango crude flow pipe	N05' 19.167' E006. 14.642'	0.022	0.024	0.23±0.010	1.9±0.8
6	Flare knock out down	N05' 19.601' E006" 14. 633'	0.020	0.018	0.019± 0.008	1.6±0.7
7	Flare stack site	N05' 19.584' E006' 14.566'	0.017	0.021	0.019±0.007	1.6±0.6
8	Well 6	N05" 19.251' E006" 15.960'	0.019	0.023	0.020±0.009	1.7±0.8
9	Well 2	N05" 19 .421' E006' 15.862'	0.022	0.026	0.024±0.012	2.0±1.0
10	***Uzere community***	***N05' 20.268' E006" 14.338'***	***0.016***	***0.019***	***0.018±0.007***	***1.5±0.6***
	MEAN FIELD LEVEL				**0.020±0.008**	**1.7±0.7**

Table 10: Uzere East and West Oil and Gas Field Background Radiation Level.

Area Code	Oil and Gas Field	Host Community	Mean field dose rate ($mSvy^{-1}$)	Host Community dose rate ($mSvy^{-1}$)	Difference (%)
OUT	Otorugu	Otujeremi	1.8±0.7	1.8±0.6	1.51
UEA	Ughelli West	Ekpamre	1.6±0.4	1.6±0.7	0.30
UER	Ughelli East	Eruemukaharie	1.5±0.6	1.1±0.3	39.10
AEM	Afiesere	Emergha	1.7±0.7	1.6±0.5	7.52
KER	Kokori	Erhioke	1.5±0.6	1.2±0.3	36.07
EGA	Eriemu	Gana-Agbarha	1.4±0.6	1.3±0.6	6.06
EVN	Evwreni	Evwreni	1.4±0.5	1.3±0.5	22.70
OWT	Oweh	Otoweh	1.5±0.6	1.1±0.4	37.14
OLO	Olomoro-Oleh	Olomoro	1.5±0.6	1.5±0.4	1.29
UZE	Uzere West & East	Uzere	1.7±0.7	1.5±0.6	14.4

Table 11: Comparison of Studies fields and Host Communities Radiation Data.

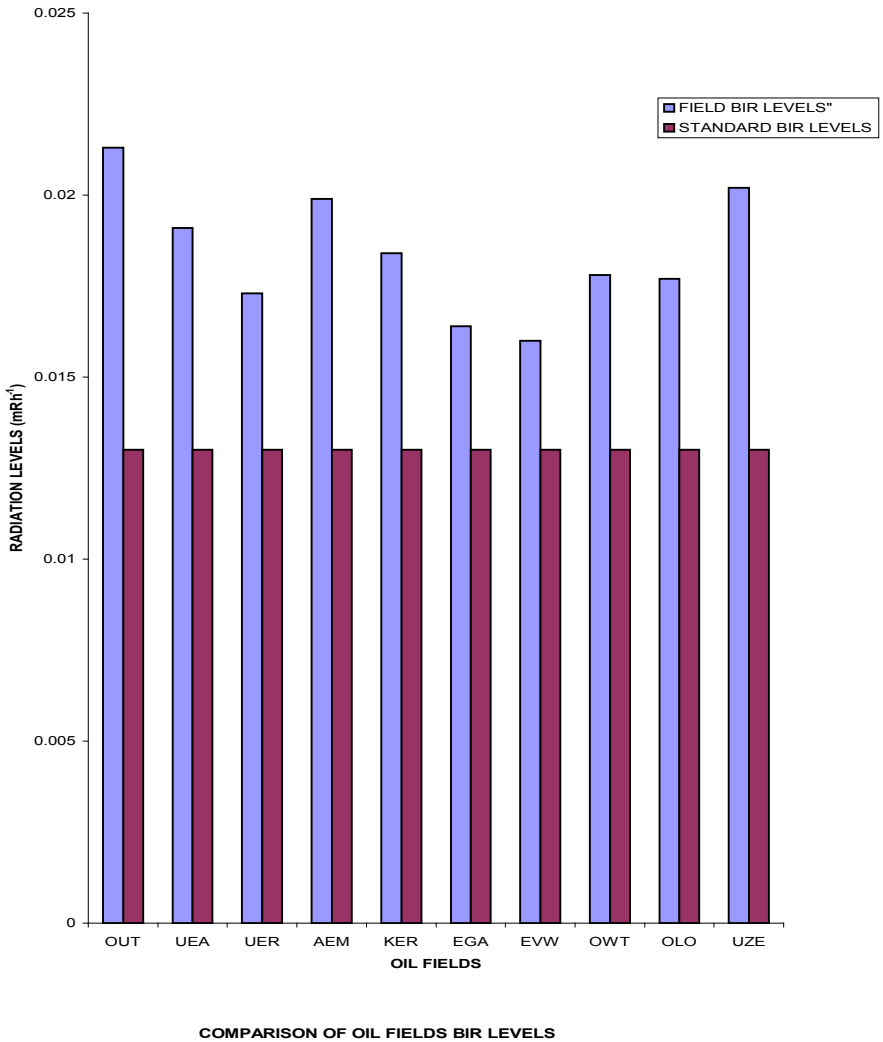


Figure 2: Comparison of Oil fields BIR levels with Standard BIR levels.

Figure 2 shows the comparison of the mean oil and gas fields' radiation levels with the standard background radiation level of 0.013 mRh^{-1} recommended by ICRP [1]. The result shows that all the oil field examined exceeded the normal standard BIR level, with the maximum field exposure rate exceeding by 63.8% while the minimum mean exposure field level exceeding by 23.1%. These values obtain are well above previously reported values in similar environment [13,4,5].

Figure 3 shows the comparison of the host communities' average BIR levels with the normal/ standard background level of 0.013 mRh^{-1} [1]. The results revealed that 70% of the host communities exposure rate exceeded the normal standard background radiation level, with the most impacted community (Otujeremi) being 161.5% of the standard background level while the least impact host community (Evwreni) being 84.6% of the standard background level. The control site (Non-oil bearing community) exposure rate is 69.2% of the standard background

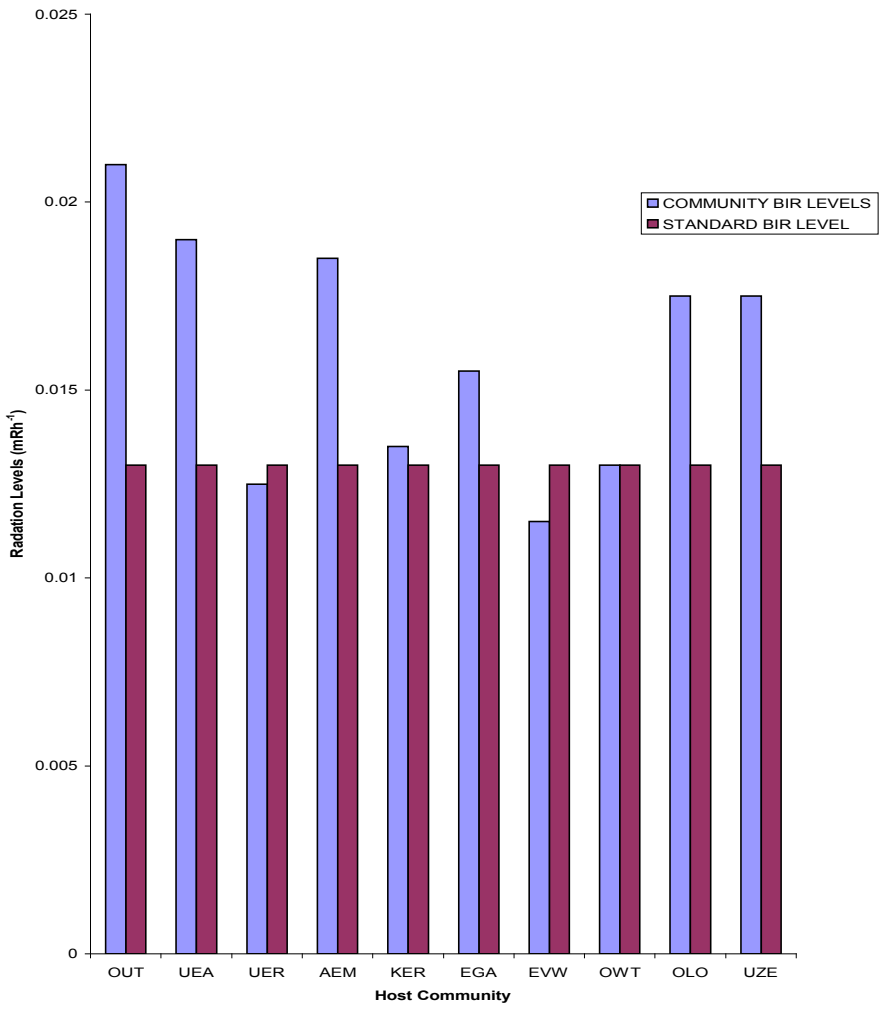


Figure 3: Comparison of host community BIR levels with Standard BIR level.

level. Examination of these three categories show that the oil bearing host communities have been impact radioactively by the operations of the oil and gas industry and their facilities in these environment.

Equivalent dose rate is the measure of the amount of radio nuclides absorbed by the human body for a given period. To avoid any somatic, epidemiological and radiological health side effect, ICRP [1] recommended and consequently set the maximum permissible limit for non– radionuclide industrial worker and the public as 1.0 $mSvy^{-1}$. Figure 4 shows the comparison of the mean fields' equivalent dose rate, host community dose rate and ICRP [1] maximum permissible limit. The results revealed that the dose levels in all of the fields and host communities examined exceed the maximum permissible limit for the public.

Conclusion

The investigation on the radiological impact of oil and gas activities on field workers and host communities residents, in production land area of Delta state have been conducted. The overall results obtained, show that the host communities and the field workers may have been impact negatively with radioactive elements that may be due to the oil activities in the environment. These reported values indicate no immediate side effects, but may cause long-term health hazard to both the oil field workers and residents of the host communities according to EPA [8].

Since radiation exposure in these environment may constitutes health hazard on the long term, especially to personnel and host communities. Contaminated facilities, radionuclides input materials and waste materials challenge must therefore be adequately recognize and addressed in the oil and gas industries.

We therefore, recommended as follows:

- The oil and gas operating companies in these areas should put in place means of reducing their radionuclide input.
- Both life and health insurance policies should be acquired for employees and contract staff working within the flow stations, to take care of their long-term health problems.
- Communities within oil and gas installation areas should have good, cheap and regular access to medical care.
- Communities within 500 meters proximity to flow stations and

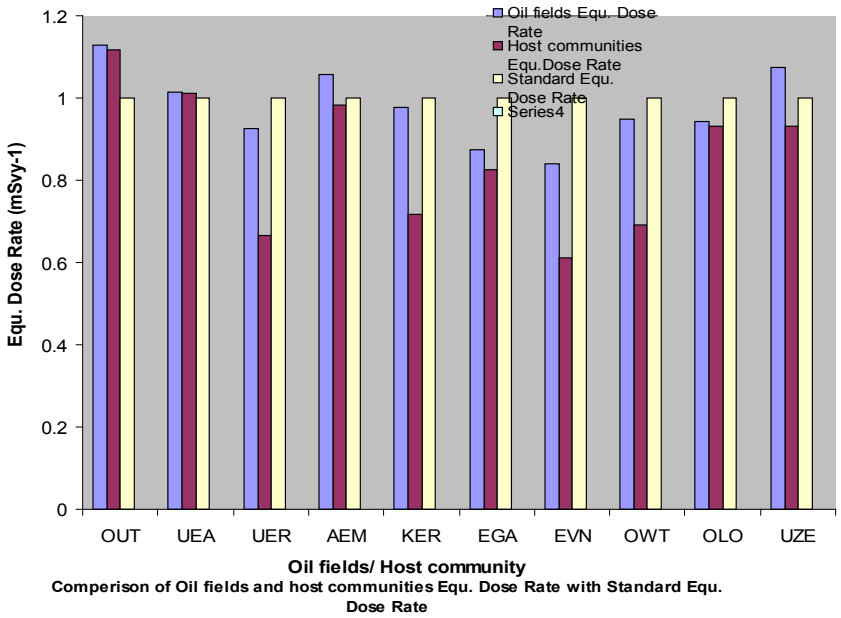


Figure 4: Comparison of Oil fields and host community Equivalent dose rates with standard Equivalent dose rate.

other oil facilities should be relocated for the safety of their health.

- All oil and gas installations should meet all known international and ISO standard.
- There should be a regular monitoring of radiation levels in these environments.
- All government agencies responsible for the safety of the environment should enforce all the existing legislation on environment protection.

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