Background Ionizing Radiation Levels Associated with the Impact of Crude Oil Pollution in Ikarama, Bayelsa State

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ABSTRACT

Crude oil operations in Ikarama, Bayelsa State, have sparked worries about ionizing radiation's potential health implications. This study evaluated background ionizing radiation (BIR) levels to gauge the impact of oil pollution on the environment and human health. The study area was divided into four to ensure even sampling point. Using a RadAlert device, measurements of BIR were taken across Ikarama. The BIR, absorbed dose, Annual Effective Dose Equivalent, and Excess Lifetime Cancer Risk ranges of (0.007 – 0.024) mR/h, (56.5 – 204.5) nGy/h, (0.069 – 0.251) mSv/y, and (0.009 – 0.308) x 10^{-3} respectively. Averages were 0.016 mR/h, 135.58 nGy/h, 0.166 mSv/y, and 0.198 x 10^{-3}. The findings suggest potential health risks to inhabitants, as levels exceeded global average except the ELCR. The study recommends regular monitoring of radiation levels and further research to determine the extent of crude oil pollution on the environment and human health in the area.

Keywords: Crude Oil Pollution, Environmental Impact, Ionizing Radiation, Ikarama, Radiation Levels

INTRODUCTION

The Niger Delta region of Nigeria, where Ikarama, Bayelsa State is located, has been grappling with the environmental consequences of crude oil exploration and production activities (Jatto, 2024; Akagbue et al., 2024). The pollution of soil, water, and air has become a weighty concern, posing serious health risks to the local population (Richard et al., 2023). One aspect of this pollution that has received relatively minute attention is the impact of crude oil activities on background ionizing radiation levels. This study seeks to explore this critical issue.

Ionizing radiation is a known carcinogen that can cause harm to living tissues and increase cancer risk (Ali et al., 2020; Omoruyi et al., 2023). Studies have shown that crude oil and its by-products contain naturally occurring radioactive materials (NORM) such as uranium, thorium, and potassium (Steinhäusler, 2004; Taheri et al., 2019; Al-Rubaye et al., 2024; Wais et al.,2025). When crude oil is extracted, processed, and transported, these radioactive materials can be released into the environment, potentially increasing background radiation levels (Le et al., 2024; Salbu, 2024). Research has highlighted the need to monitor and assess radiation levels in areas affected by oil and gas activities to mitigate potential health risks (Krzyzanowski, 2012).

Despite the growing body of research on the environmental impacts of crude oil pollution in the Niger Delta, there remains a significant gap in the literature regarding the specific impact of crude oil activities on background ionizing radiation levels in Ikarama, Bayelsa State. This study aims to address this knowledge gap by measuring and analyzing background ionizing radiation levels in Ikarama. The objective of this article is to determine the extent to which crude oil pollution has affected radiation levels in the area and provide insights that could inform policy and mitigation strategies to protect the health of the local population.

Study area

The study area is Ikarama and it is one of the several communities in Okordia clan Bayelsa State, Niger Delta region of Nigeria (Thankgod et al., 2024). Ikarama is drained by the Tailor creek and has numerous lakes and ponds distributed all over the land mass. Ikarama is known for heavy fishing and farming activities which makes it a source of agricultural produce (Kotingo, 2025). The community is a host to oil and gas facilities which are associated with multi faced activities including exploration, production, as well as crude bearing pipe line crisscrossing its environment. The usage of such radioactive materials during the afore mentioned processes makes the community to be at the risk of raised environmental radioactivity.

MATERIALS AND METHODS

The RadAlert survey meter, a widely utilized device for detecting and measuring ionizing radiation, was employed in this study. This portable, hand-held instrument is commonly used in various applications, including radiation monitoring, industrial safety, and environmental emergency response. During the survey, the device was moved slowly over the area of interest to detect radiation levels, providing real-time readings in counts per minute (cpm) or milli-Roentgen-per-hour (mRh^{-1}). To ensure accurate and reliable radiation readings, the RadAlert survey meter underwent calibration, a crucial step involving adjustment of the device to match a certified reference source, such as cesium-137 or cobalt-60. The RadAlert used in this study had been factorycalibrated, with an accuracy of ±15%.

In-situ outdoor measurements were taken. For purpose of this work, the community was divided into four areas; Free town (FT), Ikarama1 (IK1), Ikarama2 (IK2) and Farm area (FAM) to ensure even distribution of sampling point across the community. Each area was further divided into three where measurement was carried out with each measurement points were not less than 150 m from another. At every point of taking the survey meter was held at waist level and two sets of reading taken and the average value used in calculating other radiological risk parameters.

Calculations

1. Absorbed dose rate in $nGyh^{-1}$ was determined using equation 1 (Ugbede and Mokobia, 2019; Biere et al., 2024)

$$1mRh^{-1} = 8700nGyh^{-1} \quad (1)$$

2. Annual effective dose equivalent AEDE was calculated using equation 2 (UNSCEAR, 2008).

$$AEDE\ outdoor(\ ) = D\square 8760h\square 0.7SvGh^{-1}\square\ \square 0.2\ 10^{-3} \quad (2)$$

Where D is absorbed dose rate in $nGyy^{-1}$, 8760 h is total hours a year, CF is dose conversion factor from absorbed dose in air to effective dose in Sv/Gy. CF = 0.7 Sv/Gy. OF is occupancy factor, period anticipated for people in the study area to stay outdoor, OF = 0.2 as proposed by UNSCEAR, 2008

3. Excess Life Cancer Risk ELCR was calculated using equation 3 (Mohammed & Ahmed, 2017; Biere et al., 2024).

$$ELCR\ AEDE\ DL\ RF = \square\ \square \quad (3)$$

Where AEDE is annual effective dose equivalent. DL, is average lifespan or life expectancy (55.2yrs) in Nigeria (WHO, 2018) and RF is risk factor for low dose background radiation, ICRP 60 used 0.05 Sv^{-1} for public.

RESULTS AND DISCUSSION

This aspect presents the findings of the study. Table 1 below presents results of measured background ionizing radiation from which other radiological indices associated with it were calculated for the Ikarama population.

Figures 1, 2 and 3 are graphical representation of the findings. Table 1: In-situ values of background ionizing radiation

Location	BIR (mR/h)	ABD (nGy/h)	AEDE (mSv/y)	
		Average		
FT	**0.017**	**145.0**	**0.178**	**0.22**
IK1	**0.014**	**123.2**	**0.151**	**0.16**
IK2	**0.017**	**143.6**	**0.176**	**0.21**
FAM	**0.015**	**130.5**	**0.16**	**0.20**

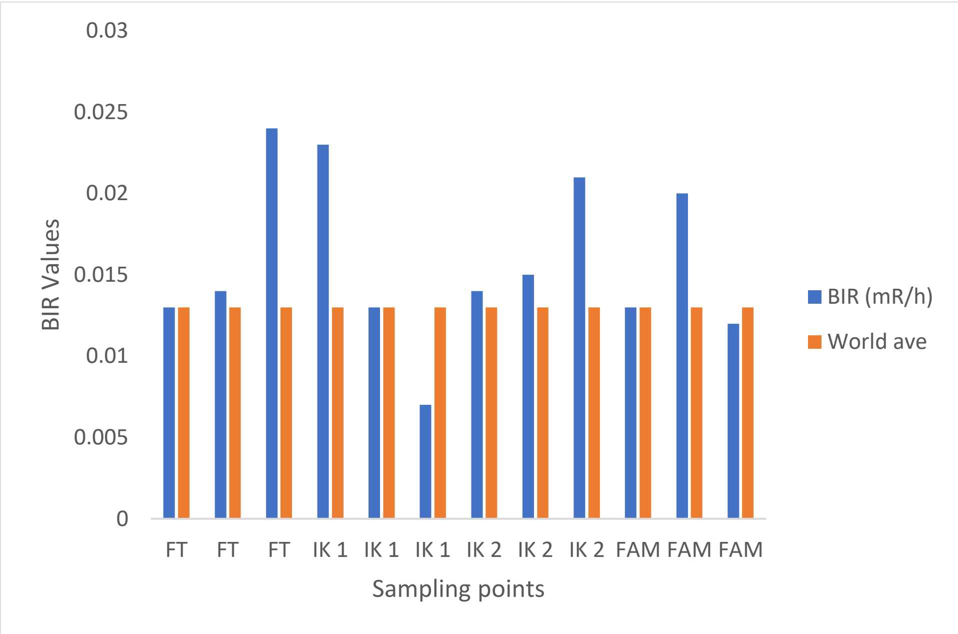

Figure 1. BIR values in Ikarama vs World average

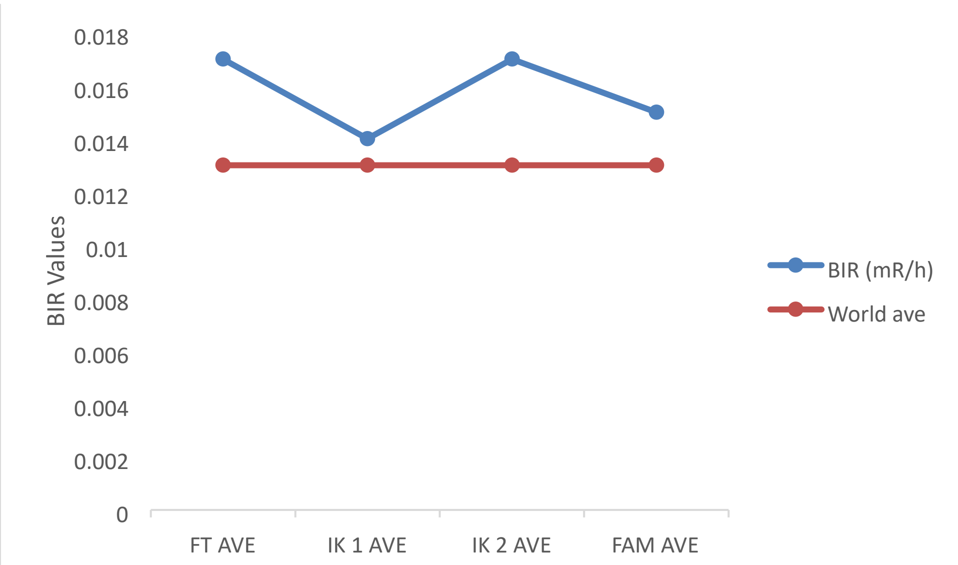

Figure 2. BIR averages in the study area vs World average

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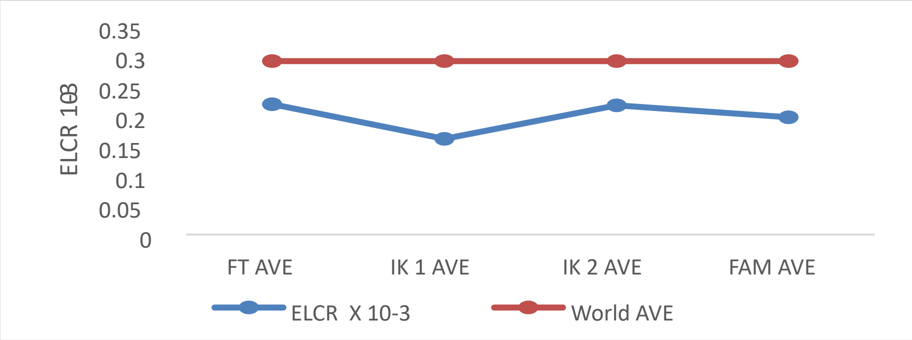

Figure 3. ELCR values vs World average

The Background Ionizing Radiation and other radiological values like Absorbed dose, Annual Effective Dose

Equivalent and Excess Lifetime Cancer Risk ranged from (0.007 – 0.024) mR/h; (56.5 – 204.5) nGy/h; (0.069 – 0.251) mSv/y and (0.009 – 0.308) x 10^{-3} respectively. While their average value was 0.016 mR/h; 135.58 nGy/h; 0.166 mSv/y and 0.198 x 10^{-3} accordingly. The highest BIR value recorded was 0.024 mR/h in sampling point under FT while the lowest value of 0.007 mR/h was recorded in IK 1. From figure 1, about 83 % of the sampled points have BIR values which are ether equal to or greater than the world average of 0.013 mR/h. while figure 2 indicates that the individual communities' averages are all higher than the world average. While figure 3 shows that the individual communities' averages of ELCR are all below the world average value of 0.29 x 10^{-3}.

CONCLUSION

The radiation profile in Ikarama community has been measured and used to calculate other radiological indices. Results indicate that Background Ionizing Radiation values are high and so radiation exposure of the community dwellers is significant. This can lead to risk like skin damage eye irritation even cancer. Among the clusters that make up Ikarama, Freetown population is most likely to be affected by radiation induced health challenges compared to other dwellers. Therefore, remediation is highly recommended and going further the use of radioactive materials during oil and gas activities should be done with stricter precaution.

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