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Environmental Impact Assessment of Exposure Level in Farm House Structure Within Uranium Mineralized Zone of Taraba State, Nigeria.

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Abstract

In this work, the radiation burden due to radio-element exposure of some houses in close proximity to the uranium-ore pits in Taraba State were examined. A fieldwork observation of the state of background count(exposure) were made via GQ-GMC-500+ model radiation meter. The Geiger tube produce an electrical signal each time radiation energy is imputed on the tube and ionize. Each flow is detected electronically and recorded as a count/sec in a selected mode (μSv/h) of the manual. The detector was fixed at 1m above ground level (Abdominal level) with the window of the equipment pointing towards the four-cardinal region (North, South, East, and West) and four readings were observed and the average value recorded. The parameter quantified are absorbed dose level (ADR), outdoor yearly effective dose level and the excess cancer lifetime risk calculation method. The mean amount of irradiation observed from the houses and its environment spanned between 0.33 to 0.11μSv/h, likewise the computed ADR varies between 0.5803 to 0.193mSv/yr, while the computed outdoor AEDR is 4.15 x10^{-4} to 1.36 x10^{-4} mSv/yr. The evaluated lifetime cancer burden due to environmental level of exposure within the buildings and its surroundings spanned from 1.45 x 10^{-3} to 9.78 x 10^{-4}. The outcomes reveal that the houses and their immediate locality within the selected abandoned mining pit of Taraba State could not have any injurious effects as the yearly effective dose level is quite lower than the public global dose benchmark of 1mSv/yr. The calculation method of lifetime cancer risk from the buildings closed to the uranium ore pits was below the 0.3mSv/yr which might not pose any significant radiation threats to the inhabitants.

Keywords: Uranium-ore pits, Radiation, Count, Effective Dose Equivalent and lifetime cancer risk.

INTRODUCTION

Uranium is a radioelement that is chemically harmful when is not properly shield or regulated. Extraction of uranium-ore from pits could yield various health crisis to the inhabitants if the contaminant is dispersed in the atmosphere, surficial (soil and crops) and water (Oruonye and Ahmed, 2017). The established entry of radioactive and chemical element

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in the examined area to every living souls is via intake, skin dose (IAEA,2020). Exploration and processing of uranium ore could lead to huge fatality if not put under check. The community and masses that dwells within the vicinity of exploration operation may likely receive some incremental level of irradiation to both natural and artificial radionuclide should mine development continues (Senes Consultants Limited Ottawa Ontario, 2008). Despite the damaging effect uranium-ore extraction in their ancestral land, the dwellers have vow not to relocate from their home while they engaged on their usual daily farming practices (Oruonye and Ahmed,2017). Materials (soil and rock samples) used in the construction of the hurts/ farm buildings which serve as a dwelling place for both miners and farmers are major source of radiation exposure.

Gamma irradiation occurs through various pathways, such as intake, inhalation and skin Contact during radio-element decay procedure (Suleiman *et al.*, 2025).

Ionization within the body tissues as a result of external exposure causes various derived compound to be created such as peroxides, free radicals and oxides. These newly formed derivatives are transients and are detrimental to the chemical balance of the cell structure, Cell death, cell dysfunction (tumors, cancer, cataracts, blood disorder), Chromosomal breaks and Organ dysfunction may arise as due to cellular effects. According to Global cancer concern, it computes and reveal 14.1million new cancer issues, 82million cancer deaths and 32.6million people living with cancer in 2012 worldwide. Projection from Globocan 2012 show that lower-income countries were home to 57% of new cancer cases and 65% of cancer deaths in 2012. In Africa as a whole cancer issues are characterized with delay in check up, low therapy accessibility and poor medication output. Delays in access to cancer therapy results in 80-90% of cases that are in advance stage at the time of arrival to therapy. In reference to Globocan, cancer is a causative agent for 72,000 deaths in Nigeria yearly, with a computed figure of 102,000 new cases of cancer yearly(NNCCP,2022). Cancer cases ranges from liver cancer, colorectal cancer, cervical cancer, prostate cancer and breast cancer while the two most common cases in Nigeria is cervical and breast cancer(NNCCP,2022).

MATERIALS AND METHODS

Study Area

The examined space spanned across abandon mine pits within Yorro, Zing and Jalingo local government area of Taraba state. Yorro LGA is bounded to the east by Zing LGA and to the west by Jalingo LGA. The few selected mine pits are located in mika(kwaji chiefdom), popule, maraba-kuni, yorro, zing, monkin, kassa, Nyagai and mayo-gwoi. The area lies within latitude 08 46′ 03 – 09 13 20′N and longitude 11 20′ 58 – 11 44′ 39E and spanned across 1,304km2. The head count of the dwellers is estimated to be 89,410. In citation to 2006 national population count. 90% of the locals engaged in exploration and Agricultural practices as their main source of earning. The miners adopt crude tools like hoes, diggers and bare hands to excavate the rocks and soil in search of valuable materials embedded in the soil (Oruonye & Ahmed, 2017).

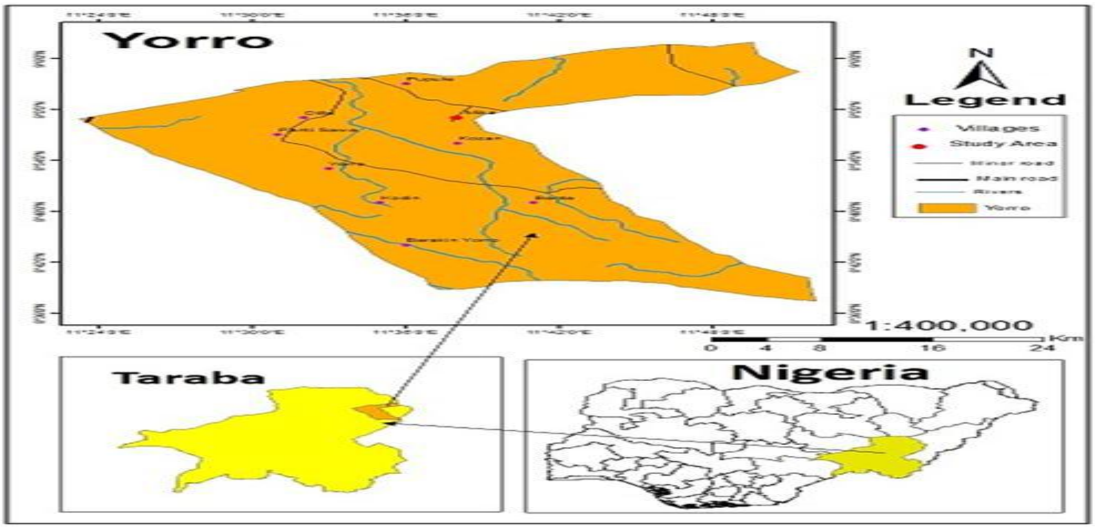

Figure 2. Topographic Map of Taraba showing part of the study area (Oruonye and Ahmed, 2017).

Datum Collation and Analytical procedures

Gamma radiation level was carried out using GQ GMC Geiger Counter radiation meter manufactured by GQ Electronics with GQ-GMC-500+ model. The equipments has a halogen quenched Geiger-Muller tube ± 45 mm effective diameter and mica window density of 1.5-2.0mg/cm3. Each pulse is digitally observed and recorded as a count in a selected mode (μSv/h) of the handler. It is placed at the gonad level of 1m above ground level with the window of the meter directed towards the four cardinal points while it is allowed to pick up absorb radiation for some duration until a stable count is achieved before taking readings, four readings were taken and the mean recorded. Measurements were obtained for both indoor and outdoor surroundings (two reading for outdoor and one reading for indoor). The in-situ background counts were computed from one hut to the other at 10m apart between the hours of 1pm and 4pm. This procedure or guideline was adopted based on the report of Inyang *et al., (*2009). A total of 30 location in some hut/ farm building with one readings from the inside of the houses and two measurements from the surrounding of each house/hurt were observed with the aid of GQ-GMC-500+ model detector. The field datum collated from the houses within the study area, were analyzed in comparison to acceptable benchmark. For detail computation of the field datum from radiation state (in μSv/hr) to other hazard factors, the following mathematical model was adopted.

Calculation Methods of Radiological Burden Parameter

For detail compilation of the field datum from radiation state (in μSv/hr) to other damaging factors, the following mathematical model was adopted.

The irradiation (σ) obtained in μSv/h is transformed to yearly absorbed radiation level ADR in mSv/yr base on equation 1 (Idris *et al*., 2021; Etuk, *et al*., 2015).

$$\boldsymbol{ADR(msvy^{-1}) = \sigma(\mu svh^{-1}) \times OF \times 24hrs \times 365.25d \times 10^{-3}} \quad (1)$$

OF is the occupancy parameter and absorbed radiation is derived in Gy/h from the observed irradiation in μSv/h using the expression in equation 2

$$\boldsymbol{D(nGyh^{-1}) = \sigma(\mu svh^{-1}) \div Q \times 10^{-3}} \quad (2)$$

Q is the quality level=1.0 for gamma dose

The yearly effective dose level (AEDR) per year received by radiation staff and the community is gotten from the calculation method in equation iii (UNSCEAR, 2000)

$$AEDR(msvy^{-1}) = D(nGyh^{-1}) \times 8760hr \times CF \times OF \quad (3)$$

Recall, that CF is given below

$$C.F = 0.7(svGy^{-1}) \quad (4)$$

OF is the occupancy factor, the suspected duration the dwellers would spend within the uranium-ore pit. OF = 0.2 for outdoor as it is expected that the inhabitants would spend 20 % of their time spent. (Idris *et al.,* 2021; Gupta and Chauhan 2011)

$$AEDR(msvy^{-1}) = D(nGyh^{-1}) \times 8760hr \times 0.7(svGy^{-1}) \times 0.2 \times 10^{-3} \quad (5)$$

Excess Lifetime Cancer Risk *($ELCR_{out}$)* is calculated from outdoor Annual Effective Dose according to Agbalagba and Onoja (2011) by the following equation

$$ECLR_{ing}(msvy^{-1}) = AEDR_{ing} \times D_L \times R_F \quad (6)$$

$$ECLR_{inh}(msvy^{-1}) = AEDR_{inh} \times D_L \times R_F \quad (7)$$

Where D_L is life time spent (70 years) and R_F is the risk factor, the fatal cancer risk per Sievert. For probability effects ICRP-60 provided R_F = 0.05 for the environment (Taskin *et al*., 2009). The recommended limit is 3.75×10^{-3} for internal exposure, $0.29\times10^{-3}$for outdoor external. The likelihood that someone will get breast, prostate, or even blood cancer increases proportionally as the ELCR rises.

RESULTS AND DISCUSSION

Results

Table 1: Mean values of ionizing radiation measured from the houses closer to the mining pit

S/N	Location	Latitude (°)	Longitude (°)	Elevation (m)	Exposure (μSv/yr)	ADR (mSv/yr)	D (mSv/yr)	AEDR (mSv/yr)	ELCR (mSv/yr)
1	ZH1	08 59 49	11 44 39	535	0.3120	0.5469	3.12E-04	3.83E-04	1.34E-03
2	ZH2	08 58 21	11 34 38	535	0.2730	0.4786	2.73E-04	3.35E-04	1.17E-03
3	ZH3	08 58 34	11 40 12	535	0.2640	0.4628	2.64E-04	3.24E-04	1.13E-03
4	MH1	09 00 19	11 32 53	528	0.2925	0.5128	2.92E-04	3.58E-04	1.25E-03
5	MH2	09 00 28	11 30 54	528	0.2860	0.5014	2.86E-04	3.51E-04	1.23E-03
6	MH3	09 00 19	11 38 44	528	0.3380	0.5926	3.38E-04	4.15E-04	1.45E-04
7	MKH1	08 58 32	11 32 53	517	0.2275	0.3988	2.28E-04	2.79E-04	9.77E-04
8	MKH2	08 58 32	11 32 53	517	0.2345	0.4111	2.35E-04	4.12E-04	1.44E-03
9	MKH3	08 58 32	11 32 53	517	0.2340	0.4100	2.34E-04	2.87E-04	1.01E-03
10	PH1	08 54 43	11 20 58	531	0.3185	0.5583	3.19E-04	3.91E-04	1.37E-03
11	PH2	08 54 43	11 20 58	531	0.3055	0.5356	3.06E-04	3.75E-04	1.31E-03
12	PH3	08 54 43	11 20 58	531	0.2145	0.3761	2.15E-04	2.64E-04	9.24E-04
13	YH1	08 42 13	11 41 17	357	0.2015	0.3532	2.02E-04	2.48E-04	8.68E-04
14	YH2	08 42 13	11 41 17	357	0.2665	0.4672	2.67E-04	3.27E-04	1.14E-04
15	YH3	08 42 13	11 41 17	357	0.2600	0.4558	2.6E-04	3.19E-04	1.11E-03
16	NH1	08 53 00	11 33 12	339	0.2275	0.3989	2.28E-04	2.79E-04	9.76E-04
17	NH2	08 53 00	11 33 12	339	0.1885	0.3305	1.89E-04	2.32E-04	8.12E-04
18	NH3	08 53 00	11 33 12	339	0.1820	0.3191	1.82E-04	2.23E-04	7.81E-04

19	LH1	08 46 06	11 32 20	334	0.2640	0.4628	2.64E-04	3.24E-04	1.13E-03
20	LH2	08 46 06	11 32 20	334	0.2470	0.4330	2.47E-04	3.03E-04	1.11E-03
21	LH3	08 46 06	11 32 20	334	0.2573	0.4511	2.57E-04	3.15E-04	1.10E-03
22	MNH1	08 46 42	11 43 16	536	0.2535	0.4440	2.54E-04	3.12E-04	1.09E-03
23	MNH2	08 46 42	11 43 16	536	0.2145	0.3760	2.15E-04	2.64E-04	9.24E-04
24	MNH3	08 46 42	11 43 16	536	0.1885	0.3305	1.89E-04	2.32E-04	8.12E-04
25	KH1	08 56 23	11 28 09	340	0.2715	0.4760	2.72E-04	3.33E-04	1.17E-03
26	KH2	08 56 23	11 28 09	340	0.2515	0.4409	2.52E-04	3.09E-04	1.08E-03
27	KH3	08 56 23	11 28 09	340	0.3310	0.5803	3.31E-04	4.06E-04	1.42E-03
28	MGH1	08 47 15	11 30 23	334	0.2015	0.3533	2.02E-04	2.48E-04	8.68E-04
29	MGH2	08 47 15	11 30 23	334	0.1820	0.3191	1.82E-04	2.23E-04	7.81E-04
30	MGH3	08 47 15	11 30 23	334	0.1105	0.1937	1.11E-04	1.36E-04	4.76E-04
	Mean			435.1	0.2466	0.4323	2.47E-04	3.1E-04	9.97E-04

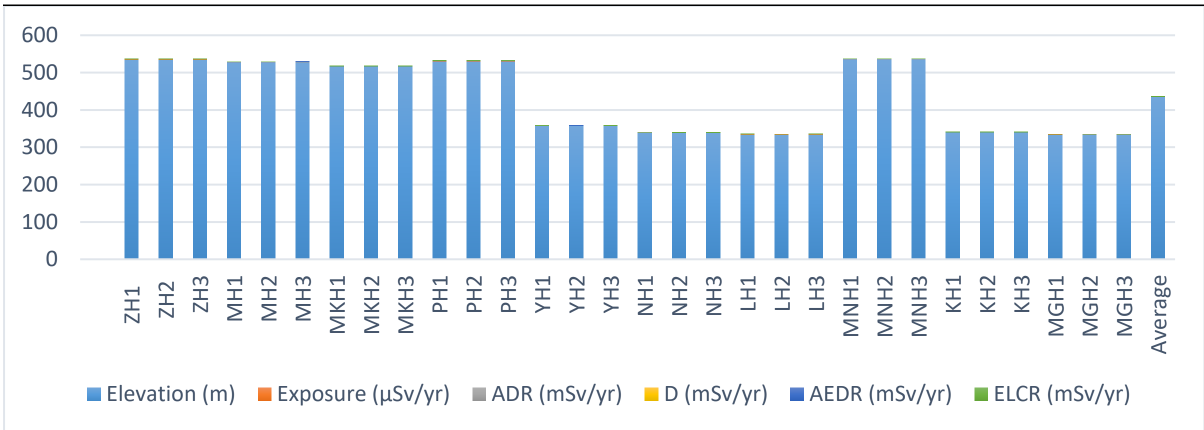

Figure 1. Graphically plots of Background Radiation Survey within structure closer to the Uranium-ore pits.

The imparted gamma radiation observed from the houses that have close proximity to the mining sites as presented in Table 1. The houses within Zing and Mika mining site have the highest value of ionizing radiation compare to the remaining hot spots. Table 2 reveal the data of the radiation rate in μSv/h. Maximum radiation state was observed in ZH1, MH3, PH2, and KH3 with output of 0.31μSv/h followed by building/hurt with code YH2, YH3, MNH1, LH1, LH3, KH1 and KH2 with value of 0.25μSv/h. The minimum output of irradiation level was observed in House with code MGH3, NH3, MNH3, NH2 with the results of 0.18μSv/h. The average recorded irradiation σ, computed annual absorbed dose rate(ADR), the annual effective dose rate (AEDR) and calculated excess cancer lifetime risk (ECLR) using the calculation method in equation 1 – 7 are provided in Table 1. The outcome of the fieldwork exercised from each hurt/farm buildings unveils the mean exposure spanned between 0.31μSv/h -0.18μSv/h (Table1) and the corresponding computed ADR is ranged between 0.58 mSv/yr to 0.19mSv/yr, while the computed outdoor AEDR ranged between outdoor are 4.15 x 10^{-4}mSv/yr -1.36x10^{-4}mSv/yr. The corresponding computed ECLR is ranged between 1.45 x 10^{-3} to 9.77 x10^{-4}. Additionally, the evaluated background readings within and around the structural buildings closer to the excavated sites within the abandoned Uranium-ore pits together with the radiation hazard parameters were display on a plot in Figure one.

Discussion

The Table 1.0 briefly display both the field data and the desk calculated outcome of the experimental findings was used to evaluate the radiological health status. In brief the mean Background Ionizing Radiation value was found to be lower than those reported by Igwe *et al.* (2021), Mgbeokwere *et al.* (2023) but higher than those reported by Idris *et al.* (2021) The mean value of background counts exposure level (0.0257mR/hr), Excess life Cancer Risk (1.00×10^{-3}) are high compare to the tolerable benchmark of $0.013mRh^{-1}$, $0.29 \times 10^{-3,}$ but the safe limit Absorbed Radiation Dose of $84.0nGh^{-1}$ is higher than the value ($2.5x10^{-4}nGy/h^{-1}$) obtained from this finding.

CONCLUSION

The radiation exposure levels in some selected hurts/farm buildings within the abandoned mine pits, of Taraba State, Nigeria have been investigated in order to assess the radiation polluted surroundings. The fieldwork reveal that all the suspected evaluated burden was within the provided safety limits of 1mSv/yr for the public and the excess lifetime cancer risk from each spot was below the 0.3mSv/yr. This implies that the undergone fieldwork exercise at the scattered settlements shows some radiologically safe and secure surroundings.

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