Measurement of Background Ionizing Radiation Around Beta Glass Plc and Its Environs, Ughelli, Delta State, Nigeria

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ABSTRACT

A study of the background ionizing radiation levels to helps monitor the impact of human activities on the environment, such as mining, farming, glass bottle production and power generation has been carried out around Beta glass Plc and Transcorp Power LTD using a hand-held gamma spectrometer (GAMMA-SCOUT; Geiger counter Radiation meter) and GPS (Oregon-450 Garmin). The study of the BIR levels was carried out between June to July, 2022. The average measured exposure rates (AV. BIR) ranged from 0.007 mRh^{-1} to 0.013 mRh^{-1}, with 0.010±0.0002 mRh^{-1} as the average. The estimated mean outdoor absorbed dose rate (ADR) for the study region was 113.10 Gyh^{-1} to 87.153±2.091 Gyh^{-1}, with an average annual effective dose equivalent (AEDE) of 106.884±2.565 $mSvy^{-1}$ and an average excess lifetime cancer risk (ELCR) of (0.374±0.009) × 10^{-3}. The measured values of radiological parameters, such as annual dose rate, annual effective dose rate, and excess lifetime cancer, were higher than background radiation levels. The average BIR is in line with the ICRP recommendation of 0.013 (mRh^{-1}), while the effective dose rate (EDR) is somewhat below the ICRP recommendation of 1.00 ($mSvy$-^{1}) for a normal environment. The obtained values of the radiological indicators, such as ADR, AEDE, and ELCR, are greater than the background radiation norm of 59 (ηGyh^{-1}), 0. 07 ($mSvy^{-1}$), and 0.29×10^{-3}. The study found that radiation levels and doses in the study location do not immediately harm personnel or residents, but increased lifetime cancer risk values suggest that cumulative dosages may cause cancer.

INTRODUCTION

Beta Glass Plc (Ughelli Plant) is a subsidiary of Frigo Glass Industries Nigeria Limited and a global affiliate of the Leventis Group. It is a Nigerian firm with branch in Ughelli, Delta state, at Kilometer 17, Warri-Patani Road. Metal Box Overseas Reading, Toyo Glass companies, investors from Japan, England, and Nigeria, as well as other equity participants, contributed to the establishment of the company on June 26, 1974. In 1992, the firm bought the assets of the previous African Glass, which had been based in Ikeja, Lagos State, Nigeria. The company had been listed on the exchange since 1986. Since its founding in the late 1970s, Beta Glass Plc has been known as Delta Glass Company Limited. In 2001, the firm changed its name to Beta Glass Plc in order to make it easier for customers to identify its goods. Currently, Beta Glass Plc is the top manufacturer of hollow glass items such as tumblers, bottle mugs, lamb bulbs, and medicine bottles. The company operates manufacturing facilities in Agbara, Ogun State, and Ughelli, Delta State. The establishment of Beta Glass Plc (Ughelli plant) was made possible because of the availability of raw materials like white sand (sand silica), labor, etc. In the developing market of West Africa, the company is the leading supplier of glass packaging; its goods are sold to a variety of nations, including Ghana, Togo, Angola, Burkina Faso, Gambia, Benin, Cameroun, Mauritius, Gabon, Guinea, Rwanda, Sierra Leone, and Liberia. The glass bottles and containers for soft drinks, brewers, wine and spirits, cosmetics, pharmaceuticals, food, and cosmetics firms are produced, distributed, and sold by Beta Glass Plc. The organization produces, distributes, and sells glass bottles and containers to a variety of businesses, including breweries, wineries, and spirits industries, as well as soft drink bottlers like Coca-Cola. Their products include hollow glassware such as 75cl Star bottles, Eagle Aromatic Schnapps bottles, Hero bottles, Veleta wine bottles, and 35cl Ultra Sprite bottles (Ekpo, 2016).

Glass is described as an inorganic solid that is often transparent or translucent, hard, brittle, and impervious to the natural elements. More than a dozen raw materials, including limestone, soda ash, cullet, feldspar, dolomite, iron chromite, quartz powder, iron oxide, sodium sulfate, and barium sulfate, are used to make glass bottles. High temperatures are needed for glass manufacture, which is an energy-intensive process that emits byproducts such as CO_2, SO_2, NO, and high-temperature atmospheric nitrogen (N_2) oxidation. Additionally, the emissions from furnaces include small amounts of metal as well as matter particles. 80 to 90% of the overall air pollution in the glass manufacturing facility and surrounding area is caused by the melting furnace. There are several different types of glass manufacturing processes that are connected to the emissions from the hot end (the glass production phase) and the cold end (the finishing phase). Due to the interaction between the molten glass and the equipment lubricants in the container press and blow machines, emissions are also produced. Glassware such as hollow glass containers, tableware, flat glass, and artistic glass produce emissions related to combustion during the annealing process, where the glass product is held at 500-550°C (control cooling procedure) in the annealing furnace (Fernando et al., 2023).

The environment's radioactive contamination and BIR level increase may come as a result of activities in the glass-producing industries such as natural gas combustion, the breakdown of raw materials during melting, evaporation from molten glass and raw materials, waste disposal, and spills of toxic chemicals and radionuclide materials (primarily used as glass colorants) such as uranium oxide, ion (II) oxide chromium, lead, antimony, manganese oxide, and cadmium oxide. Workers, residents of the hosting community, and members of nearby towns may suffer negative health impacts as a result of exposure to this background radiation. The most frequent health problems linked to the production of glass include noise from various machines (such as valve actuators, mixer engines, vibrators, dust collectors, and blowing machines), radiant energy, ergonomic risks, physical risks, exposure to respirable airborne particles (which may cause lung cancer, pulmonary tuberculosis, eye problems, skin dermatitis, and allergic mechanisms), heat stress disorders, and infrared radiation. Long-term exposure to silica (SiO_2) increases the chance of developing chronic conditions such as silico-tuberculosis, complex pneumoconiosis, and pulmonary illnesses (Abdel-Rasoul et al., 2013).

Different types of waste are produced by human and industrial operations; when these wastes are improperly managed, they can cause aesthetic nuisance, lower the socioeconomic worth of the location, and pose a radioactive health danger to the people (Agbalagba, 2016). Studying the environmental impact of radionuclides employed by various businesses is of high importance worldwide since environmental radioactivity is prevalent everywhere and has led to substantial research and surveys in many nations of the world. For the sake of the public's health as well as the safety of the workforce, radiometric evaluation is crucial in the glass manufacturing sector. This is because radioactive particles that may be released into the atmosphere during the production of glass as well as solid waste and waste water disposal pose a threat to the environment.

The transfer or emission of energy, which can take the form of waves or particles and travel through an intermediary medium or across space, is referred to as radiation. It is released from a source and travels many feet into the atmosphere before entering the human body (CDC, 2022). Radiation is produced through nuclear fusion and fission, chemical reactions, hot objects, and radioactive decay. Based on differences in their energy, masses, and penetrating powers, radiation is divided into ionizing and non-ionizing types. Ionizing radiation is regarded as dangerous; when present, it can endanger human and environmental health and harm DNA in genes and tissues. Ionizing radiation can be divided into four main categories: beta, alpha, neutrons, and gamma rays. Since non-ionizing radiation lacks the energy to completely remove an electron from an atom or molecule, it is seen as being less hazardous and just capable of causing thermal damage (Avwiri, 2011).

To ascertain the radiological influence of human activities on the environment, a number of studies on the analysis of background ionizing radiation levels have been carried out, both in industrial contexts. Oluyide et al. (2018) researched the radioactivity levels and transmission factors of natural radionuclides near an iron and steel smelting operation in Fashina village, Ile-Ife, Osun State, Nigeria. For the in-situ examination, they employed a portable survey meter with a GPS, and they measured the radioactivity with a well-calibrated NaI (Tl) detector system. The findings of It were discovered that the quantities of ^{238}U and ^{232}Th in several of the food and water samples in the research region were greater than the recommended limit. The authors' analysis came to the conclusion that, in comparison to the study region, the control vicinity displayed a general tendency toward lower activity concentration in the samples that were evaluated. The presence of industrial operations in the area under study can be criticized for this finding. In addition, it was discovered that the soil-transfer factor to plant for ^{238}U and ^{232}Th was significantly larger in comparison to that of ^{40}K. It's possible that a radioactive particle's settling from the ^{238}U and ^{232}Th series on the surfaces of the plants in the study region could be responsible for this phenomenon.

An analysis was done to determine the increased lifetime cancer risk in Warri City based on terrestrial BIR levels. The investigation was assisted by the use of GPS for a GIS mapping and a Digilert100 nuclear radiation sensor. The study's findings were intended to express the level of danger in numerical terms. With a mean value of 0.016 mRh^{-1} (1.37 $mSvy^{-1}$) and a standard deviation of 0.006mRh^{-1}, the assessed average exposure rates varied from 0.006mRh^{-1} (0.51 $mSvy^{-1}$) to 0.029 mRh^{-1} (2.49 $mSvy^{-1}$). The average value of the calculated mean outdoor absorbed dose rate, 141.30±31.31 $nGyh^{-1}$, ranged from 121.90±25.32 $nGyh^{-1}$ in the Ajamogha zone to 190.16±51.60 $nGyh^{-1}$ in the industrial zone. $nGyh^{-1}$ represents the nanogram per hour unit. The mean excess lifetime cancer risk (ELCR) was discovered to be (0.61±0.14) × 10^{-3} $mSvy^{-1}$, and the annual effective dose equivalent (AEDE) was assessed to be 0.17 $mSvy^{-1}$. The testes experienced the highest organ dosage, 0.11 $mSvy^{-1}$, and the liver received the lowest, 0.06 $mSvy^{-1}$, in accordance with the dose that was anticipated to be absorbed by the organs. Geographic information system (GIS) maps of the research region revealed that 64 of the 94 sampling areas, or 68.1% of the total, had exposure levels that were higher than the 0.013 mRh^{-1} (1.0 $mSvy^{-1}$) global ambient standard values. The values here are greater than those recommended as being appropriate in the literature because that is what UNSCEAR proposes. On the other hand, it's likely that these numbers don't currently constitute a significant health risk for those living in Warri City. The study area's residents had a tiny chance of developing cancer at a higher effective dose from the current rate of organ exposure for adults that were assessed, according to the extra lifetime cancer risk values that were estimated. The values' consideration of an individual's lifetime chance of developing cancer serves as evidence for this. The results of this study are reinforced by the fact that cancer incidence is relatively low among residents of the study area (Agbalagba, 2016).

The ground radiometric survey that was carried out in southwestern Nigeria for the purpose of determining the level of ambient radioactivity in fertilized farmland was done using a Gamma RAE II R full-range dosimeter based on cesium iodide that was held at an elevation above the ground. It was stated that the result of the in-situ absorbed dose rate in the air as well as the possible threats to farmers and citizens living nearby were found. The findings showed that the measured ADR (absorbed dose rate) on the farms is high, which is most likely associated with the usage of fertilizer in the field. These findings were found as a consequence of measuring the ADR. The researchers made the suggestion that the management of the farms should cut back on the amount of fertilizer they use and instead make use of natural organic manure, since this would be less harmful. In addition, to ensure sufficient monitoring, the radioactivity of the surrounding environment ought to be checked on the farmland on a consistent basis (Ekhaguere et al., 2019).

A radiometric analysis of the levels of environmental radioactivity in the vicinity of the Ijako dumpsite was performed using a portable gamma spectrometer. Ten onsite measurements were performed. The levels of radioactivity of ^{238}U, ^{232}Th, and ^{40}K that were acquired were utilized in the process of determining the amount of radiological risk present in the vicinity. When contrasted to the global average, the following results were found when the mean results of radiological parameters were analyzed: the R_{eq} (Radium Equivalent) was significantly lower than 370 $Bqkg^{-1}$; the H_{ex} (External Hazard) was lower than a unit; the AEDE (Annual Effective Dose Equivalent) was lower than 0.08 $mSvy^{-1}$; the $I\gamma$ (Gamma Index) was lower than a unit; and the ELCR (Excess Life Cancer Risk) was lower than the accepted limit (0.29 × 10^{-3}). According to Adagunodo et al.'s research from 2021, this indicates that the Ijako dumpsite does not present a radioactive risk to the general public (Adagunodo et al., 2021).

In order to give reliable statistics and scientific information on the radiological health effects of such exposure, this study is focused on background ionizing radiation (BIR level) emanating from Beta Glass Plc's (Ughelli plant) and its surroundings.

Study area

Ughelli is situated around 50 kilometers (31 miles) to the east of the city of Warri, and it lies between latitudes N5° 30' 0.6732" and longitude of E5° 59' 37.8024". Ughelli, which is also a major agricultural region, is one of the Niger Delta regions of Nigeria's most significant industrial cities. The extraction of oil and gas, the generation of power, the manufacturing and processing of bottles, and the provision of vehicle mechanical services are only some of the industries that are active in the region. In the vicinity of Ughelli, one of the most significant onshore oil production areas in Nigeria's Niger Delta, there are over 0.432 million people residing (NPC Bulletin, 2006). This area boasts one of the biggest onshore oil and gas outputs in the Niger Delta, with roughly 160 oil and gas wells and five flare stations. It is traversed through a network of pipes that bring gasoline from the many oil wells to the flow stations. These pipelines crisscross the landscape. This study includes few chosen locations in Ughelli, which includes Beta Glass Plc, located at Kilometer 17 on the Warri-Patani Road in Ughelli, as well as the nearby communities, Ekakpamre, Eruemukohwarie, and Ekrerhavwen. The map depicting the research areas as well as the sampling points is presented in Fig. 1.

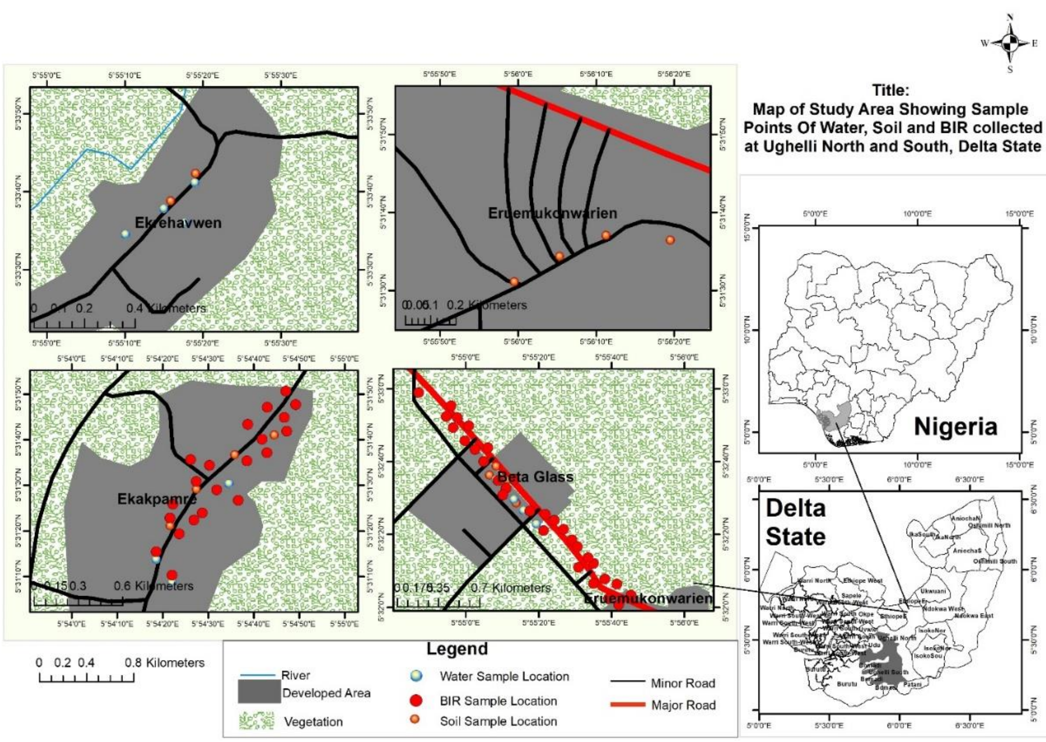

Fig. 1: A map depicting the research areas as well as the sampling points (Aniekwe et al, 2023)

Materials and method

The research data includes an on-site evaluation of the level of ionizing radiation concentration that was collected via a radiometric survey of Beta Glass Plc and its environs. Random measurement of BIR level in the areas under research (each community) were simultaneously gathered using a portable handheld digital radiation detector known as a Gamma-Scout. This equipment, which contains a Geiger-Muller tube and is able to measure alpha, beta, and gamma rays, was used to collect the data. In addition, a portable handheld geographical positioning system (Germin Oregon 450 GPS) that was utilized to determine the exact location of the radiation source, the radiation meter was calibrated to measure gamma rays (γ) at temperatures between -10 and 50 degrees Celsius.

RADIOLOGICAL HAZARD INDICATORS

Equivalent Dose Rate

According to the NCRP's (National Council on Radiation Protection and Measurement) recommendation (Avwiri et al., 2013), the whole-body equivalent dose rate (EDR) over the course of a year can be estimated.

$$1\text{mRh}^{-1} = \frac{0.96\times24\times365}{100}\ \text{mSv}y^{-1} \quad (1)$$

$$\text{EDR} = \text{BIR} \times 84.096\ \text{mSv}y^{-1} \quad (2)$$

where EDR stands for equivalent dose rate, BIR for background ionizing radiation level, and 84.096 mSvy^{-1} for NCRP's estimated value of BIR

Absorbed Dose Rate

The resulting external exposure data rate measured in μRh^{-1} was converted to absorbed dose rates using the conversion factor mentioned in Eqn. 3 (Agbalagba, 2016).

$$1\mu\text{Rh}^{-1} = 8.7\boldsymbol{\eta}\text{G}y\text{h}^{-1} = \frac{8.7\times10}{(^{1}/_{8760\text{y}})}\ \mu\text{G}yy^{-1} = 76.212\ \mu\text{G}yy^{-1} \quad (3)$$

Annual Effective Dose Equivalent (AEDE)

The outdoor AEDE (Annual Effective Dose Equivalent) induced by gamma ray exposure was computed using the absorbed dose rates mentioned in Eqn. 4 (Ogungbemi et al., 2023). The outdoor occupancy factor was set to 0.2, and the dose conversion factor was set to 0.7 SvGy^{-1} (the conversion coefficient from absorbed radiation in air to effective dose received by humans).

$$AEDE_{outdoor}(mSvy^{-1}) = ADR(nGyh^{-1}) \times 8760h \times 0.7SvGy^{-1} \times 0.2 \quad (4)$$

$$AEDE_{outdoor}(mSvy^{-1}) = ADR\ (nGyh^{-1}) \times 1.2264 \times 10^{-3} \quad (5)$$

where $AEDE_{outdoor}$ is the annual effective dose equivalent for outdoor, ADR is the annual dose rate and 8760h in a year (being 24hrs of the 365days).

Excess Lifetime Cancer Risk (ELCR)

The ELCR (Excess Lifetime Cancer Risk) probability was determined using the computed values of AEDE as expressed in Eqn. 6 (Avwiri et al, 2014).

$$ELCR = AEDE \times DL \times RF \quad (6)$$

where AEDE is the annual effective dose equivalent, DL denotes the average duration of life or life expectancy (calculated at 70 years), and RF denotes risk factor (Sv^{-1}), i.e., the risk of deadly cancer per Sievert.

RESULTS AND DISCUSSION

The results of measuring the BIR exposure levels collected from 47 study spots around Beta Glass Plc were reported. Readings were taken at 47 different points throughout the study region to identify these concentrations. The radiation risk presented by the amounts of gamma radiation in Beta Glass and its surroundings was evaluated using the following radiation hazard indicators: EDR ($mSvy^{-1}$), ADR (ηGyh^{-1}), AEDE ($mSvy^{-1}$), and ELCR (μSvy^{-1}) as reported in Table 1. and comparison of the radiological hazard indices with UNESCEAR standards in the areas under study is presented in Figs. 2–5. In radiation studies, analyses of various established radiation health hazard indices are employed to derive a more dependable estimate of the health hazards to an individual exposed to radiation (Agbalagba, 2016).

Table 1: The identified risk indicators and assessed exposure rate in Beta Glass Plc and the nearby communities

S/N	GEOGRAPHICAL LOCATION	AV. BIR (mRh^{-1})	EDR ($mSvy$-^{1})	ADR (ηGyh^{-1})	AEDE ($mSvy^{-1}$)	ELCR ($\times 10^{-3}$)
1	N $05^0$32′493″ E $005^0$55′899″	0.012	1.009	104.40	128.036	0.448
2	N $05^0$32′519″ E $005^0$55′851″	0.012	1.009	104.40	128.036	0.448
3	N $05^0$32′506″ E$005^0$55′836″	0.013	1.093	113.10	138.706	0.485
4	N $05^0$32′494″ E $005^0$55′826″	0.013	1.093	113.10	138.706	0.485
5	N $05^0$32.488" E $005^0$55′804″	0.012	1.009	104.40	128.036	0.448
6	N $05^0$32′541″ E $005^0$55′827″	0.008	0.673	69.60	85.357	0.299
7	N $05^0$32′569″ E $005^0$55′821″	0.008	0.673	69.60	85.357	0.299

8.	N 05^{0}32′598″ E 005^{0}55′809″	0.009	0.757	73.30	89.895	0.315
9	N 05^{0}32′619″ E 005^{0}55′790″	0.008	0.673	69.60	85.357	0.299
10	N 05^{0}32′642″ E 005^{0}55′751″	0.008	0.673	69.60	85.357	0.299
11	N 05^{0}32′657″ E 005^{0}55′713″	0.008	0.673	69.60	85.357	0.299
12	N 05^{0}32′667″ E 005^{0}55′644″	0.007	0.589	57.42	70.420	0.246
13	N 05^{0}32′678″ E 005^{0}55′600″	0.007	0.589	55.68	68.286	0.239
14	N 05^{0}32′634″ E 005^{0}55′583″	0.007	0.589	55.68	68.286	0.239
15	N 05^{0}32′367″ E 005^{0}55′265″	0.009	0.757	78.30	96.027	0.336
16	N 05^{0}32′353″ E 005^{0}55′280″	0.009	0.757	78.30	96.027	0.336
17	N 05^{0}32′327″ E 005^{0}55′306″	0.008	0.673	69.60	85.357	0.299
18	N 05^{0}32′534″ E 005^{0}55′210″	0.009	0.757	78.30	96.027	0.336
19	N 05^{0}32′523″ E 005^{0}55′258″	0.011	0.925	95.70	117.366	0.411
20	N 05^{0}32′505″ E 005^{0}55′285″	0.011	0.925	95.70	117.366	0.411
21	N 05^{0}32′489″ E 005^{0}55′289″	0.010	0.841	87.00	106.697	0.373
22	N 05^{0}32′470″ E 005^{0}55′307″	0.011	0.925	95.70	117.366	0.411
23	N 05^{0}32′452″ E 005^{0}55′323″	0.011	0.925	95.70	117.366	0.411
24	N 05^{0}32′432″ E 005^{0}55′328″	0.012	1.009	104.40	128.036	0.448
25	N 05^{0}32′410″ E 005^{0}55′365″	0.011	0.925	95.70	117.366	0.411
26	N 05^{0}32′429″ E 005^{0}55′542″	0.011	0.925	95.70	117.366	0.411
27	N 05^{0}32′544″ E 005^{0}55′237″	0.010	0.841	87.00	106.697	0.373
28	N 05^{0}32′570″ E 005^{0}55′217″	0.010	0.841	87.00	106.697	0.373

29	N 05^{0}32′591″ E 005^{0}55′199″	0.010	0.841	87.00	106.697	0.373
30	N 05^{0}32′612″ E 005^{0}55′170″	0.010	0.841	87.00	106.697	0.373
31	N 05^{0}32′630″ E 005^{0}55′161″	0.010	0.841	87.00	106.697	0.373
32	N 05^{0}32′650″ E 005^{0}55′146″	0.010	0.841	87.00	106.697	0.373
33	N 05^{0}32′665″ E 005^{0}55′132″	0.011	0.925	95.70	117.366	0.411
34	N 05^{0}32′690″ E 005^{0}55′108″	0.010	0.841	87.00	106.697	0.373
35	N 05^{0}32′708″ E 005^{0}55′093″	0.010	0.841	87.00	106.697	0.373
36	N 05^{0}32′733″ E 005^{0}55′070″	0.009	0.757	78.30	96.027	0.336
37	N 05^{0}32′750″ E 005^{0}55′056″	0.010	0.841	87.00	106.697	0.373
38	N 05^{0}32′749″ E 005^{0}55′037″	0.011	0.925	95.70	117.366	0.411
39	N 05^{0}32′729″ E 005^{0}55′016″	0.012	1.009	104.40	128.036	0.448
40	N 05^{0}32′712″ E 005^{0}55′999″	0.011	0.925	95.70	117.366	0.411
41	N 05^{0}32′684″ E 005^{0}55′973″	0.011	0.925	95.70	117.366	0.411
42	N 05^{0}32′765″ E 005^{0}55′043″	0.011	0.925	95.70	117.366	0.411
43	N 05^{0}32′780″ E 005^{0}55′031″	0.011	0.925	95.70	117.366	0.411
44	N 05^{0}32′796″ E 005^{0}55′015″	0.011	0.925	95.70	117.366	0.411
45	N 05^{0}32′815″ E 005^{0}55′998″	0.011	0.925	95.70	117.366	0.411
46	N 05^{0}32′833″ E 005^{0}55′982″	0.011	0.925	95.70	117.366	0.411
47	N 05^{0}32′530″ E 005^{0}55′209″	0.008	0.673	69.60	85.357	0.299
	Minimum	**0.007**	**0.589**	**55.68**	**68.286**	**0.239**
	Maximum	**0.013**	**1.093**	**113.10**	**138.706**	**0.485**
	Mean ± SE	**0.010±0.0002**	**0.846±0.019**	**87.153±2.091**	**106.884±2.565**	**0.374±0.009**

WORLD STANDARD	**0.013**	**1.00**	**59.00**	**0.07**	**0.29**

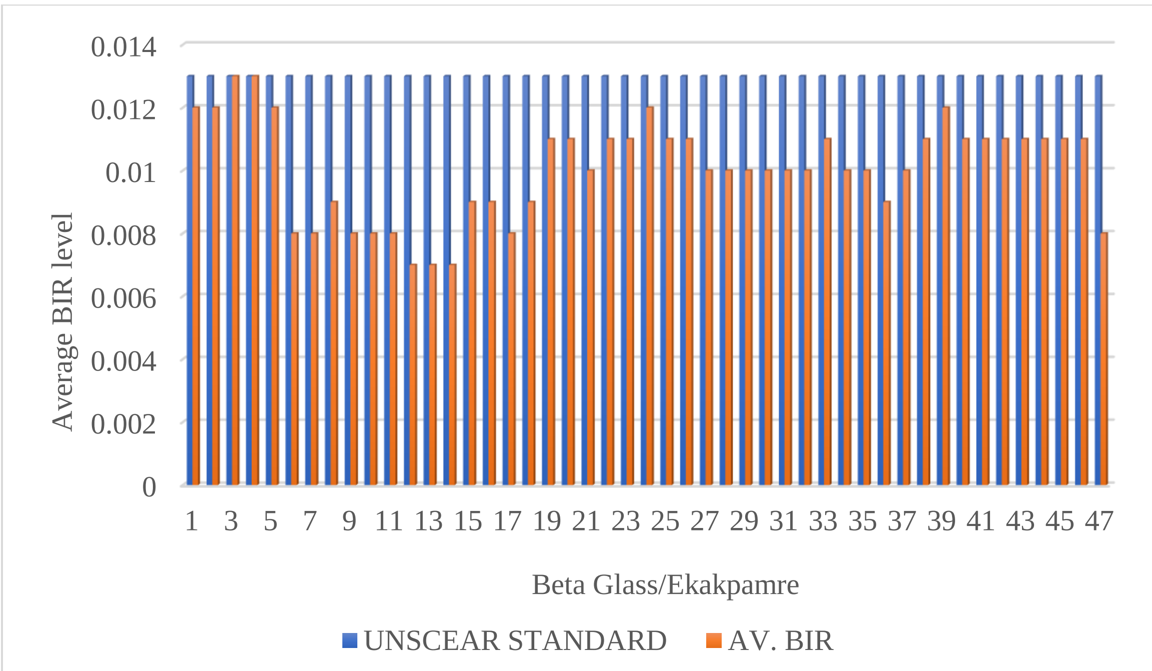

Fig 2: The comparison of average background ionizing radiation (Av. BIR (mRh^{-1})) with UNESCEAR standard in the areas under study

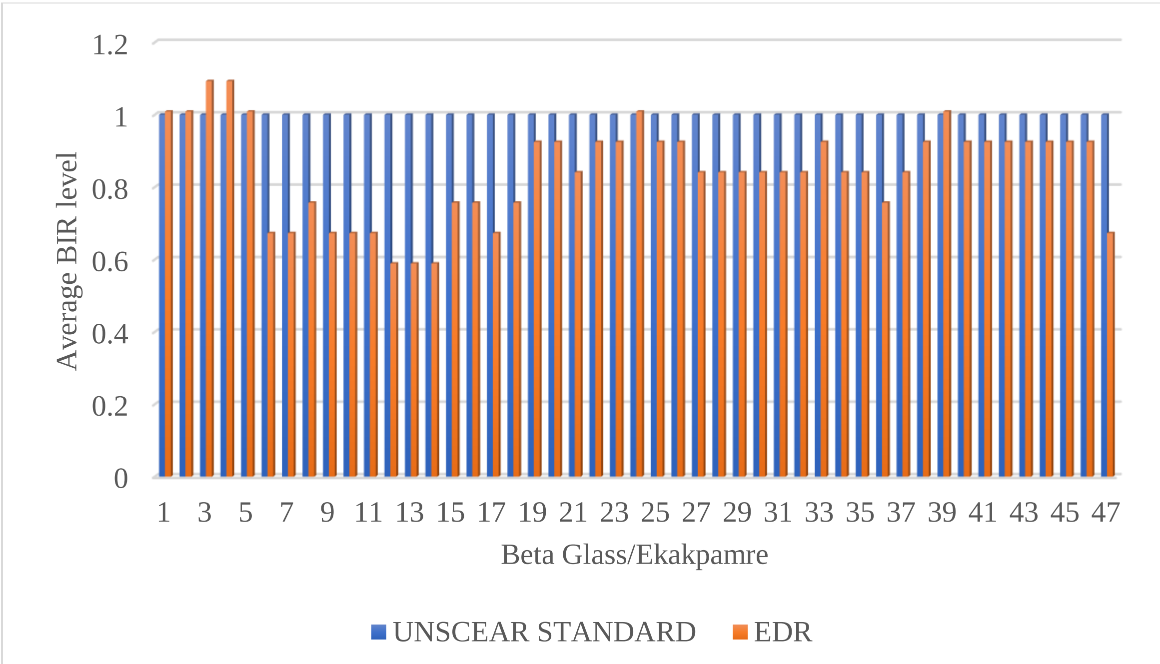

Fig 3: The comparison of effective dose rate (EDR (mSvy^{-1})) with UNESCEAR standard in the areas under study

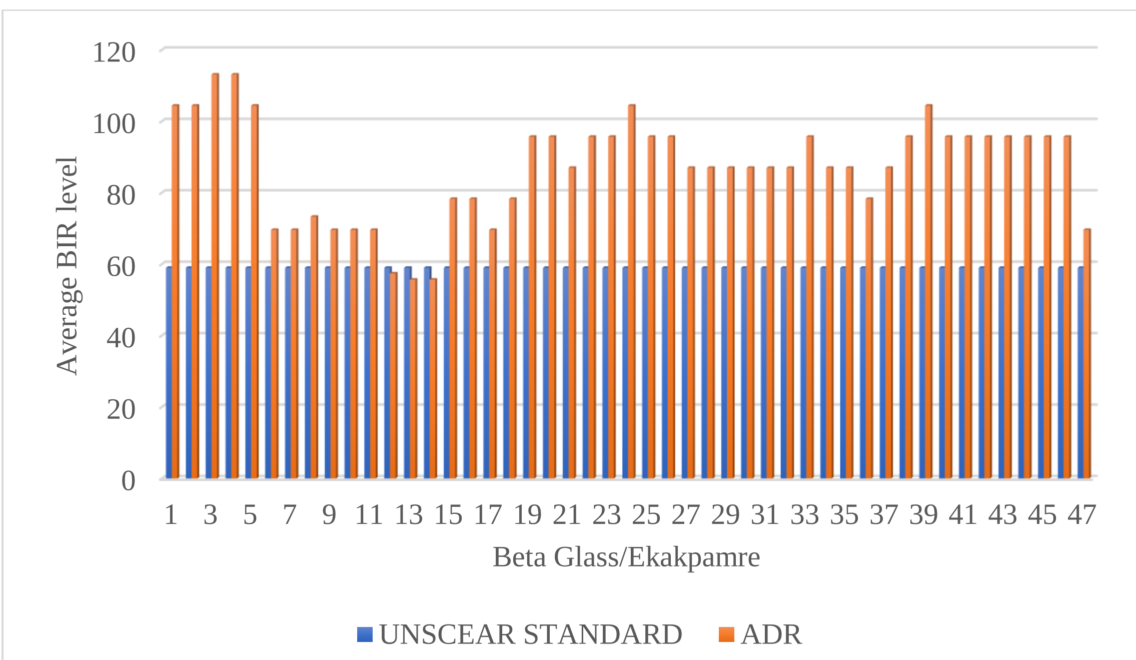

Fig 4: The comparison of the annual dose rate (ADR (ηGyh^{-1})) with UNESCEAR standard in the areas under study

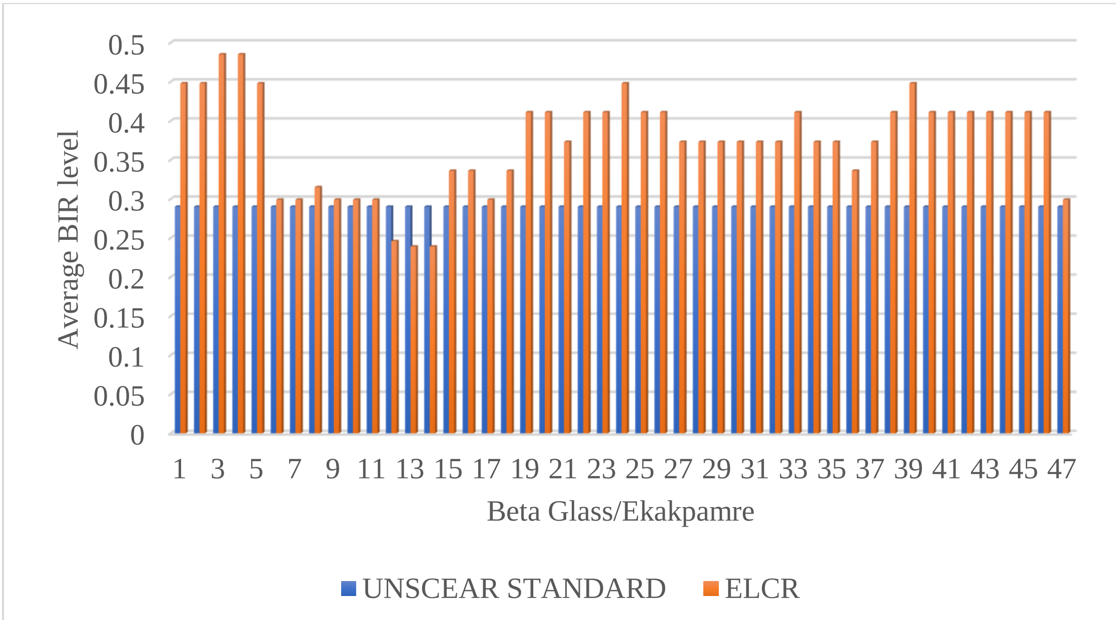

Fig 5: The excess lifetime cancer risk (ELCR ($\times 10^{-3}$)) comparison with UNESCEAR standard in the areas under study

DISCUSSION

Table 1 give the results of the radiometric evaluation of the natural radioactivity concentration and the BIR exposure levels that were determined with the accompanying hazard indicators near Beta Glass plc. In radiation, research analyses utilizing various well-known radiation hazard indicators are employed to reach a more accurate estimate of the dangers of radiation exposure to a person's health (Agbalagba, 2016). The following radiation hazard indices were taken into consideration when assessing the radiation risks associated with the gamma radiation levels in Beta Glass plc and the area around it: equivalent dose rate, absorbed dose rate, annual effective dose equivalent, excess lifetime cancer risk, radium equivalent, external and internal hazard indices, annual gonadal equivalent dose, and representative gamma index.

Comparing the radiological parameter's mean values to the global average; The average measured exposure rates (AV. BIR) ranged from 0.007 mRh^{-1} to 0.013 mRh^{-1}, with 0.010±0.0002 mRh^{-1} serving as the average. The BIR's approximate mean outdoor absorbed dose rate (ADR) in the research region varied from 55.68 $nGyh^{-1}$ to 113.10 $nGyh^{-1}$, with an average result of 87.153±2.091 $nGyh^{-1}$. Where (0.374±0.009) × 10^{-3} was the average excess lifetime cancer risk and 106.884±2.565 $mSvy^{-1}$ was the mean annual effective dose equivalent for the BIR measurement. The average BIR is in line with the ICRP recommendation of 0.013 (mRh^{-1}), while the effective dose rate (EDR) is somewhat below the ICRP recommendation of 1.00 ($mSvy$-^{1}) for a normal environment. The obtained values of the radiological indicators, such as ADR, AEDE, and ELCR, are greater than the background radiation norm of 59 (ηGyh^{-1}), 0. 07 ($mSvy^{-1}$), and

0.29×10^{-3}. The detected radiation levels are comparable to studies done by Agbalagba (2016) and which show that the study areas' BIR levels were higher than the required BIR standard.

CONCLUSION

The radiometric evaluation of Beta Glass plc and its environs have been carried out and the following conclusions were made.

i. The study revealed that the background ionizing radiation levels around Beta Glass plc (the area under study) exceeded average BIR levels and had been influenced by radiation from farming and industrial activities in the environment.
ii. The research area's computed equivalent dose rate is just a little bit higher than the UNSCEAR (2000) advised radiation safety limit of 1.0 $mSvy^{-1}$.
iii. The computed excess lifetime cancer risk revealed that the effective doses from the current exposure rate to adults are relatively significant, and that the likelihood of developing cancer for study region workers or residents who will spend their entire lives in the city is somewhat high.
iv. There might not be an immediate health concern associated with these elevated values for the workers or the adjacent communities' people.

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