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Research Article

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Environmental Impact of Radiation Emitted from Radionuclide Across Southern Borno, Nigeria Using Inspector Alert Nuclear Radiation Monitor

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Abstract
Radiation association with the body produces micro sub-cellular-level effects that may course cellular responses and, in the accumulation, may produce macro observable health effects on some organs or tissues. This work aimed to check the environmental impact of radiation emitted from radionuclide across southern Borno, Nigeria using Inspector Alert Nuclear Radiation Monitor. Finding of this study have revealed that the mean Dorgan values for the lungs, ovaries, bone marrow, testes, kidney, liver and whole body for different local governments of southern Borno are 0.065, 0.059, 0.070, 0.083, 0.063, 0.046 and 0.069 mSv/y respectively. From the findings presented, it can be concluded that the background radiation in Southern Borno is not an issue of health concern in regards to sensitive organs and may not course immediate health effect except on excessive exposure which may cause cancer to the indoor members on approximately seventy years of exposure. It is therefore, advised or recommended that the government encourage regular researches of such for easy control of the health effects.

Keywords: Radionuclides, Mining, D_{organ}, Radiation, Effective Dose, Excess Lifetime Cancer Risk

Introduction

The penetration of radiation into matter can pose biological hazard which may later show clinical symptoms [1-3]. The mode and extent of these symptoms and the time they take to appear depends on the amount of radiation absorbed and the rate at which it is received [4-6]. Radiation Safety is bothered about cellular effects, which may damage the chromosomes and their components (e.g., genes, DNA, etc.). Radiation association with the body produces micro sub-cellular-level effects that may course cellular responses and, in the accumulation, may produce macro observable health effects on some organs or tissues [7]. Irradiation of tissue sets a series of intracellular biochemical events into motion that start with ionization of a molecule, and may lead to cellular injury [8]. This may, in turn, lead to further injury to the organ and to the organism. Some factors can modify the response of a living organism to a given radiation dose [9]. Factors associated with the dose include the dose rate, the energy and type of radiation (Depending on the quantity of ionization deposited along a unit length of track of radiation, LET), and the temporal pattern of the exposure. The DNA is considered to be the main target molecule for radiation toxicity [10]. Molecular effects, which includes effect to the DNA, can occur in any of two ways from an exposure to radiation. Firstly, radiation can associate directly with the DNA, causing a single or double-strand DNA breaks or bonding base pairs. Secondly, radiations can associate directly with other neighboring molecules within or outside of the cell, such as water, to produce free radicals and active oxygen species. These reactive molecules, in turn, associates with the DNA and/or other molecules within the cell (membranes, mitochondria, lipids, proteins, etc.) to produce a wide range of health implication at the cellular and tissue levels of the organism [11-14]. Cellular/Organ Radio sensitivity [15-18]. The health consequences of radiation exposure depend on also some biological factors which include species, age, sex, the portion of the body tissues exposed, different radio sensitivity, and repair mechanisms. According to the Law of Bergonie and Tribondeau, the sensitivity of cell lines is directly proportional to their mitotic rate and inversely proportional to the degree of differentiation [19-22]. Cellular changes in susceptible cell types may result in cell death; extensive cell death may produce irreversible damage to an organ or tissue, or may result in the death of the individual [23-26]. If the cells are adequately repaired and relatively normal function is restored, the subtler DNA alterations may also be expressed at a later time as mutations and/or tumors [27-29].

This study will find solution to question like; the various factors that leads to the variation in radiation effects in Southern Borno, the hazards of man's continual exposure to radiation through different radiation emitting source and possible protection and control measures to its exposure.

This study aimed at assessing the Health Effects of Radiation Exposure to Human Sensitive Organs across Some Selected Mining Sites of Southern Borno Nigeria.

Materials and Method

Materials

The materials used to execute this research work are;
The inspector Alert Nuclear Radiation Monitor with the serial number 35440, made in USA by ion spectra (International Med. Com. Inc) using alkaline battery 0f 9.0 volts, a scientific calculator, personal computer (laptop), pen and exercise book.

Method

The methods adopted in this research work was the use of radiation monitor with in-build Geiger Muller tube operating in the Dose Rate mode to determine the background ionizing radiation level from the selected Mining Sites of Plateau State. The Geiger Muller tube generates a pulse of electrical current each time radiation passes through the tube which cause ionization. Each pulse is electrically detected and registered as a count mSv/hr, but CPM, been the most direct and appropriate method of measuring alpha and beta activity was chosen as the correct mode. The inspector Alert was held above the ground level (1m above). The device was turn on and measurements were taken after a deep sound that indicates the statistical validity of the readings on the liquid crystal display (LCD) of the monitor.

Study Area

Biu is a town and a Local Government Area (LGA) in southern Borno State of Nigeria. The town is the administrative center of the LGA and was once the capital of the Biu kingdom, and is now capital of the Biu Emirate. Biu lies on the Biu Plateau at an average elevation of 626 meters. The region is semi-arid. The name of Biu was initially called Viu which in Babur and Bura Language means high [30-32].

The Biu kingdom became established around 1670 in the reign of Mari Watila Tampta. King Mari Watirwa (1793–1838), whose capital was near Biu at Kogu, defeated Fulani invaders from the Gombe Emirate to the west. In 1878 Mari Biya, became the first Babur king to rule from Biu. The emir's palace is now situated in the town [30-32].

With British rule, Biu division was created in 1918. Mai Ari Dogo was acknowledged as the first emir of Biu in 1920. The area became known as the Biu federation after 1957, when the districts of Shani and Askira were added to the emirate. Maidalla Mustafa dan Muhammad (1915) became Mai Biu, also styled Kuthli, in 1959 [30-32].

The inhabitants of the region are mainly Babur and Bura people (also known as Pabir), Tera, Bura, Marghi, Mina and Fulani people. Babur, Bura, Tera, Marghi and Mina are Biu–Mandara languages of the Chadic language group [30-32].

Fikayel Bayo is a Local Government Area of Borno State, Nigeria. Its headquarters are in the town Fikayel. It has an area of 956 km2 and a population of 78,978 at the 2006 census [30-32].

It is one of the four LGAs that constitute the Biu Emirate, a traditional state located in Borno State, Nigeria [30-32].

Hawul is a Local Government Area of Borno State, Nigeria. It's located in the southern part of the state. Is headquarters being in the town of Azare. It has an area of 2,098 km^2 and a population of about 120,000 at the 2006 census [30-32].

It is one of the four LGAs that constitute the Biu Emirate, a traditional state located in Borno State, Nigeria [30-32].

Kwaya Kusar is a Local Government Area of Borno State, Nigeria. Its headquarters are in the town of Kwaya Kusar. It has an area of 732 km^2 and a population of 56,500 at the 2006 census. The inhabitants speak the Bura language. They are mostly subsistence farmers [30-32].

It is one of the four LGAs that constitute the Biu Emirate, a traditional state located in Borno State, Nigeria [30-32].

Shani is a Local Government Area of Borno State, Nigeria. Its headquarters are in the town of Shani [30-32].

It has an area of 1,262 km^2 and a population of 102,317 as of the 2006 census. Shani Local Government Area is located in the south-eastern axis of Borno state. It is bordered by Bayo, Hawul, and Kwaya Local Government Area. Its administrative headquarters lies in the heart of Shani town [30-32].

The maps of the study areas are shown in Figure 1,2 and 3. Figure 1 presents the map of Nigeria showing Borno state, Figure 2 presents the map of Borno state showing Borno south and Figure 3 presents the map of Borno south showing the data points respectively.

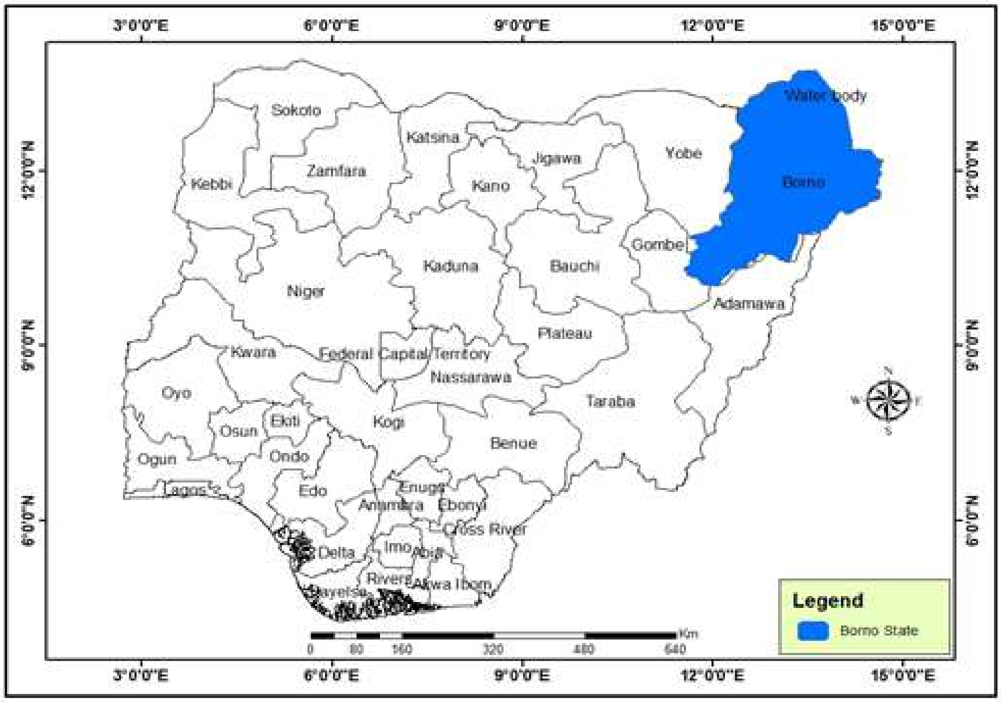

Figure 1: Map of Nigeria Showing Borno State

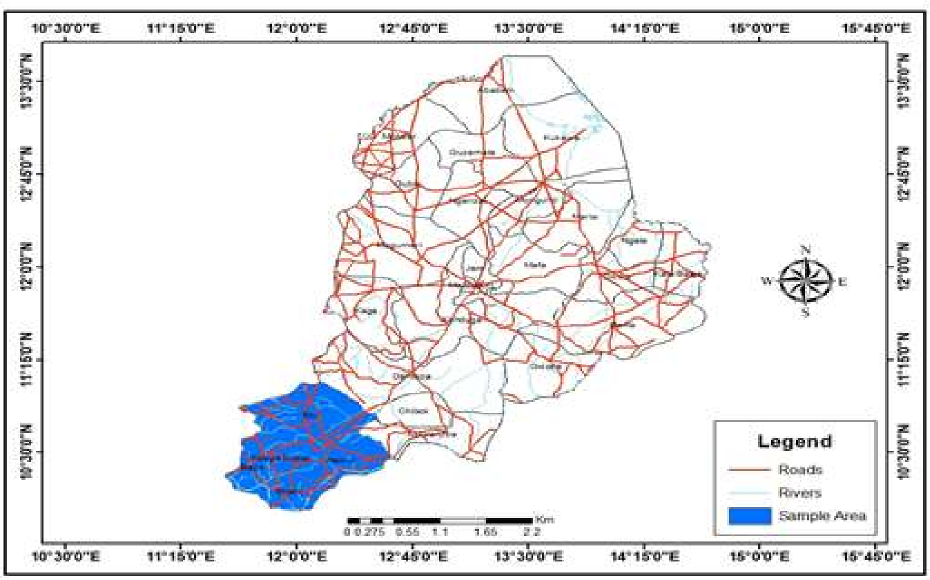

Figure 2: Map of Borno State Showing Borno South

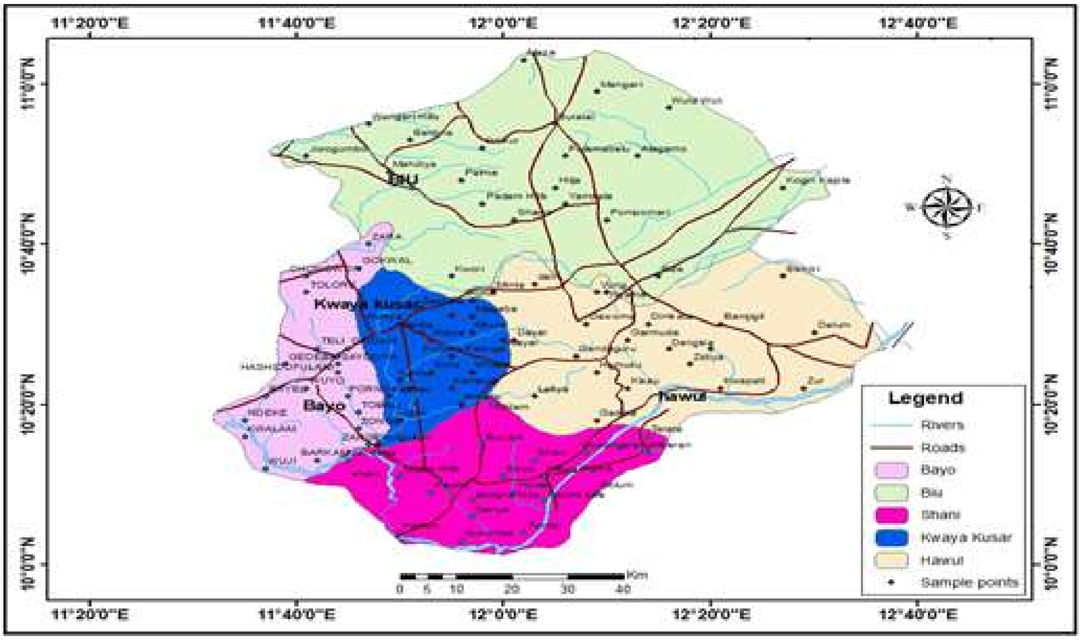

Figure 3: Map of Borno South Showing the Data Points

Method Data Collection and Measurement

The instrument used was Inspector Alert Meter. This detector is a relatively economical meter frequently used to perform surveys of very low radiation fields. It can measure variations in background dose rate. The measuring range is 0 to 5000 μR/hr. (For μSv/h, use Model 19 Series 8, P/N: 48-2582.) The cast aluminum instrument housing with a separate battery compartment and accompanying metal handle offer an industrial robustness and quality that promote long lasting protection.

The meter was held one meter above the ground to reflect abdominal level of human readings in count per minute. Readings were taken three times in μR/hr after which the average reading was calculated for each of the camp work visited. The analytical procedure was conducted for five days, in Borno South.

Method of Data Analysis

[33] Recommended indoor occupancy factors of 0.8. This occupancy factor is the proportion of the total time during which an individual is exposed to a radiation field. Eight thousand seven hundred and sixty hours per year (8760hr/yr) were used. Equation (1) converts from Gamma Activity in milli Röentgen per hour to Exposure Dose Rate in micro – Sievert per hour, equation (2) converts the Exposure Dose Rate in micro – Sievert per hour to Annual Effective Dose Rate in milli Sievert per year, equation (3) evaluates the Excess Lifetime Cancer Risk, while equation (4) evaluates the Annual Effective Dose Rate to different sensitive organs.

$$10mR/hr(GA) = 1\mu Sv/hr(EDR) \quad (1)$$

$$AEDR\,mSv/yr = [(EDR)\mu Sv/hr \times 8760hr/yr \times 0.8] \div 1000 \quad (2)$$

$$ELCR = AEDR \times DL \times RF \quad (3)$$

$$D_{organ} = AEDR \times F \quad (4)$$

Results and Discussion

Results

Gamma activity level was obtained from the field, after which equations (1) – (4) were used to evaluate the Exposure Dose Rate (EDR), Annual Effective Dose Rate (AEDR), Excess Lifetime Cancer Risk (ELCR) and Effective Dose to different organs of the body (Dorgan) and are presented in Table 2, 3, 4, 5 and 6.

Table 1: Gamma Activity (mR/hr), Exposure Dose Rate (µSv/hr), Effective Dose Rate (mSv/yr) and Excess Lifetime Cancer Risk of Bayo Local Government Area

Villages	Gamma Activity (mR/hr)	Exposure Dose Rate (µSv/hr)	Effective Dose Rate (mSv/yr)	Excess Lifetime Cancer Risk
Bayo	0.14	0.014	0.098	0.343
Bulama Kabi	0.16	0.016	0.112	0.392
Dagon Zaga	0.09	0.009	0.063	0.221
Fikayah	0.15	0.015	0.105	0.368
Gama dadi	0.12	0.012	0.084	0.294
Guburunde	0.16	0.016	0.112	0.392
Hara-Guwal	0.13	0.013	0.091	0.319
Kabara	0.18	0.018	0.126	0.442
Karko	0.14	0.014	0.098	0.343
Limanti	0.17	0.017	0.119	0.417
Maina Baba	0.11	0.011	0.077	0.270
Maduya	0.10	0.010	0.070	0.245
Tashan Itashe	0.15	0.015	0.105	0.368
Tashan tsamiya	0.12	0.012	0.084	0.294
Tenteni	0.16	0.016	0.112	0.392
Tundun Wada	0.18	0.018	0.126	0.442
Jara Guwal	0.14	0.014	0.098	0.343
Garun Gado	0.17	0.017	0.119	0.417
Jauro Garga	0.14	0.014	0.098	0.343
Kanawa	0.16	0.016	0.112	0.392
Mean	**0.14**	**0.014**	**0.101**	**0.352**

Table 2: Gamma Activity (mR/hr), Exposure Dose Rate (µSv/hr), Effective Dose Rate (mSv/yr) and Excess Lifetime Cancer Risk of Biu Local Government Area

Villages	Gamma Activity (mR/hr)	Exposure Dose Rate (µSv/hr)	Effective Dose Rate (mSv/yr)	Excess Lifetime Cancer Risk
Biu	0.19	0.019	0.133	0.466
Kabura	0.17	0.017	0.119	0.417
Mbulamel	0.10	0.010	0.070	0.245
Waka Biu	0.10	0.010	0.070	0.245
Zara Wuyaku	0.18	0.018	0.126	0.442
B.C.G	0.13	0.013	0.091	0.319
Kampala	0.10	0.010	0.070	0.245
Nasarawa	0.12	0.012	0.084	0.294
Tabra	0.10	0.010	0.070	0.245
Zara Diza	0.11	0.011	0.077	0.270
Bam	0.10	0.010	0.070	0.245
Buratai	0.10	0.010	0.070	0.245
Gunda	0.17	0.017	0.119	0.417
Kurnari	0.10	0.010	0.070	0.245
Yarda	0.10	0.010	0.070	0.245

Alagarno	0.10	0.010	0.070	0.245
Garubula	0.12	0.012	0.084	0.294
Mandaragrau	0.10	0.010	0.070	0.245
Miringa	0.11	0.011	0.077	0.270
Zira	0.12	0.012	0.084	0.294
Mean	**0.12**	**0.012**	**0.085**	**0.297**

Table 3: Gamma Activity (mR/hr), Exposure Dose Rate (µSv/hr), Effective Dose Rate (mSv/yr) and Excess Lifetime Cancer Risk of Hawul Local Government Area

Villages	Gamma Activity (mR/hr)	Exposure Dose Rate (µSv/hr)	Effective Dose Rate (mSv/yr)	Excess Lifetime Cancer Risk
Hawul	0.12	0.012	0.084	0.294
Dangola	0.18	0.018	0.126	0.442
Kwagu Shar	0.16	0.016	0.112	0.392
Pela Chiroma	0.17	0.017	0.119	0.417
Shaffa	0.12	0.012	0.084	0.294
Agula Tulari	0.13	0.013	0.091	0.319
Buta Kayamda	0.16	0.016	0.112	0.392
Kwaya Bura	0.17	0.017	0.119	0.417
Mularam	0.19	0.019	0.133	0.466
Taga-Ramta	0.15	0.015	0.105	0.368
Vina Dam	0.12	0.012	0.084	0.294
Agga Bura	0.16	0.016	0.112	0.392
Azare Tasha	0.18	0.018	0.126	0.442
Batabwa	0.16	0.016	0.112	0.392
Bubalkwi	0.17	0.017	0.119	0.417
Damudanaka	0.12	0.012	0.084	0.294
Gumshim	0.13	0.013	0.091	0.319
Nduraku	0.16	0.016	0.112	0.392
Turkuta	0.17	0.017	0.119	0.417
Zange	0.19	0.019	0.133	0.466
Mean	**0.16**	**0.016**	**0.109**	**0.381**

Table 4: Gamma Activity (mR/hr), Exposure Dosr Rate (µSv/hr), Effective Dose Rate (mSv/yr) and Excess Lifetime Cancer Risk of Kwaya Kusar Local Government Area

Villages	Gamma Activity (mR/hr)	Exposure Dose Rate (µSv/hr)	Effective Dose Rate (mSv/yr)	Excess Lifetime Cancer Risk
Kwaya Kusar	0.11	0.011	0.077	0.270
Charangi	0.14	0.014	0.098	0.343
Dunkur	0.10	0.010	0.070	0.245
Gaidam	0.17	0.017	0.119	0.417
Gashina	0.10	0.010	0.070	0.245
Gudula	0.17	0.017	0.119	0.417
Gwandi	0.11	0.011	0.077	0.270
Hutayankwar	0.19	0.019	0.133	0.466

Jugual	0.14	0.014	0.098	0.343
Kopala	0.16	0.016	0.112	0.392
Kullankasan	0.18	0.018	0.126	0.442
Kwardun	0.17	0.017	0.119	0.417
Algarno	0.13	0.013	0.091	0.319
Lafiya	0.16	0.016	0.112	0.392
Minta	0.17	0.017	0.119	0.417
Pela Tsuigi	0.19	0.019	0.133	0.466
Pukuma Miyim	0.10	0.010	0.070	0.245
Wada	0.17	0.017	0.119	0.417
Wandali	0.10	0.010	0.070	0.245
Kuthi Dika	0.17	0.017	0.119	0.417
Mean	**0.15**	**0.015**	**0.103**	**0.359**

Table 5: Gamma Activity (mR/hr), Exposure Dosr Rate (µSv/hr), Effective Dose Rate (mSv/yr) and Excess Lifetime Cancer Risk of Shani Local Government Area

Villages	Gamma Activity (mR/hr)	Exposure Dosr Rate (µSv/hr)	Effective Dose Rate (mSv/yr)	Excess Lifetime Cancer Risk
Shani	0.09	0.009	0.063	0.221
Burashika	0.19	0.019	0.133	0.466
Dumbuku	0.16	0.016	0.112	0.392
Gwalasho	0.13	0.013	0.091	0.319
Kashime	0.19	0.019	0.133	0.466
Kubo	0.17	0.017	0.119	0.417
Gasi	0.15	0.015	0.105	0.368
Gora	0.15	0.015	0.105	0.368
Kombo	0.13	0.013	0.091	0.319
Kubodemo	0.14	0.014	0.098	0.343
Kurnglung	0.18	0.018	0.126	0.442
Lakundum	0.15	0.015	0.105	0.368
Yabe	0.17	0.017	0.119	0.417
Bakaima	0.15	0.015	0.105	0.368
Burgulok	0.15	0.015	0.105	0.368
Ghari	0.13	0.013	0.091	0.319
Bargu	0.19	0.019	0.133	0.466
Guldugurung	0.16	0.016	0.112	0.392
Gwaskara	0.13	0.013	0.091	0.319
Kurje	0.19	0.019	0.133	0.466
Mean	**0.16**	**0.016**	**0.109**	**0.380**

Table 6: Effective Dose Rate to Different Sensitive Organs for Bayo Local Government Area in (mSv/yr)

Villages	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
Bayo	0.063	0.057	0.068	0.080	0.061	0.045	0.067
Bulama Kabi	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Dagon Zaga	0.040	0.037	0.044	0.052	0.039	0.029	0.043
Fikayah	0.067	0.061	0.073	0.086	0.065	0.048	0.071
Gama dadi	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Guburunde	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Hara-Guwal	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Kabara	0.081	0.073	0.087	0.103	0.078	0.058	0.086
Karko	0.063	0.057	0.068	0.080	0.061	0.045	0.067
Limanti	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Maina Baba	0.049	0.045	0.053	0.063	0.048	0.035	0.052
Maduya	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Tashan Itashe	0.067	0.060	0.073	0.086	0.065	0.048	0.071
Tashan tsamiya	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Tenteni	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Tundun Wada	0.081	0.073	0.087	0.103	0.078	0.058	0.086
Jara Guwal	0.063	0.057	0.068	0.080	0.061	0.045	0.067
Garun Gado	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Jauro Garga	0.063	0.057	0.068	0.080	0.061	0.045	0.067
Kanawa	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Mean	**0.064**	**0.058**	**0.069**	**0.083**	**0.062**	**0.046**	**0.068**

Table 7: Effective Dose Rate to Different Sensitive Organs for Biu Local Government Area in (mSv/yr)

Villages	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
Biu	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Kabura	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Mbulamel	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Waka Biu	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Zara Wuyaku	0.081	0.073	0.087	0.103	0.078	0.058	0.086
B.C.G	0.058	0.053	0.063	0.075	0.05648	0.042	0.062
Kampala	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Nasarawa	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Tabra	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Zara Diza	0.049	0.045	0.053	0.063	0.048	0.035	0.052
Bam	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Buratai	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Gunda	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Kurnari	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Yarda	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Alagarno	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Garubula	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Mandaragrau	0.045	0.041	0.048	0.057	0.043	0.032	0.048

Miringa	0.049	0.045	0.053	0.063	0.048	0.035	0.052
Zira	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Mean	**0.054**	**0.049**	**0.059**	**0.070**	**0.053**	**0.039**	**0.058**

Table 8: Effective Dose Rate to Different Sensitive Organs for Hawul Local Government Area in (mSv/yr)

Villages	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
Hawul	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Dangola	0.081	0.073	0.087	0.103	0.078	0.058	0.086
Kwagu Shar	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Pela Chiroma	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Shaffa	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Agula Tulari	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Buta Kayamda	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Kwaya Bura	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Mularam	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Taga-Ramta	0.067	0.061	0.073	0.086	0.065	0.048	0.071
Vina Dam	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Agga Bura	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Azare Tasha	0.081	0.073	0.087	0.103	0.078	0.058	0.086
Batabwa	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Bubalkwi	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Damudanaka	0.054	0.049	0.058	0.069	0.052	0.039	0.057
Gumshim	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Nduraku	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Turkuta	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Zange	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Mean	**0.070**	**0.063**	**0.075**	**0.089**	**0.068**	**0.05**	**0.074**

Table 9: Effective Dose Rate to Different Sensitive Organs for Kwaya Kusar Local Government Area in (mSv/yr)

Villages	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
Kwaya Kusar	0.049	0.045	0.053	0.063	0.048	0.035	0.052
Charangi	0.063	0.057	0.068	0.080	0.061	0.045	0.067
Dunkur	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Gaidam	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Gashina	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Gudula	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Gwandi	0.049	0.045	0.053	0.063	0.048	0.035	0.052
Hutayankwar	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Jugual	0.063	0.057	0.068	0.080	0.061	0.045	0.067
Kopala	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Kullankasan	0.081	0.073	0.087	0.103	0.078	0.058	0.086
Kwardun	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Algarno	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Lafiya	0.072	0.065	0.077	0.092	0.070	0.052	0.076

Minta	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Pela Tsuigi	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Pukuma Miyim	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Wada	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Wandali	0.045	0.041	0.048	0.057	0.043	0.032	0.048
Kuthi Dika	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Mean	**0.066**	**0.060**	**0.071**	**0.084**	**0.064**	**0.047**	**0.070**

Table 10: Effective Dose Rate to Different Sensitive Organs for Shani Local Government Area in (mSv/yr)

Villages	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
Shani	0.040	0.037	0.044	0.052	0.039	0.029	0.043
Burashika	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Dumbuku	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Gwalasho	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Kashime	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Kubo	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Gasi	0.067	0.061	0.073	0.086	0.065	0.048	0.071
Gora	0.067	0.061	0.073	0.086	0.065	0.048	0.071
Kombo	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Kubodemo	0.063	0.057	0.068	0.080	0.062	0.045	0.067
Kurnglung	0.081	0.073	0.087	0.103	0.078	0.058	0.086
Lakundum	0.067	0.061	0.073	0.086	0.065	0.048	0.071
Yabe	0.076	0.069	0.082	0.098	0.074	0.055	0.081
Bakaima	0.067	0.061	0.073	0.086	0.065	0.048	0.071
Burgulok	0.067	0.061	0.073	0.086	0.065	0.048	0.071
Ghari	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Bargu	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Guldugurung	0.072	0.065	0.077	0.092	0.070	0.052	0.076
Gwaskara	0.058	0.053	0.063	0.075	0.056	0.042	0.062
Kurje	0.085	0.077	0.092	0.109	0.083	0.061	0.091
Mean	**0.070**	**0.063**	**0.075**	**0.089**	**0.067**	**0.05**	**0.074**

Result Analysis

Comparison of Results with United Nation Scientific Committee on Effect of Atomic Radiation

In this section, the data presented in Table 1 to Table 5 is used to plot charts in order to compare the results of the present study with UNSCEAR.

Comparison of Annual Effective Dose Rate and Excess Lifetime Cancer Risk with United Nation Scientific Committee on Effect of Atomic Radiation

The data presented in Table 1, 2, 3, 4 and 5 was used to plot a chart in order to compare the result of annual effective dose rate and excess lifetime cancer risk with UNSCEAR. These charts arepresented in Figure 4,5,6,7 and 8 for Bayo, Biu, Hawul, Kwaya Kusar and Shani respectively.

On the other hand, the data presented in Table 6, 7, 8, 9 and 10 was used to plot a chart in order to compare the result of annual effective dose to sensitive organ with UNSCEAR. These charts are presented in Figure 9,10,11,12 and 13 for Bayo, Biu, Hawul, Kwaya Kusar and Shani respectively.

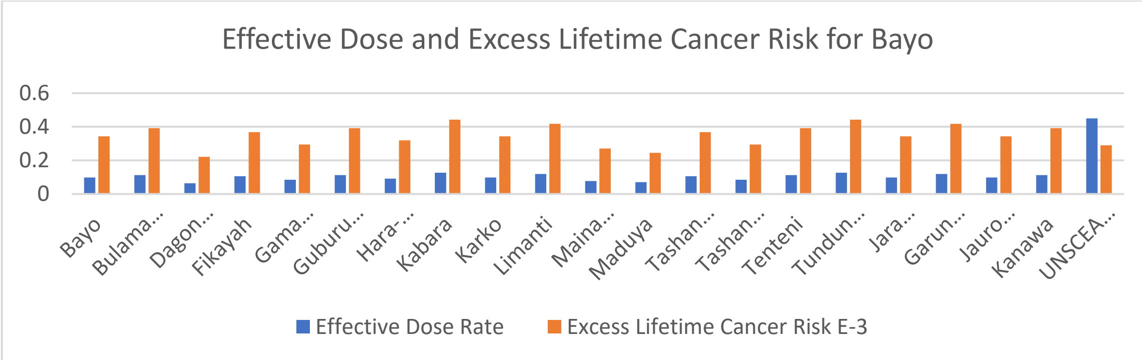

Figure 4: Effective Dose and Excess Lifetime Cancer Risk for Bayo with UNSCEAR

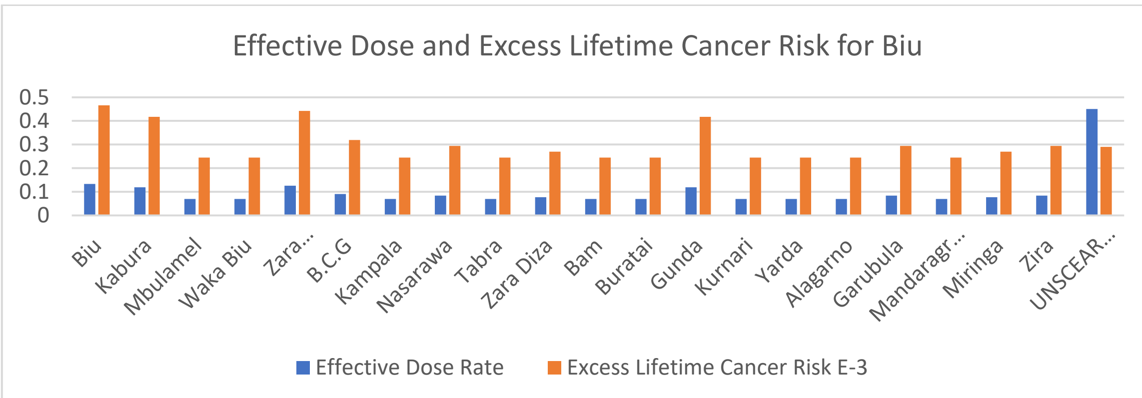

Figure 5: Effective Dose and Excess Lifetime Cancer Risk for Biu with UNSCEAR

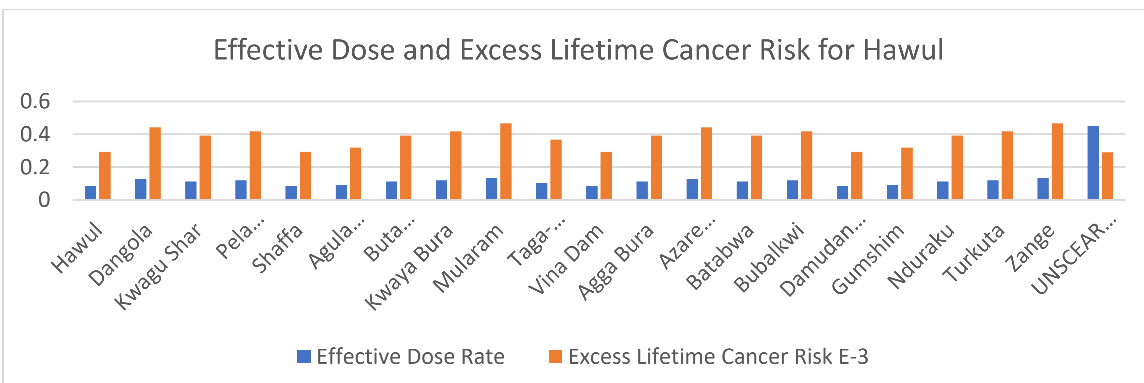

Figure 6: Effective Dose and Excess Lifetime Cancer Risk for Hawul with UNSCEAR

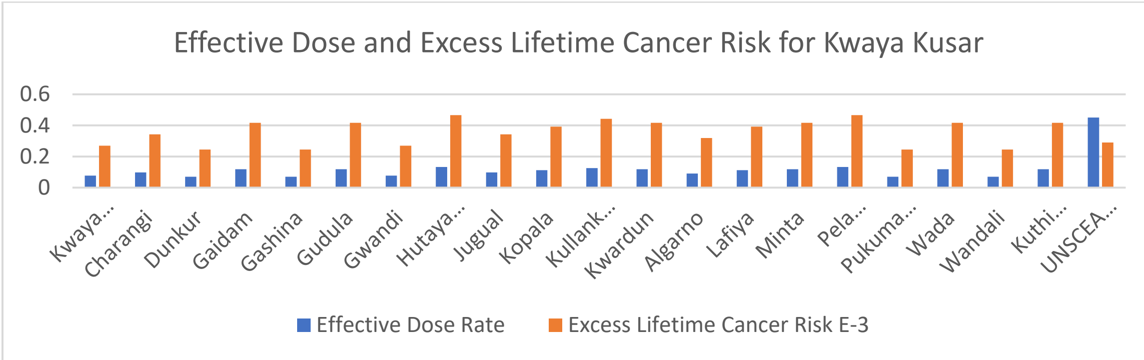

Figure 7: Effective Dose and Excess Lifetime Cancer Risk for Kwaya Kuasr with UNSCEAR

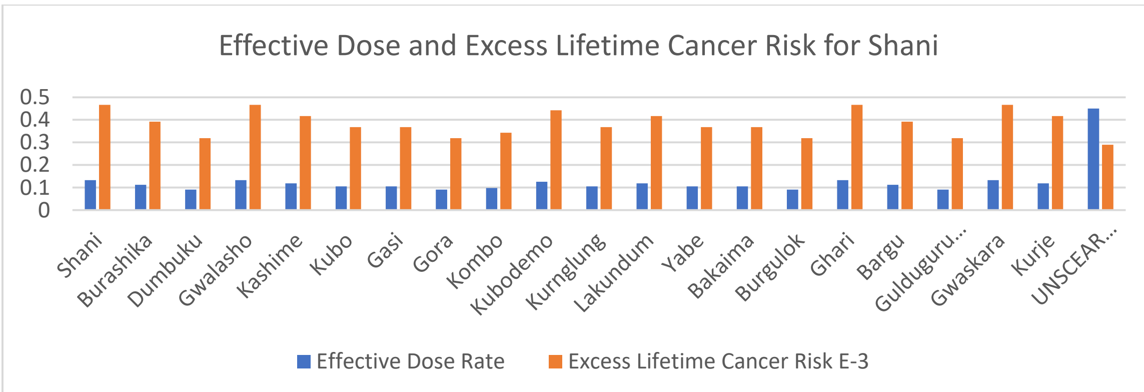

Figure 8: Effective Dose and Excess Lifetime Cancer Risk for Shani with UNSCEAR

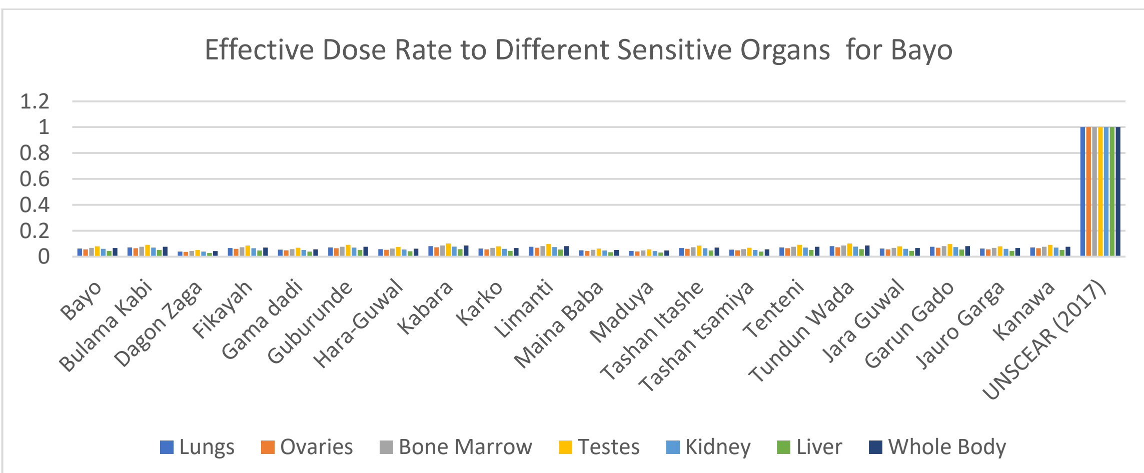

Figure 9: Effective Dose to Different Organs for Bayo with UNSCEAR

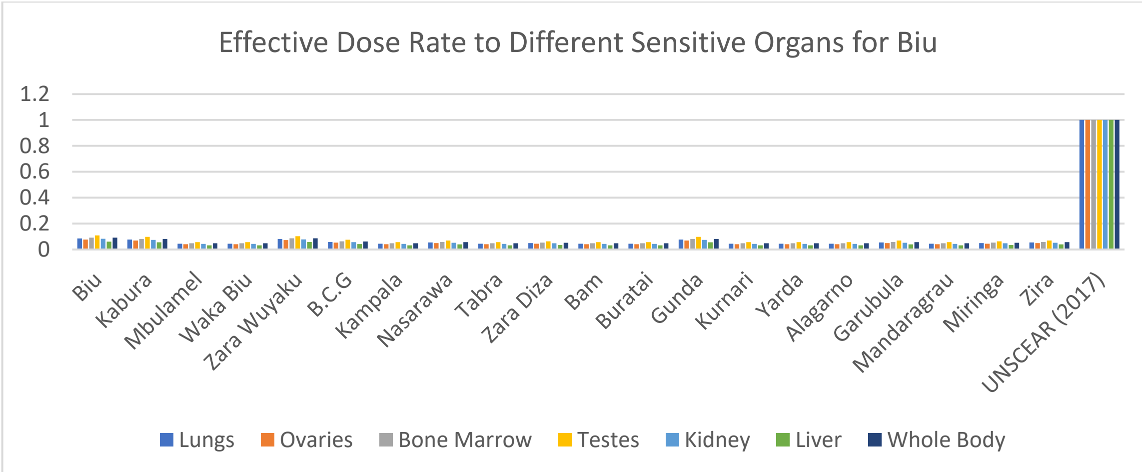

Figure 10: Effective Dose to Different Organs for Biu with UNSCEAR

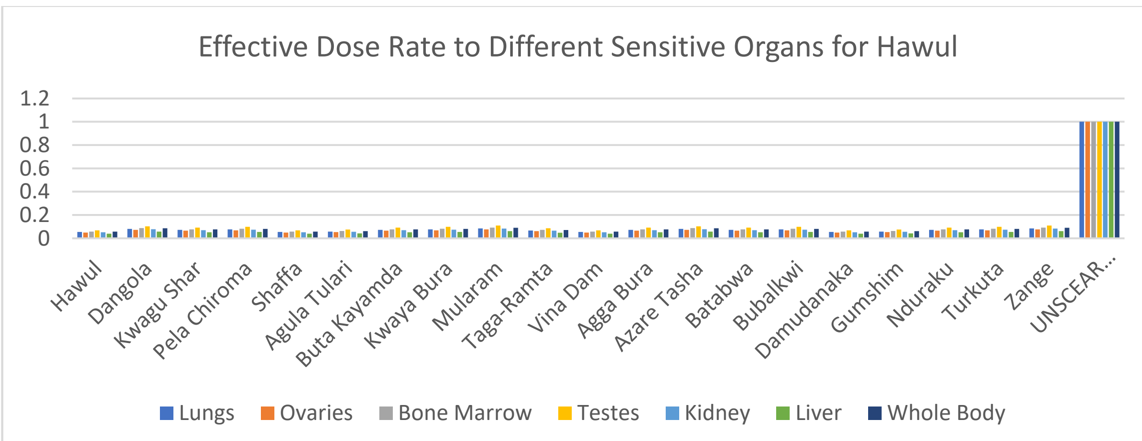

Figure 11: Effective Dose to Different Organs for Hawul with UNSCEAR

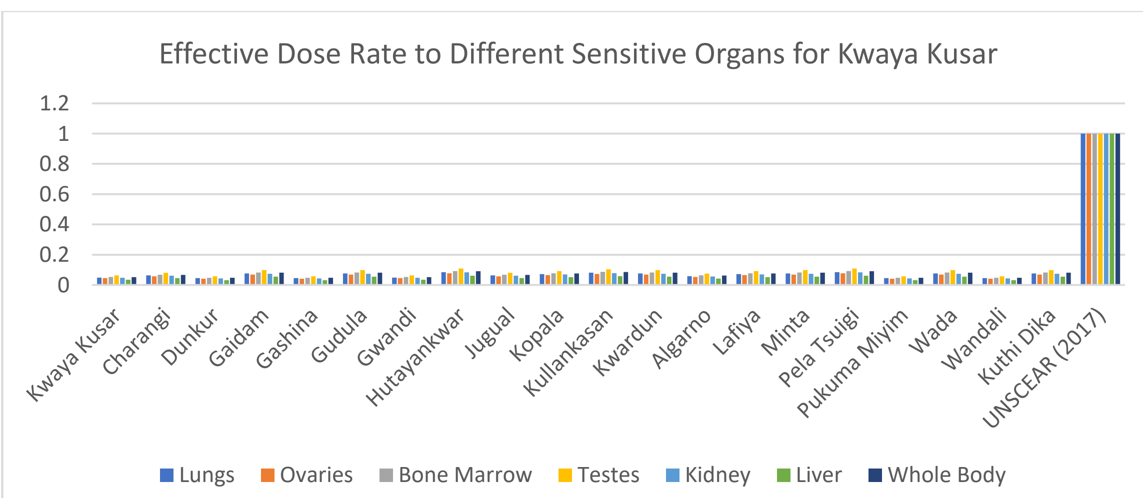

Figure 12: Effective Dose to Different Organs for Kwaya Kusar with UNSCEAR

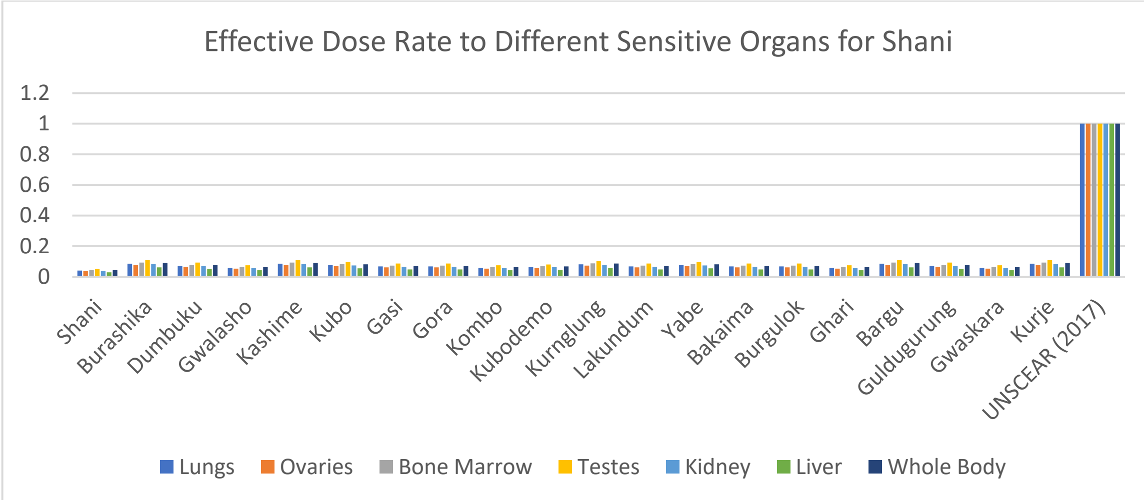

Figure 13: Effective Dose to Different Organs for Shani with UNSCEAR

Discussion

Based on the data presented and the chart plotted in Figure 4, the annual effective dose rate for all villages under Bayo are found to be lower than 0.45mSv/y as recommended by UNSCEAR and may not cause radiological hazard to the public and workers except on excessive exposure. On the other hand, the excess lifetime cancer risk for villages in Bayo was found to be higher than 0.29 x 10-3 except for Dagon Zaga, Maina Baba and Maduya which are found to be lower as recommended by UNSCEAR and may cause radiological hazard to the public and workers.

Data from Biu local government also showed clearly in Figure 5 that, the annual effective dose rate for all villages were found to be lower than 0.45mSv/y as recommended by UNSCEAR and may not cause radiological hazard to the public and workers except on excessive exposure. Meanwhile, the excess lifetime cancer risk for villages in Biu was found to be lower than 0.29 x 10-3 except for Biu, Kabura, Zara Wuyaku, B.C.G, Nassarawa, Gunda, Garubula and Zira which are found to be higher as recommended by UNSCEAR and may cause radiological hazard to the public and workers.

Based on the Data obtained from Hawul local government, as seen in Figure 6, the annual effective dose rate for all villages were also found to be lower than 0.45mSv/y as recommended by UNSCEAR and may not cause radiological hazard to the public and workers except on excessive exposure. But that of excess lifetime cancer risk were found to be higher than 0.29 x 10-3 as recommended by UNSCEAR and may cause radiological hazard to the public and workers.

The people of Kwaya Kusar local government according to Figure 7 have their annual effective dose rate for all villages to be lower than 0.45mSv/y as recommended by UNSCEAR and may not cause radiological hazard to the public and workers except on excessive exposure. Whereas, the excess lifetime cancer risk is higher than 0.29 x 10-3 except for Kwaya Kusar, Dunkur, Gashina, Gwandi, Pukuma Miyim, and Wandali which are found to be lower as recommended by UNSCEAR and may cause radiological hazard to the public and workers.

It can also be observed from Figure 8 that, the people of Hawul local government have their annual effective dose rate for all villages to be lower than 0.45mSv/y as recommended by UNSCEAR and may not cause radiological hazard to the public and workers except on excessive exposure. Unlike the excess lifetime cancer risk which is higher than 0.29 x 10-3 as recommended by UNSCEAR and may cause radiological hazard to the public and workers.

It is finally seen clear from Figure 9, 10, 11, 12 and 13 that, the effective dose to Different Organs (Dorgan) values for the lungs, ovaries, bone marrow, testes, kidney, liver and whole body is lower than the value of effective dose to organs recommended by the international tolerable limits of 1.0 mSv annually which further stress that the radiation levels do not constitute any immediate health effect on residents of the area except on excessive exposure.

Conclusion

This work targeted to unveil the danger associated with exposure to radiation on human organs as a result of topological settings of southern Borno. Data in milli Roentgen per hour (mR/hr) were converted to exposure dose rate in micro Sivert per hour (μSv/hr), from exposure dose rate in micro Sivert per hour (μSv/hr) to Annual Effective Dose Rate in milli Sivert per year (mSv/yr), from Annual Effective Dose Rate in milli Sivert per year(mSv/yr) to Excess Lifetime Cancer Risk and also lastly, from Annual Effective Dose Rate in milli Sivert per year (mSv/yr) to Annual Effective Dose Rate to Organs in milli Sivert per year (mSv/yr). From the findings presented, it can be concluded that the background radiation in different local governments of southern Borno is not an issue of health concern except when accumulated by the public over a long period of time which may cause cancer to the members of public on getting themselves to seventy years of consistent and regular exposure. It is therefore, advised or recommended that the government encourage regular researches of such for easy control of the health effects.

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