8.	JEDDO ZONE	0.013±0.005	1.12±0.45	116.60±40.38	0.14±0.06	0.50±0.20
TOTAL MEAN		**0.015±0.004**	**1.26±0.32**	**129.82±32.98**	**0.16±0.04**	**0.56±0.14**
WORLD STANDARD		**0.013**	**1.00**	**59.00**	**0.07**	**0.29**

Table 10: Comparison of estimated Effective dose rate to different organs and tissues and ICRP recommendation.

Organs	Lung	Ovary	Bone marrow	Testes	Kidney	Liver	Whole Body
ICRP 1996, UNSCEAR, 2000 Recommendation	0.64	0.58	0.69	0.82	0.62	0.42	0.68
D_{organ} ($mSvy^{-1}$)	0.08	0.07	0.09	0.10	0.08	0.06	0.09

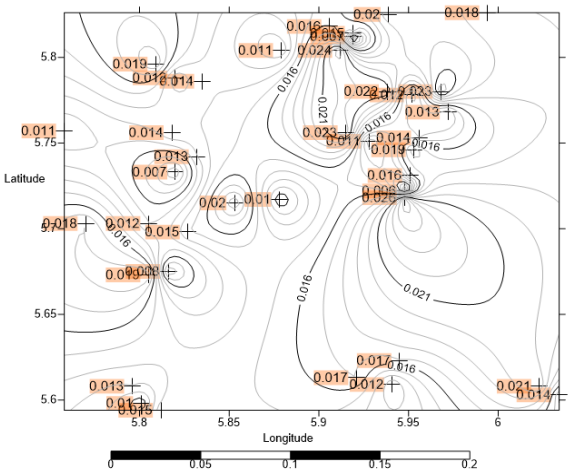

Figure 2: GIS contour map of the study area showing sampled points with BIR exposure rate

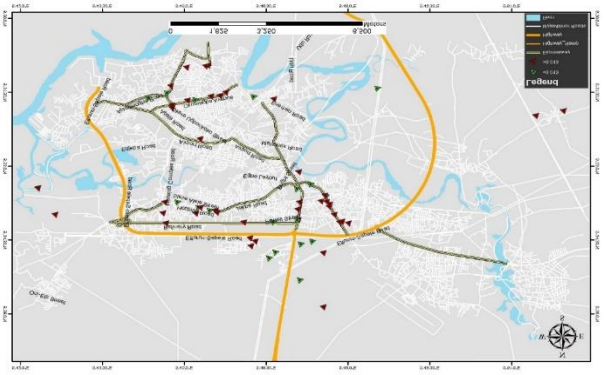

Figure 3: GIS map of the sampled area showing sampled points with BIR exposure rate within and above world normal BIR level ($0.013mRh^{-1}$)

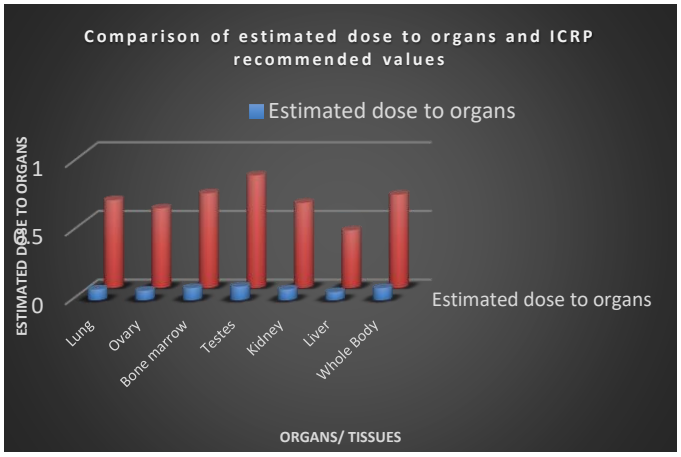

Figure 4: Comparison of estimated dose to organs and ICRP recommended standard

3.2 Discussion of Results

The obtained values of the measured background ionizing radiation levels and their computed radiological risk parameters for the eight delineated regions that were grouped within Warri metropolis for this research convenience are presented in Tables 1-8 while Table 10 present the summary of the results obtained. It has been proven that to arrive at an unbiased, reliable and fair conclusion on radiological health side-effect status to human in a given radiation enveloped environment or an irradiated population, the following five radiation hazard indices are used as tools: equivalent dose, absorbed dose rate, annual effective dose equivalent, excess lifetime cancer risk and effective dose to different organs.

3.2.1 Background Ionizing Radiation (BIR) Levels

The obtained values of the BIR levels measured as presented in column 4 of Tables 1-8 in the eight regions that constitute the study area show that in Sapele road region (1) along the East-West road, the BIR levels ranged from $0.009mRh^{-1}$ NNPC filling station at Mofor to $0.020mRh^{-1}$ in FEJIKEV gas station, with a mean exposure rate of $0.015\pm0.003mRh^{-1}$. In the Enerhen region (2), the BIR levels ranged from $0.011mRh^{-1}$ to $0.023mRh^{-1}$ with a mean value of $0.014\pm0.004mRh^{-1}$. The BIR levels ranged from $0.011mRh^{-1}$ to $0.017mRh^{-1}$ with a mean value 0.014 ± 0.002 at the Water resources region (3), while in the Ajamogha region (4), the exposure levels ranged from $0.012mRh^{-1}$ to $0.019mRh^{-1}$ with a mean value of $0.016\pm0.002mRh^{-1}$. The mean exposure values for the Effurun region (5), the refinery-Ekpan region (6), the PTI region (7) and the Jeddo region (8) are $0.014\pm0.003mRh^{-1}$, $0.016\pm0.005mRh^{-1}$, $0.017\pm0.006mRh^{-1}$, and $0.013\pm0.005mRh^{-1}$ respectively. The mean values obtained in all the regions except at Jeddo region are above the world ambient BIR levels of $0.013mRh^{-1}$, which indicates that the exposure levels in most of the stations in Warri metropolis are elevated. The values obtained in the filling stations are comparable to previously reported values in oil and gas installations environment, but they are slightly higher than values previously reported in Warri metropolis *(Agbalagba, 2017; Agbalagba et al., 2009, Agbalagba and Meindiyo, 2010; Avwiri and Agbalagba, 2012)*. The mean BIR level of $0.013\pm0.005mRh^{-1}$ obtained at Jeddo region may be attributed to the abandonment of most of the fuel filling stations where readings are obtained while some of them are out of stock of products at the time of the study. Figures 2 and 3 show the contour and GIS map of the assessed radiation levels in the study area, they revealed at a glance that the BIR level exceeded the worldwide average in most of the sample sites. The elevation in the BIR level in most of fuel stations can be attributed to the emission of γ-ray from the dispensed fuel and gas as readings were taken while fuel is being dispensed and when gas are being filled at the stations. These obtained exposure levels are comparable to values reported in literatures in some cities of Nigeria and in some regions and countries of the World *(Farai and Jibiri, 2000; Akpabia et al., 2005; Avwiri et al., 2007a; Sadiq and Agba, 2011; Ramli et al., 2014; Osimobi et al,. 2015; Chikasawa et. al.2001; Clouvas, et al. 2004; Erees et al. 2006; Senthilkumar et al. 2010; Rafique et al. 2013; Rafique 2013)*.

3.2.2 Equivalent Dose Rate

When exposed to ionizing radiation, it is appropriate to evaluate the dose rate to the entire body per year, in line with the National Council on Radiation Protection recommendation *(NCRP, 1993; Avwiri et al., 2013)*.

Using the National Council on Radiation Protection and measurements recommendation:

$$1.0\ mRh^{-1} = \frac{0.96\times24\times365}{100}\ \text{mSvy}^{-1} \quad (2)$$

Column 5 of Tables 1-8 present the estimated whole body equivalent dose rate. The results obtained show mean values of 1.22±0.28 $mSvy^{-1}$ for the Sapele road region, 1.19±0.36 $mSvy^{-1}$ in Enerhen region, 1.20±0.19 $mSvy^{-1}$ in Water Resources region and 1.38±0.20 $mSvy^{-1}$ for Ajamogha region. The obtained values for the Effurun, Refinery-Ekpan, PTI and Jeddo regions are 1.17±0.24 $mSvy^{-1}$, 1.33±0.40 $mSvy^{-1}$, 1.44±0.48 $mSvy^{-1}$ and 1.12±0.45 $mSvy^{-1}$ respectively. The computed equivalent dose rates obtained for the eight regions are well above the standard permissible limit of 1.0mSvy^{-1} recommended as safe for the global society. The values when compared with previous research findings from hydrocarbon and crude covered laden and contaminated environment, shows a strong correlation which suggested that these gas and petroleum filling stations are radiologically contaminated, but higher than values reported in urban environment of some regions and countries of the world *(Arogunjo et al, 2004; Akpabio et al., 2005; Avwiri et al., 2007a; Agbalagba and Meindiyo, 2010; Avwiri and Agbalagba, 2012; Avwiri, et al., 2013; Osimobi et al., 2015; Agbalagba, 2017; Chikassawa et al., 2001; Erees et al., 2006; Clouvas et al., 2013; Rafique et al., 2013)*.

3.2.3 Absorbed Dose Rate

The external exposure rate data obtained for the BIR levels were used for the evaluation of the absorbed dose rates nGyh^{-1} using the conversion factor *(Rafique et al., 2014)*:

$$1\mu Rh^{-1} = 8.7\eta Gyh^{-1} = 8.7x10^{-9}\mu Gy\ x\ 8760\ y^{-1} = 76.212\ \mu Gyy^{-1} \quad (3)$$

The results of the Columns 6 of the absorbed dose rates at the dispensing stations for the eight regions/ districts are presented in Tables 1-8. The obtained results indicates a mean value of 126.20±29.20 $nGyh^{-1}$ for Sapele road region (East-West road), 122.89±37.02 $nGyh^{-1}$ for Enerhen region, 123.54±20.14 $nGyh^{-1}$ for Water Resources region and 142.68±21.02 $nGyh^{-1}$ for Ajamogha region. The obtained values for the fuel, DPK, Gasoline and gas filling and dispensing stations in Effurun, Refinery-Ekpan, PTI and Jeddo regions are 120.71±24.77 $nGyh^{-1}$, 137.03±41.67 $nGyh^{-1}$, 148.9±49.63 $nGyh^{-1}$ and 116.60±40.38 $nGyh^{-1}$ respectively, and an overall mean absorbed dose rate value of 129.82±32.98 $nGyh^{-1}$. The obtained mean gamma absorbed dose rate of the studied sites is lower than the 143.55±52.20 ηGyh^{-1} reported in coal mining environment in Nigeria and the 141.30 ± 31.31 nGyh^{-1} earlier reported in Warri metropolis but higher than the 81.61 $nGyh^{-1}$ values of absorbed dose previously reported for Muzaffarabad city, 102.70 $nGyh^{-1}$ for Poonch in Turkey, 78.30 $nGyh^{-1}$ also in the City of Turkey and 32 $nGyh^{-1}$ for Greece *(Clouvas et al., 2004; Erees et al., 2006; Rafique, 2013; Rafique et al., 2014; Agbalagba et al., 2016; Agbalagba, 2017).* They are also higher than the values reported in some of the countries of the world as documented in the *UNSCEAR* report (*UNSCEAR, 2000)*. These countries include New Zealand (20 $nGyh^{-1}$), the United States (38n $nGyh^{-1}$), the United Kingdom (60 $nGyh^{-1}$), Poland (67 $nGyh^{-1}$), Norway (80 $nGyh^{-1}$), china (100 $nGyh^{-1}$), Portugal (102 $nGyh^{-1}$), and Italy (105 $nGyh^{-1}$). However, the gamma dose rates obtained in the study area agrees with the range of values reported in turkey (78.30-135.70 $nGyh^{-1}$) and lower than the maximum value of 509.38nGyh^{-1} reported in Japan *(UNSCEAR, 2000)*. The mean value of 129.82±32.98 $nGyh^{-1}$ obtained in studied is 2.20 magnitude higher than the world population weighted average gamma dose rate value of 59 $nGyh^{-1}$, which an indication that the environments where these refined natural mineral resources are dispensed for use are radiologically polluted.

3.2.4 The Annual Effective Dose Equivalent (AEDE)

The annual effective dose equivalent (AEDE) received by the stations attendants who spend an average of twelve hours per day dispensing fuel and gases were calculated from the absorbed dose rates, dose conversion factor of 0.75Sv/Gy recommended by UNSCEAR for the conversion coefficient from the absorbed dose in air received by adults and an occupancy factor of 0.2 for outdoor exposure. The annual effective dose equivalent was evaluated using the equation *(UNSCEAR, 2000)*:

$$AEDE\ (outdoor)\ (mSvy^{-1}) = Absorbed\ dose\ (nGyh^{-1})x1.2264 \times 10^{-3} \quad (4)$$

The computed annual effective dose equivalent shows a mean value of 0.16±0.011 $mSvy^{-1}$ for the Sapele road region, 0.15±0.05 $mSvy^{-1}$ for the Enerhen region, 0.15±0.02 $mSvy^{-1}$ for Water Resources region and 0.17±0.03 $mSvy^{-1}$ for the Ajamogha region. For the Effurun, Refinery-Ekpan, PTI and Jeddo regions, the estimated values for the annual effective dose equivalent are 0.15±0.03$mSvy^{-1}$, 0.17±0.05$mSvy^{-1}$, 0.18±0.06$mSvy^{-1}$ and 0.14±0.06 $mSvy^{-1}$ respectively, with an overall mean value of 0.16±0.04 $mSvy^{-1}$. The annual effective dose equivalent values obtained are comparable to the values reported in Al-Rakkah, Saudi Arabia *(Al Mugren, 2015).* The values obtained in this study are well above the world average annual effective dose level of 0.07 $mSvy^{-1}$for outdoor environment which is an indication of radiological contamination of the studied environment *(UNSCEAR 2000; Amekudzie et al., 2011; Al Mugren, 2015).* The inhalation of the elevated level of ionizing radiation (radon gas) emitted from the dispensed petroleum products and cooking gas by these attendants can lead to lung cancer from accumulated doses *(Ademola and Onyema, 2014).*

3.2.5 Excess Lifetime Cancer Risk (ELCR)

The Excess Life Cancer Risk estimates the likelihood of contacting cancer over a lifetime period at a specific exposure rate in a given population of persons. The excess lifetime cancer risk (ELCR) was estimated based on the computed values of AEDE using the equation:

$$\text{ELCR} = \text{AEDE} \times \text{average duration life (DL)} \times \text{risk factor (RF)} \quad (5)$$

Where AEDE, represent the annual effective dose equivalent, DL, is the duration of life (70years) and RF is the fatal cancer risk factor (Sv^{-1}). For low dose background radiation which is considered to produce stochastic effects, ICPR 60 uses a fatal cancer risk factor value of 0.05 for public exposure. The mean estimated excess lifetime cancer risk (ELCR) values are 0.55±0.12, 0.53±0.17, 0.53±0.08 and 0.61±0.09 for the Sapele road, Enerhen, Water Resources and Ajamogha regions respectively. While the mean values for the Effurun, Refinery-Ekpan, PTI and Jeddo regions are 0.52±0.10, 0.60±0.18, 0.64±0.2 and 0.50±0.20, respectively with an overall mean excess lifetime cancer risk (ELCR) of 0.56±0.14. The average ELCR value obtained in the current study area is less than the world average value of 0.29×10^{-3}. This ELCR value obtained indicates a likelihood of contracting cancer by workers at these fuel and gas dispensing stations of the study area is insignificant.

3.2.6 Effective Dose Rate (D_{Organ}) to Different Body Organs and Tissues

The model of the annual effective dose to organs estimates the amount of radiation intake by a person that accumulates in various body organs and tissues. The effective dose rate to a particular organ can be estimated using the relation *(Rafique et al., 2014; Agbalagba, 2017; Ekong et al., 2019).*

$$D_{organ}\ (mSvy^{-1}) = O\ x\ AEDE\ x\ F \quad (6)$$

Where AEDE is annual effective dose, O represent the occupancy factor which have a value of 0.8 and F stands for the conversion factor for organ dose from ingestion whose values for different organs and tissues are presented in Table 10, with the F values as reported by ICRP. Seven organs and tissues were examined as presented in Table 10, the results as presented in Figure 4 show that the testes received the highest dose with an average value of 0.10mSvy^{-1} while the liver received the lowest dose with a value of 0.06mSvy^{-1}. The estimated doses to the different organs examined revealed that values were considerably below the international tolerable limits of 1.0 mSv annually. The relatively higher dose to the testes and low dose intake to the liver is justified by the absorption rate of the organs (Agbalagba, 2017). This result shows that the exposure to BIR levels around fuel/gas dispensing stations in Warri city contributions to the radiation dose to these organs in adults are insignificant.

The overall results show moderate elevation of the BIR exposure level

equivalent dose rate, absorbed dose rate and annual effective dose equivalent of the studied environment over previous study carried out within the Metropolis and other parts of the world. However, these values obtained from the study may not constitute any immediate health risk for the populace especially fuel/gas attendants working for long periods (more than eight hours per day over a period of 30 years) in these stations.

4. Conclusion

The study of the Terrestrial background ionizing radiation around selected fuel/gas dispensing stations Warri city to estimate the radiological implications cum the associated excess lifetime cancer risk has been conducted. The following conclusions and recommendations were reached from the present study:

- The study revealed that the background ionizing radiation levels around fuel/gas dispensing stations of the study area exceeded normal BIR levels, thus the environments around fuel and gas dispensing stations have be impacted radiologically.
- The elevation of the BIR levels above the world ambient level of $0.013Rh^{-1}$ was attributed to the presence of the fossil fuel in the environment.
- Three out of the five risk parameters examined exceeded global levels and the world ambient radiation permissible limit for the public of $1.0mSvy^{-1}$ reported by (UNSCEAR, 2000; ICRP. 1996). The calculated excess lifetime cancer risk and the exposure dose rate to the adult organs investigated are insignificant. Thus, the elevated values may not constitute any immediate health risk to the stations attendants.
- However, the attendants of these dispensing outlets are cautioned against prolonged exposure to avoid future accumulative health risks.
- Periodic monitoring of these study sites for BIR status is recommended.

References

Ademola, J.A., Onyema, U.C., 2014. Assessment of natural radionuclides in fly ash produced at Orji River thermal Power Station, Nigeria and the associated radiological impact. Nat Sci 6, 752–759. doi:10.4236/ns.2014.610075

Agbalagba, E.O., Meindinyo, R.K., 2010. Radiological Impact of Oil Spilled Environment: A Case Study of the Eriemu Well 13 and 19 Oil Spillage in Ughelli Region of Delta State, Nigeria. Indian Journal of Science and Technology, 2, 1001-1005.

Agbalagba, E.O., 2017. Assessment Of Excess Lifetime Cancer Risk From Gamma Radiation Levels In Effurun And Warri City Of Delta State, Nigeria. Journal of Taibah University for Science http://dx.doi.org/10.1016/j.jtusci.2016.03.007

Agbalagba, E.O., Avwiri, G.O., Chad-Umoreh, Y.E., 2013. Radiological Impact of Oil and Gas Activities in Selected Oil Fields in Production Land Area of Delta State. Nigeria. Journal of Applied Science Environmental Management, 17(3), 279-288.

Agbalagba, E.O., Awviri, G.O., Chad- Umoren, Y.E., 2009. Occupational radiation profile of oil and gas facilities during production and off-production periods in Ughelli, Nigeria. Facta Universitis; Working and Living Environmental Protection, 6(1), 11-19.

Agbalagba, E.O., Osimobi, J.C., Avwiri, G.O., 2016. Excess lifetime cancer risk from measured background ionizing radiation levels in active coal mines sites and environment. Springer: Environmental Process, 3, 895-908. DOI 10.1007/s40710-016-0173-z

Aigbedion, I., Iyayi, S.E. 2007. Radiation studies. International Journal of Physical Sciences, 2, 33-38.

Akpabio, L.E., Etuk, E.S., Essian, K., 2005. Environmental radioactive levels in Ikot Ekpene Nigeria. Nig J. Space Res, 1, 80-87.

Al Mugren, K.S., 2015. Assessment of natural radioactivity levels and radiation dose rate in some soil samples from historical area, Al-Rakkah, Saudi Arabia. Natural Science, 7, 238-247.

Amekudzie, A., Emi-Reynolds, G., Faanu, A., Darko, E.O., Awudu, A.R., Adukpo, O., Quaye, L.A.N., Kpordzro, R., Agyemang, B., Ibrahim, A., 2011. Natural radioactivity concentration and dose assessment in shore sediments along the coast of Greater Accra, Ghana. World Applied Science Journal, 13(11), 2338-2343.

Arongunjo, A.M., Farai, I.P., Fuwape, I.A., 2004. Impact of oil and gas industrial to the natural radioactivity distribution in the delta region of Nigeria. Nig. J. Phys., 16, 131-136.

Avwiri, G.O., Egieya, J.F., Chinyere, P.O., 2013. Radiometric survey of Aluu landfill, in Rivers State, Nigeria. Adv Phys Theories Appl., 22, 24–30.

Avwiri, G.O., Agbalagba, E.O., 2012. Studies on the radiological impact of oil and gas activities in Oil Mineral Lease 30 (OML3) oil fields in Delta State, Nigeria. J. Petroleum Environ. Biotechnology, 3 (2), 1-8. www.omicsonline.org/21577463/pdfdownload.php?download

Avwiri, G.O., Agbalagba, E.O., Enyinna, P.I., 2007. Terrestrial radiation around oil and gas facilities in Ughelli Nigeria. Asian Network for Science Information. J. Applied Sci., 7(11), 1543-1546.

Avwiri, G.O., Egieya, J.F., Chinyere, P.O., 2013. Radiometric Survey of Aluu Landfill, In Rivers State, Nigeria. Advances in Physics Theories and Applications, 22, 24-30.

Ayaji, N.O., Laogun, A.A., 2006. Variation of environmental gamma radiation in Benin with vertical height. Nig. J. Space Res., 2, 47-54.

Chad-Umoren, Y.E., 2012. Ionizing Radiation Profile of the Hydrocarbon Belt of Nigeria *in* Mitsuru Nenoi (Editor): Current Topics in Ionizing Radiation Research, InTech Publications, Janeza Trdine 9, 51000 Rijeka, Croatia. ISBN 978-953-51-0196-3

Chikasssawa, K., Ishil, T., Sugiyama, H., 2001. Terrestrial gamma radiation in Kochi Prefecture, Japan. Journal of Health Science, 47(4), 362-372.

Clouvas, A., Xianthos, S., Antonopoulos-Domis, M., 2004. Radiological map of outdoor and indoor gamma dose rates in Greek urban areas obtained by *insitu* gamma spectrometry. Radiation Protection Dosimetry, 112(2), 267-275.

Diab, H.M., Nouh, S.A., Hamdy, A., El- Fiki, S.A., 2008. Evaluation of natural radioactivity in a cultivated area around a fertilizer factory. J. Nucl. and Rad. Phys., 3(1), 53- 62.

Ekong, G., Akpa, T., Umaru, I., Lumbi, W., Akpanowo, M., Nsikak, G., 2019. Assessment of Radiological Hazard Indices from Exposures to Background Ionizing Radiation Measurements in South-South Nigeria. International Journal of Environmental Monitoring and Analysis, 7 (2), 40-47. doi: 10.11648/j.ijema.20190702.11

Erees, F.S., Akozcan, S., Parlak, Y., Cam, S., 2006 Assessment of dose rates around Manisa (Turkey). Radiation Measurement, 41(5), 593-601.

Farai, I.P., Jibiri, N.N., 2000. Baseline studies of terrestrial outdoor gamma dose rate levels in Nigeria. Radiat. Prot. Dosim., 88, 247-254.

ICRP, (International Commission on Radiological Protection), 1996. Age - dependent doses to members of the public from intake of radionuclides. Part5: Compilation of ingestion and inhalation coefficients ICR Publication 72, Oxford: Pergamon Press.

Kabir, K.A., Islam, S.A.M., Rahman, M.M., 2009. Distribution of radionuclides in surface soil and bottom sediment in the district of Jessore, Bangladesh and evaluation of radiation hazard. Journal of Bangladesh Academic of Sci., 33(1), 117- 130.

Murugesan, S., Mullainathan, S., Ramasamy, V., Meenakshisundaram, V., 2011. Radioactivity and radiation hazard assessment of Cauvery River, Tamilnadu, India. Iran. J. Radiat. Res., 8(4), 211-222.

National Council on Radiation Protection and Measurements (NCRP), 1993. Limitation of exposure to ionizing radiation, NCRP report No.116. March Nobel, B.J 1990. An introduction to radiation protection, Macmillan family Encyclopedia 2nd Ed. Pp. 16-118.

National Research Council (NRC), 2006. BEIR VII PHASE 2. Health risks from exposure to low levels of ionizing radiation. National Research Council of the National Academics. Washington D.C. The National Academics Press, ISBN 0-309-53040-7.

Nigeria Population Commission (NPC), 2010. Population distribution by

age and sex. Federal Republic of Nigeria 2006, Population and housing census. Priority Table. Volume IV.

Ononugbo, C.P., Avwiri, G.O., Agbalagba, E.O., 2017. Radioactivity pollution and excess lifetime cancer risk due to gamma exposure of soil and ground water around open landfills in Rivers State, Nigeria. Canadian Journal of Pure and Applied Sciences, 11(1), 4121-4130.

Osimobi, J.C., Agbalagba, E.O., Avwiri, G.O., Ononugbo, C.P., 2015. GIS Mapping and Back- ground Ionizing Radiation (BIR) Assessment of Solid Mineral Mining Sites in Enugu State, Nigeria. Open Access Library Journal, 2, e1979, http://dx.doi.org/10.4236/oalib.1101979

Rafique, M., Basharat, M., Azhar Saeed, R., Rahamn, S., 2013. Effects of geological and altitude on the ambient outdoor gamma dose rates in district Poonch, Azad Kashmir. Carpathian Journal of Earth and Environmental Sciences, 8(4), 165-173.

Rafique, M., 2013. Ambient indoor/ outdoor gamma radiation dose rates in the city and at high altitudes of Muzaffarabad (Azad Kashmir). Environmental Earth Sciences, 70(4), 1783-1790.

Rafique, M., Saeed, U.R., Muhammad, B., Wajid, A., Iftikhar, A., Khursheed, A.L., Khalil A.M., 2014. Evaluation of excess life time cancer risk from gamma dose rates in Jhelum valley. Journal of Radiation Research and Applied Science, 7, 29-35.

Ramli, T., Aliyu, A.S., Agba, E.H., Saleh, M.A., 2014. Effective dose from natural background radiation in Keffi and Akwanga towns, central Nigeria. Int J Radiat Res., 12(1), 234–239.

Sadiq, A.A., Agba, E.H., 2011. Background radiation in Akwanga, Nigeria. Facta Univ, Ser: Work Living Environ Prot, 8(1), 7–11.

Senthilkumar, B., Dhavamani, V., Ramkuma, S., Philominathan, P., 2010. Measurement of gamma radiation levels in soil samples from Thanjavur, using γ- ray spectrometry and estimation of population exposure. J. Med. Phys., 35, 48- 53.

Taskin, H., Karavus, M., Ay, P., Topuzoghi, A., Hindiroglu, S., Karaha, G., 2009. Radionuclide concentrations in soil and lifetime cancer risk due to the gamma radioactivity in Kirklareli. Turkey Journal of Environmental Radioactivity, 100, 49- 53.

UNSCEAR. (United Nationals, Sources and Effects of Atomic Radiation), 2000. Sources and effects of ionizing radiation. United Nations Scientific Committee on the effect of atomic radiation, Report to the General Assemble, Annex B exposure from natural radiation sources. United Nations, New York.

WHO. (World Health Organization), 1993. Guideline for drinking water quality; measurement of natural and artificial radioactivity in powder milk corresponding Annual Effective Dose Radiation Protection Vol.1 Recommendations Geneva.

Zaid, Q.A., Khled, M.A., Anas, M.A., Abdalmajeid, M.A., 2010. Measurement of Natural and Artificial radioactivity in Powder Milk corresponding Annual Effective Dose. Radiation Protection Dosimetry, 138 (3), 278 – 283.

Zarie, K.A., Al Mugren, K.S., 2010. Measurement of natural radioactivity and assessment of radiation hazard in soil samples from Tayma area (KSA). Isotope and Rad. Res., 42(1), 1- 9.