# EVALUATION OF RADIATION RISK INDICATORS DUE TO EXPOSURES IN BUILDING MATERIALS SALES OUTLETS IN UYO, AKWA IBOM STATE, NIGERIA

WOJAST
ISSN: 2141 – 3290
www.wojast.com

**ESSIEN, I.. E., EKOTT, E. E., UMOH, U. A. AND OKONKWO, N. J**
*Department of Physics, University of Uyo, Nigeria*
*imeessien27@yahoo.com*

## ABSTRACT

Radionuclides and their isotopes contaminate our environment and could cause deleterious health risk on human beings when ingested or inhaled. The occupational risk due to the contamination from building materials sale outlets in Uyo, Akwa Ibom State, Nigeria was evaluated. In situ-method of measurement of gamma exposure was conducted with a radiation survey meter which measured the exposures in micro Seviert per hour. Eighteen outlets, with six outlets each for cements, tiles and timber in different building materials markets in Uyo were included in the study. The mean exposure obtained from cement shops was 0.14±0.02 µSv/h and the calculated mean annual effective dose rate was 0.25± 0.03 mSv/yr. For tiles shops the mean exposure was 0.12±0.02 µSv/h, the corresponding mean annual effective dose rate 0.21±0.07 mSv/yr respectively. Results show low values for timbers shops where the mean measured exposure of 0.10±0.02 µSv/h, and corresponding mean annual effective dose rate of 0.17±0.05 mSv/yr. The measured background radiation exposure at 10 meters away from the markets, and the calculated annual effective dose rate were 0.06µSv/h and 0.11mSv/yr respectively. The results show a significant increase in background ionising radiation at the markets but is the effective dose rate is below the acceptable safe dose limit of 1mSv/yr. Hence the occupational risk for the workers within the sales outlets is tolerable. However the sales person should not stay indoors of the stores for a longer time to avoid stochastic effect

## INTRODUCTION

Our environment is continuously bombarded by ionising radiation from terrestrial and artificial sources, with its effects on human beings and environment. The naturally occurring radioactive materials (NORMs) which are the chief producers of the ionising radiation are found in soils and rocks and are mostly potassium, thorium, uranium, radium and their associated decayed radionuclides. These NORMs come to the soil surface from human activities and also transferred into the soil through infiltration process (Taskin, *et al.,* 2009, Kessaratikoon and Awaekechi, 2008) and also transferred to plants which is one of the pathways through which radioactive materials get to man in food chain (NCRP ,1987).

It is also established from various studies that these NORM are also present in building materials such as, stones, sand, gravel, cement, concrete, brick, tiles, wood, gypsum, granites etc (Alharbi *et al.,* 2011, Akhar, 2005), clay soils and river sediments (Ramasammy *et al.,* 2009), quarry sites, waste dumpsites (Essien and Akpan 2016, Essien and Essiet 2016). (Akinloye and Olomo 2005) established that vegetation in an environmental field in Nigeria contains traces of radionuclides and (Inyang et al 2009) measured radiation emission from timbers from the forest in Northern Cross River State sold in the timber markets in Calabar, Nigeria. In some parts of Nigeria, a number of authors have reported measurements of both outdoor and indoor gamma radiation exposure levels from building materials sale outlets and seen in the literatures (Iwanbot *et al.*, 2014, Jibiri and Obarhua 2013, Inyang, *et al.,* 2016).

In this study, the risk indicators considered are exposure and annual effective dose rate from the building materials such as, cements, tiles and timbers in the building material sales outlets in building materials sales outlets in Akwa Ibom State, Nigeria.

## MATERIALS AND METHOD

### Study Sites

The building materials sales outlets considered for this study are in the central building material markets in Uyo metropolis. These building materials sales outlets are located in Ifa Ikot Okpon timber market, Uyo, Akwa Ibom State, Nigeria.

### Sampling Procedure

The preliminary studies included visitation to the markets and identification of the shop owners. The authors explained to the shop owners the importance of this investigation and a few who accepted were investigated. Information from the shop owners on the sources of the materials show that, the timbers were locally procured from the forests within the state and some from Cross River State and forest in neighbouring countries like the Republic of Cameroun. The tiles and cement were also locally procured from manufacturers in Nigeria. The timbers are kept in piles in open space and inside the shops while tiles are stored in cartons inside the shops and cements in bags and occasionally brought out for sales during sales period. The shops investigated were coded as CSA, CSB, CSC, CSD, CDE and CSF for cements shops (A-F), similarly tiles shops TS(A-F) and timbers shops WS(A-F). The authors did not take into consideration the brands of the cements and the tiles (nor their manufacturers) and timbers, because exposure levels from brands of material was not our concern. The terrestrial radiation exposure was evaluated by direct measurement with a radiation survey meter.

### Exposure Measurement

In situ method of measurement of the exposure level was carried out using Radex (RD 1212) radiation survey meter which measured radiation absorbed dose rate in micro Sievert per hour (μSv/h) both indoors and outdoors. For effective monitoring, the radiation meter was placed at the gonad level of 1m above ground level with the window of the meter directed towards the piles of timbers, cartons of tiles and bags of cements respectively and 10 readings taken in different directions in each shop and the mean recorded. Again background radiation was also measured in five different locations at 10 m away from each of the shop. Measurements of exposure levels in this investigation were taken in the afternoon between 1000 hours and 1700 hours for effective response of the meter to environmental radiation exposures within Calabar (Inyang *et al.*, 2009).

### Calculation of Risk Indicator

The exposure (σ) measured in μSv/h is converted to annual effective dose E in mSv/yr according to equation 1 ((UNSCEAR 2000, Gupta and Chauhan 2011, Awiri *et al.*, 2013)

$$E(mSv/yr) = \sigma(\mu Sv/h) \times 10hrs \times 312days \times 0.8 \times 0.7 \times 10^{-3} \qquad 1$$

The annual effective dose rate E per year received by the sales person is obtained from equation 1 as they are expected to work in these shops between 7 am to 5pm for 6 days a week, with 0.8 the indoor occupancy factor and 0.7 the conversion factor from exposure rate to effective dose rate .

## RESULTS

The results of the measured exposure and the calculated effective dose rate from the building material sales outlets investigated are presented in Tables 1-3. Table 1 show an exposure range of 0.13 to 0.15 μSv/h with mean measured exposure of 0.14±0.02μSv/h and the mean calculated annual effective dose rate of 0.25±0.03 mSv/yr was obtained from cement shops.

Table 1: Mean exposure and E (mSv/yr) for Cement shops.

| S/N | Site Code | Mean σ (µSv/h) | E (mSv/yr) |
|---|---|---|---|
| 1 | CSA | 0.13 | 0.23 |
| 2 | CSB | 0.14 | 0.25 |
| 3 | CSC | 0.15 | 0.26 |
| 4 | CSD | 0.13 | 0.23 |
| 5 | CSE | 0.14 | 0.25 |
| 6 | CSF | 0.14 | 0.25 |

Table 2 shows the results for tiles shops that the exposure range of (0.10-0.14) µSv/h with mean exposure of 0.12 ± 0.02 µSv/h and the mean E (mSv/yr) is 0.21± 0.07 mSv/yr, while the result obtained from Timber shops show the mean exposure of 0.01±0.02µSv/h and the corresponding effective dose rate is 0.17±0.05 mSv/yr and presented in Table 3.

Table 2: Mean exposure and E (mSv/yr) for Tiles shops

| S/N | Site Code | Mean σ (µSv/h) | E (mSv/yr) |
|---|---|---|---|
| 1 | TSA | 0.12 | 0.21 |
| 2 | TSB | 0.10 | 0.18 |
| 3 | TSC | 0.14 | 0.25 |
| 4 | TSD | 0.11 | 0.19 |
| 5 | TSE | 0.13 | 0.23 |
| 6 | TSF | 0.12 | 0.21 |

Table 3: Mean exposure and E (mSv/yr) for Timber shops

| S/N | Site Code | Mean σ (µSv/h) | E (mSv/yr) |
|---|---|---|---|
| 1 | WSA | 0.13 | 0.23 |
| 2 | WSB | 0.14 | 0.25 |
| 3 | WSC | 0.15 | 0.26 |
| 4 | WSD | 0.13 | 0.23 |
| 5 | WSE | 0.14 | 0.25 |
| 6 | WSF | 0.14 | 0.25 |

To verify for a possible rise in the environmental radiation due to the operation in the building materials market the background radiation was measured at 10 m away from the sales outlets. The background radiation recorded a mean exposure of 0.06 µSv/h and the consequent effective dose rate of 0.105 mSv/yr.

## DISCUSSION

The knowledge of radiation levels within building material industries and its sales outlets is necessary to properly guide shop owners, industry workers, the public and regulators on the potential radiation health risks because the presence of these building materials could raise radiation level above the natural background radiation level of 1.0 mSv/yr as indicated by radiation regulatory authorities (ICRP, 2007).

The aim of this investigation was to determine the contribution of these building materials to the background radiation of the environment and the consequent effective dose rate. The environment considered are the outdoors and indoors in the house built with these materials. Therefore knowledge of these radiation risk indicator is necessary as a screening tool to determine if these materials could be used in bulk for building of houses. This is because these building materials could contribute to the internal inhalation of radiation exposure due to Radon-222 and its short lived decay products.

The results presented in Tables 1-3 show that the measured mean exposure is higher than the natural background radiation of the environment with cement (60 %) and tiles (57.1%) shops contributing the highest value and timbers (45.5%) presenting the least value. This shows that there is residual radioactivity in these materials, for cements and tiles it could be from the presence of TENORM or radionuclides in the raw material used in manufacturing it (Jibiri and

Obarhua 2013). The exposure from timber shops could be from the residual radionuclide transferred into the timber from the soil in the forest as these soils are rich in NORMS (Uwah and Inyang, 1998)

The distribution of the annual effective dose rate in shows a mean annual effective dose rate for the 18 sites to be 0.21 mSv/yr with cement contributing the highest mean annual effective dose rate of 0.24 mSv/yr, tiles contribute 0.21 mSv/yr and timber 0.17 mSv/yr the least. The mean annual absorbed dose rate obtained for this work is less than 0.65 mSv/yr obtained for cement sales outlets in Kaduna State, Nigeria (Abdullahi *et al.,* 2014)

The calculated annual effective dose rate from the measured exposure are presented in Tables 1-3 shows that E within the sales outlets is higher than the background values. The indoor radiation is the radiation dose irradiating the store and sales attendants as they interact often indoors and with those in the cement and tiles shops most affected because these materials are mostly stored indoors. There is variation between the annual effective dose obtained by (Inyang *et al.,* 2009) for timbers in Calabar, Nigeria and the results from this work. Analysing the results in the tables it could be noted that despite the high dose of total E none is higher than the ICRP recommended value of 1 mSv/yr, a limit for the public and lower than the 20 mSv/yr occupational dose limit (Iwanbot *et al.,* 2014) . The E values (outdoor) is lower than those obtained in similar investigation elsewhere (Jibiri and Obarhua 2013), This could be as a result of variations in the nature of the places where these building materials are obtained as it is reported that precipitation, humus and vegetation of the forest where timbers are sourced could affect the seasonal dose rate of the gamma radiation (Holmes and Adams, 1993). The mean total AEDR for both indoor and outdoor obtained for the study area is 0.68 mSv/yr which exceed the background radiation by 0.31 mSv/yr. This shows that the building materials raised the background radiation by over 50%. This excess gamma radiation falls within the 0.3 – 1.0 mSv/yr which is recommended that regulatory controls be exercised. Secondly the value of the excess gamma radiation is higher than the 0.3mSv recommended for building materials as safety limit in the EC guidelines (EC, 1999) again controls required for the safety of the salesperson. The probable regulatory measure is that the salesperson should spend less period a day in the shop, probably 60 hours a week throughout 50 weeks in a year in order to limit the exposure level (Jibiri and Obarhua 2013.). In addition, if these building materials are used in bulk in building houses it is expected the house should be highly ventilated to guard against the radon inhalation. However, the situation is not too bad as the radiological risk indicator is below the internationally acceptable safety limit of 1.0 mSv/yr

## CONCLUSION AND RECOMMENDATION

The radiation exposure levels in some building materials in sales outlets in Uyo metropolis, Nigeria have been carried out in order to assess the radiological implications to the salesmen and saleswomen and the public. The results for this study show that the radiological risk indicator evaluated were within the acceptable safe limits of 1mSv/yr for the public and the excess effective dose from the building materials was within the 0.3 – 1 mSv/yr . This indicates that these building materials may not pose any significant radiation hazard to the sales persons and public in the short term period. However it is recommended that workers in these sales outlets should put in less working hours and the members of the public living in houses built with these materials should design the building with adequate sources of ventilation .

## REFERENCES

Abdullahi, M. A., Abdukarim, M. S. and Abdullahi, N. K. (2014). Contributions of building materials to background dose in Nigeria. International journal of Engineering Science invention, 3(11), 56-58

Alharbi, W. R., Alzahrani, J. H., and Abbady, A. G. 2011: Assessment of radiation hazards indices from granite rocks of Southern Arabian shield, Kingdom of Saudi Arabia. *Australian Journal of Basic and Applied Sciences*, 5(6): 672-682

Akhtar, N., Tufail, M. and Ashraf, M. (2005). Natural environmental radioactivity and estimation of radiation exposure for saline soils. *International Journal of Environmental Sciences and Technology*, 1(4): 279-285

Akinloye, M.K., Olomo J. B. (2005): The radioactivity in some grasses in environment of nuclear research facilities located within the Obafemi Awolowo University, Ile-Ife, Nigeria. Nigerian Journal of Physics. 17: 219-225

Essien, I. E. and Akpan, (2016). Evaluation of Radiological Hazards Indices Due to Radioactivity in Quarry Sites in Itu, Akwa Ibom State, Nigeria. *International Journal of Scientific Research in Environmental Sciences*, 4(3): 0071-0077

Essien, I. E. and Essiett, A. A. (2016). Investigation of radiological Hazards Indices within Uyo Metropolis Central Dumpsites, Akwa Ibom State, Nigeria. *International Journal of Scientific Research Publications*, 6(5): 687-691

Etuk, S. E., George, N. J., Essien, I. E. and Nwokolo, S. C. (2015). Assessment of radiation exposure levels within Ikot Akpaden Campus of Akwa Ibom State University, Nigeria. *IOSR Journal of Applied Physics*, 7(3): 86-91

Gupta, M. and Chauhan, R. P. (2011). Estimating radiation dose from building materials. *Iran Journal of Radiation Research*, 9(3): 187-194

Holmes–Siodle, A. and Adams, L. (1993). *Handbook of Radiation Effects*. Oxford University Press, 469p

ICRP (2007). *Recommendation of the International Commission on Radiological Protection*, ICRP Publication 103, Pergamon Press Oxford

Inyang, S. O., Inyang, I. S. and Egbe, N. O. (2009). Radiation exposure levels within timber industries in Calabar, Nigeria. *Journal of Medical Physics*, 34(2): 97-100.

Iwanbot, D. I., Izam, M. M. and Nyam, G. G. (2014). Indoor and outdoor gamma dose rate exposure levels in major commercial building materials distribution outlets in Jos Plateau State, Nigeria. *Asian Review of Environmental and Earth Sciences*, 1(1): 5-7

Jibiri, N. N. and Obarhua, (2013). Indoor and outdoor gamma dose rate exposure levels in major commercial building materials distribution outlets and their radiological implication to occupants in Ibadan, Nigeria. *Journal of Natural Sciences Research*, 25-31

NCRP (1987). *Exposure of the Population of the United States and Canada from Natural Background Radiation*. National Council on Radiation Protection and Measurements Report no. 94. Bethesda:

NNRA (2006). *Radiation safety regulations 2006: Radiotherapy, Nuclear medicine and Diagnostic Radiology*. Nigerian Nuclear Regulatory Authority. Federal Government of Nigeria

Ramasamy, V., Suresh, G., Meenakshisundaram, V. and Gajendran V. (2009). Evaluation of natural radionuclide content in river sediments and excess lifetime cancer risk due to gamma radioactivity. *Research Journal of Environmental and Earth Sciences*, 1(1): 6-10

Taskin, H.M, Karavus, P., Touzogh, S., Hindiroglu and Karaham, G. (2009). Radionuclide concentration in soil and lifetime cancer risk due to the gamma radioactivity in Kirklareli, Turkey. *Journal of Environmental Radioactivity*, 100: 49-50

UNSCEAR (2000). *Sources and Effect of Ionising Radiation*. United Nations Scientific Committee on the Effects of Atomic Radiations. New York

Uwah, E. J. and Inyang, S O. (1998). Studies of environmental radioactivity levels in Calabar. *Global Journal of Pure and Applied Sciences*; 4:187-190.