DETERMINATION OF BACKGROUND IONIZATION RADIATION (BIR) LEVELS IN SOME SELECTED FARMS IN DELTA STATE, NIGERIA

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In-situ background ionization radiation (BIR) level in 25 farms spread across the local government areas of Delta State, Nigeria was measured using a FOS 2011+ radiation metre, with reading accuracy of 0.001. The precise positions of the locations were determined using a geographical positioning device (GPS). Results show that the BIR levels range from 0.008 – 0.014 mRh^{-1}, with a mean of 0.009 ± 0.0004 mRh^{-1}. Three (12 %) of the studied farm lands have radiation levels higher than the 0.013 mRh^{-1}recommended by the ICRP. The mean values of the radiation health parameters obtained are 7.19 $mGyy^{-1}$, 3.78 $mSvy^{-1}$ and 12.46 x 10^{-3} for dose rate, annual equivalent dose and excess life-time cancer risk, each of which is higher than the corresponding internationally recommended value of 1.0 mGy^{-1}, 1. 0 $mSvy^{-1}$ and 0.29 x 10^{-3} respectively. It is suggested that there should be an immediate monitoring and regulatory action by the relevant radiation protection authorities.

Key words: Background ionization radiation, farms, Delta State, immediate monitoring.

INTRODUCTION

Natural radiation is inseparable from the terrestrial environment. The public therefore is continuously exposed. This exposure is traceable to natural as well as anthropogenic sources (Agbalagba and Meindinyo, 2010). In soils alone, the notable sources of radioactivity include: Uranium-238/ ^{238}U, Thorium-232/^{232}Th and Potassium-40/^{40}K (ClueBot, 2016).

One of the roles of radiation protection bodies is to ensure that this exposure of the public does not exceed certain safe limits as set up from time to time by these regulatory agencies. With the current world slump in oil prices, a major alternative of income generation is farming. Activities involved and inputs are more likely to increase the radiation levels in the environments where the farms are located. Such activities include radiation production of high yielding and viable seeds and radiation preservation/curing of agricultural products (Nuclear Energy Institute NEI, 2016).

It is therefore important that before these additions, baseline data be provided. These will provide bases for assessing any additions following any manmade/artificial activity. Besides, a section of the population is either involved in the farming activities or domiciled in the immediate environments where the farms are located. Human health laws demand that these are adequately protected. This work therefore investigates the background ionization radiation levels in selected farms scattered over the 25 local government areas of Delta State. It is expected that the number of farms will increase in the coming months in the State for obvious reasons. This apparently pioneering measurement thus aims at providing baseline data of background radiation in the environments. The data can be used to assess the radiological health status of the population now and besides they will clearly reveal further and future additions.

MATERIALS AND METHODS

The natural background ionization (BIR) levels in 25 selected farms spread across the 25 local government areas of Delta State, Nigeria were measured. A portable gamma radiation metre FOS 2011+ with reading accuracy of 0.001 was used. The geological map of the state showing these local governments is given in Figure 1. To be able to locate the precise positions of the studied farms (Table 1), a geographical positioning device (GPS) was employed. The determined values from farm to

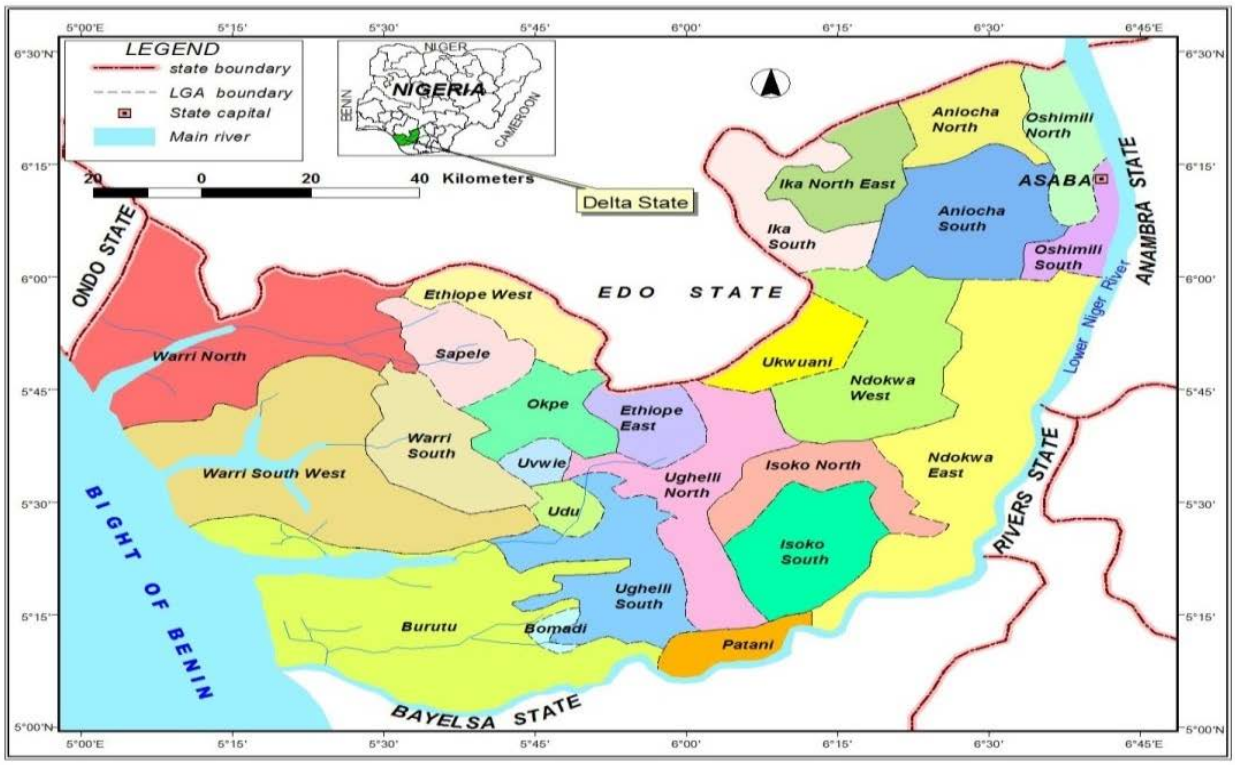

Figure 1. Geological map of Delta State (https://www.google.com.ng).

Table 1. Measured In-situ BIR Levels in Some Farms in Delta State.

S/N	Local Govt/Town	Identity	Location	Mean BIR	μSvh-1mRh-1
1	Aniocha North (Issele uku)	F001	N06° 18.01', E006° 28. 10'	0.08	0.008
2	Aniocha South (Isa Ogwashi)	F002	N06° 13.15', E006° 29. 36'	0.09	0.009
3	Bomadi (Bomadi)	F003	N05° 10.84', E005° 54. 36'	0.10	0.010
4	Burutu (Eyakromor)	F004	N05° 19.93', E005° 45. 34'	0.10	0.010
5	Ethiope East (Abraka)	F005	N05° 46.48', E006° 07. 00'	0.08	0.008
6	Ethiope West (Mosogar)	F006	N05° 54.17', E005° 45.47'	0.09	0.009
7	Ika North (Mbiri)	F007	N06° 16.70', E006° 18. 23'	0.10	0.010
8	Ika South (Agbor)	F008	N06° 115.45' E006° 10.87'	0.09	0.009
9	Isoko North (Owhelogbo)	F009	N05° 35.26', E006° 11.99'	0.09	0.009
10	Isoko South (Oleh)	F010	N05° 28.76', E006° 12.63'	0.12	0.012
11	Ndokwa East (Ase)	F011	N05° 39.14', E006° 24.42'	0.10	0.010
12	Ndokwa West (Kwale)	F012	N05° 42.51', E006° 26.09'	0.08	0.008
13	Okpe (Ugolo)	F013	N05° 35.13', E005° 50.40'	0.09	0.009
14	Oshimili North (Okpanam)	F014	N06° 13.84', E006° 38.24'	0.08	0.008
15	Oshimili South (Anwai)	F015	N06° 15.56', E006° 42.09'	0.09	0.009
16	Patani (Aven)	F016	N05° 112.94',E006° 08.67'	0.12	0.012
17	Sapele (Amukpe)	F017	N05° 50.98', E005° 44.61'	0.10	0.010
18	Udu (Udu)	F018	N05° 28.73', E005° 48.77'	0.08	0.008
19	Ughelli North (Agbarho)	F019	N05° 33.87', E005° 52.19'	0.09	0.009
20	Ughelli South (Otegbo)	F020	N05° 21.57', E005° 45.34'	0.10	0.010
21	Ukwuani (Obiaruku)	F021	N05° 48.48', E006° 07.65'	0.09	0.009
22	Uwvie (Effurun)	F022	N05° 34.12', E005° 48.33'	0.08	0.008
23	Warri North (Koko)	F023	N05° 59.85', E005° 25.85'	0.14	0.014
24	Warri South (Ifie)	F024	N05° 45.73', E005 ° 44.93'	0.09	0.009
25	Warri South West (Ogbe-ijor)	F025	N05° 28.61', E005° 44.40'	0.09	0.009

Mean= 0.09±0.004; 0.009±0.0004.

farm were compared. Each of them was also compared with the standard value recommended by the International Commission on Radiological Protection (ICRP). In carrying out the radiation measurements, the conventional practices regarding the positioning of the

radiation metre one metre above the ground level as well as indicating the time of measurement (Ebong and Alagoa, 1992 and NCRP, 1987) were followed accordingly. At least three readings were taken in each location and then the mean was noted. The measurements obtained were then related to the radiation health of the public in the immediate environments by carrying out a number of radiological health calculations using appropriate mathematical models as follows: Gamma Radiation Dose Rate, DR (UNSCEAR, 2010):

$$DR\left(mRh^{-1}\right) = 76.212\left(mGy^{-1}\right) \quad (1)$$

Annual Dose Equivalent, ADE (Pashazadeh et al., 2014):

$$ADE\left(m\,Sv\,y^{-1}\right) = \frac{DR\left(8760\,hr\;x\;0.7\;x\,0.80\right)}{365\;x\,24\,hr} \quad (2)$$

Excess Lifetime Cancer Risk, ELCR (Mangset et al., 2014):

$$ELCR = ADE\,x\,ALD\,x\,CRF \quad (3)$$

where ALD is 70 years which is the average life duration and CRF is $5x10^{-5}$ $(mSv)^{-1}$ which is the cancer risk factor. The values of the radiological health parameters so obtained were then compared with their respective internationally stipulated values. Informed deductions were then made with respect to radiological health status in the farm environments.

RESULTS AND DISCUSSION

The results of the *in-situ* measurements are presented in Table 1. Data from the Table show BIR levels ranging from 0.008 to 0.014 mRh^{-1}, with a mean of 0.009±0.0004 mRh^{-1}.This mean value was measured in 40 % of the farms investigated. The closeness of majority of these measurements seems to be in concord with the documented fact that radiation emanating from natural sources remains relatively constant with time at specific locations (UNSCEAR, 1962).

As can be seen in Figure 2 representing the inter- comparison of measured BIR values as well as comparison with ICRP standard, the highest reading was obtained from the farm identified as F023 located at Koko in Warri North Local Government Area. This may be attributable to the 1987 and 1988 radioactive toxic waste dumps in this sea port (Oritse and Bivbera, 2010; The Sun, 2014). Another striking feature of Figure 1 is the rising and falling pattern of the distribution of these measured BIR values. This radiation distribution pattern had earlier been observed in the Okpara coal mine environment (Mokobia and Balogun, 2004) as well as in some beach environments in the state (Mokobia et al., 2016).

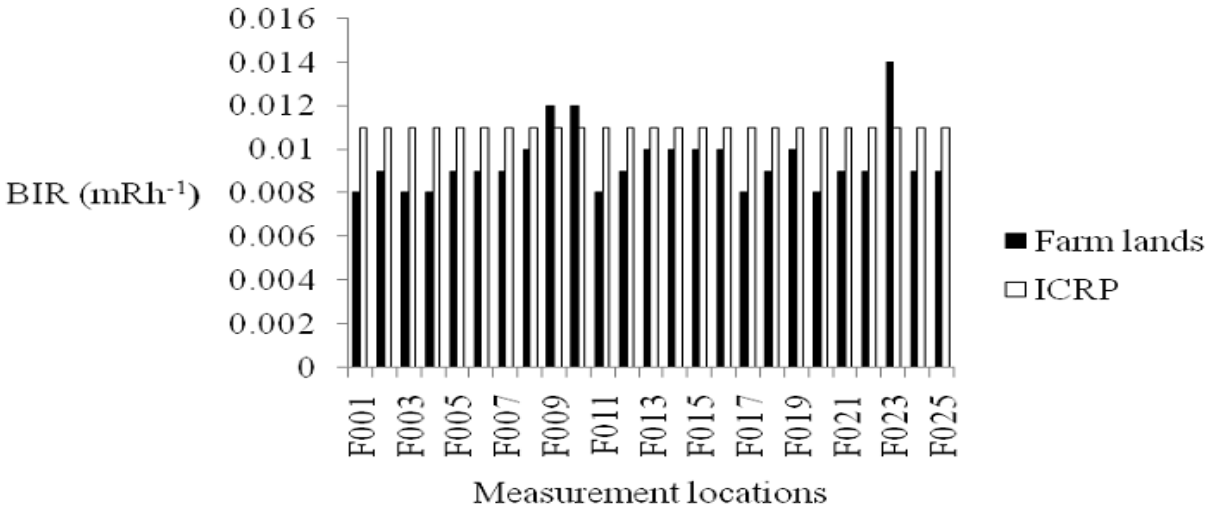

Figure 2. Inter comparison of measured BIR values and comparison with ICRP standard.

It is also observed that just three (12 %) of the studied farm lands have radiation levels higher than the 0.013 mRh^{-1}recommended by the ICRP (ICRP, 1977). Thus it can be adduced that ambient radiation levels in farms across the 25 local government areas in Delta State are in tandem with the international stipulated level. The radiation health of the population in the three areas with higher radiation levels (F009, F010 and F023) however suggests the need for immediate monitoring and regulatory actions by the relevant radiation protection authority – NNRA. The mean values of the radiation health parameters obtained (Table 2) are 7.19 $mGyy^{-1}$, 3.78 $mSvy^{-1}$ and 12.46 x 10^{-3} for DR, AEDE and ECLR respectively.

Table 2. Radiation health parameters associated with BIR levels in farms in Delta State.

Dose Rate (mGyy-1)	AEDE (mSvy-1)	Cancer Risk (x 10-3) F001
6.09696	3.200904	10.56298 F002
6.85908	3.601017	11.88336 F003
6.09696	3.200904	10.56298 F004
6.09696	3.200904	10.56298 F005
6.85908	3.601017	11.88336 F006
6.85908	3.601017	11.88336 F007
6.85908	3.601017	11.88336 F008
7.62120	4.001130	13.20373 F009
9.14544	4.801356	15.84447 F010
9.14544	4.801356	15.84447 F011
6.09696	3.200904	10.56298 F012
6.85908	3.601017	11.88336 F013
7.62120	4.001130	13.20373 F014
7.62120	4.001130	13.20373 F015
7.62120	4.001130	13.20373 F016
7.62120	4.001130	13.20373 F017
6.09696	3.200904	10.56298 F018
6.85908	3.601017	11.88336 F019
7.62120	4.001130	13.20373 F020
6.09696	3.200904	10.56298 F021
6.85908	3.601017	11.88336 F022
6.85908	3.601017	11.88336 F023
10.66968	5.601582	18.48522 F024
6.85908	3.601017	11.88336 F025
6.85908	3.601017	11.88336 Mean
7.194413	3.777067	12.46432

Each of these mean values is higher than the corresponding internationally stipulation of 1.0 mGy^{-1}, 1. 0 $mSvy^{-1}$ and 0.29 x 10^{-3}, respectively (ICRP, 1977; 1999 and Rafique et al., 2014). This is an indication of above normal exposure of the public. Specifically, the obtained mean ECLR value of 12. 46 x 10^{-3}> 0.29 x 10^{-3} recommended value implies that members of the public in the studied farm environments are likely to develop cancer within 65 to 70 years of their life-time. It is important therefore that the radiation levels in these environments and hence the state be monitored.

CONCLUSION

From these results, it is concluded that although the BIR levels in the studied farms in Delta State are generally lower than radiation regulatory stipulations, higher than normal values were observed in few of them. Besides, the estimated

radiation health parameters are higher than normal.

RECOMMENDATION

From the forgoing, it is thus recommended that the relevant radiation protection bodies such as the Nigeria Nuclear Regulatory Agency (NNRA) and the Nigeria Atomic Energy Commission (NAEC) take immediate actions so as to ensure the radiation health safety of the populace in and around these farms.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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