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The Concentration Of Natural Radionuclides In Soil Samples From The Practical Year Agricultural Farmland, University Of Ibadan

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Abstract: *A total of 48 soil samples from the University of Ibadan practical year farmland were collected and analyzed using gamma ray spectrometer in order to determine the activity concentrations of the natural radionuclides. From the activity concentrations determined, the radium equivalent activity, the external hazard index, the internal hazard index, the absorbed dose rate and the effective dose rate in the soil were evaluated. The activity concentrations and hazard indices values were less than the accepted world average values.*
Keywords- *Concentration, Gamma Exposure, Hazard Indices, Natural Radionuclides, Soil Sediments*

I. Introduction

1. Introduction

Radionuclides are found in natural surroundings, mostly in the air, soil and water. Radionuclide means type of atom that exhibits radioactivity. Each radionuclide is characterized by its own half-life, which is the time required for half of the radioactive substance to undergo spontaneous decay. It is the nucleus of atom that exhibits the properties of spontaneous disintegration. Radionuclides can be used to calculate the age of rocks and minerals using radiometric dating method. Naturally occurring radioactivity is common in the rocks and minerals as well as the soil that make up the planet. Also, they exist in the homes, building materials and so on

The concentration of the ^{235}U, ^{232}Th, and ^{40}K were varied depending on soil type, the mineral content, geological features and geological conditions. [1]; [2].These can severely affect the distribution of radionuclides in soil. Types of rocks also dictate the higher radionuclide present in it. Higher radionuclide level are mostly found in igneous rocks, such as granite and lower levels commonly with the sedimentary rocks [3].The concentration of thorium and uranium in high background radiation dose rate areas is as a result of soil developed from igneous rocks [4]. Natural radioactivity is widespread in the earth environment and it exists in various geological formations such as earth crust, rocks, soils, plants, water and air [5]. Soil radionuclide activity concentration is one of the main determinants of the natural occurring radiation. When rocks are disintegrated through natural process, radionuclides are carried to soil by rain infiltration process [6]. In addition to natural sources, soil radioactivity is also affected by man-made activities. Naturally occurring radionuclides (uranium and thorium series, etc.) are the largest contributors to radiation doses received by human beings.

Furthermore, the knowledge of the radionuclide content of soils is central to the establishment of environmental baselines for various substrates and environments [7]. Although, Farming is one of the most crucial means of survival in Nigeria back in the early centuries and it is still a prominent way of sustenance till date. Planting of crops is essential since human beings and some animals depend on plants and crops to survive. The soil where this cropping is done may be as a result of sediments of rocks or rocks that are broken down through weathering processes and transported by erosion. The mineral contents that make up the soil may have some naturally occurring radionuclides and may as well give the details about the type of rocks that comprises of the soil. To understand the pathways by which radionuclides reach humans requires an assessment of those soil properties that affect the abundance and distribution of radionuclides. In addition, continuous farming and application of fertilizers are seen to increase the distribution of radionuclides in the farm. Therefore, this research is carried out to evaluate and to analyze the concentration of natural radionuclides and the gamma exposure levels in soils from the University of Ibadan agricultural farm. The concentrations of natural radionuclides in the farm soil and their distribution across the farm will be determined and if the continuous farming has had any effect on the concentration of these radionuclides which may increase exposure levels in the area of the farm.

The aim of this study is to evaluate and analyze the distribution of the concentration of natural radionuclides and the gamma exposure levels in soils from the University of Ibadan agricultural farm. To achieve this aim, the following are the objectives of the research:

- To determine the activity concentration of ^{40}K, ^{226}Ra and ^{232}Th in the soil samples.

- To determine, relate and compare the natural level of radioactivity in the soil samples with other farms.
- To evaluate the gamma exposure level in the environment of the student practical year farm.

II. Materials and Methods

2.1 Collection of Sample and Study area

The Faculty of Agriculture is situated in the University of Ibadan. Ibadan is a city in south-western Nigeria, capital of Oyo State, located about 110 km (about 70 mi) northeast of Lagos. Ibadan is located between 7°23'47"N 3°55'0"E and 7.39639°N 3.91667°E. The total area of the land where samples were collected is about 4 (four) acres (16,187.44 m^2) from the University central mosque. It has a dimension of 270 m by 60 m, which is a farmland used for one year mandatory practical year training programme of the University of Ibadan students in the Faculty of Agriculture, opened officially in 1984 by Professor N.O. Adedipe. It enjoys a tropical climate with two distinct seasons. These are the rainy season (April – October) and the dry season (November-March). The approximate longitudes and latitudes of the area of the farm are 7°26'57.09"N and 3°53'46.70"E respectively.

Soil samples were collected at depths 0–5 cm, 5–10 cm and 10–15 cm from the surface at each point using a hand trowel. A total of 48 soil samples were collected from 16 sample points on the farm. The spacing between each sample point was about 34 m x 29 m. After collection, the wet samples, each weighing about 400 g were placed in polythene bags and carefully labelled to prevent sample mix up. Soil sampling was done in the month of May – June, 2014 from different types of soils on the farm. The samples were properly marked, catalogued and taken to Radiation and Health Physics Laboratory at the Department of Physics, University of Ibadan, Oyo State, Nigeria, for processing before analysis. The farm is in between the Parry road and the Benue –Sarapa road, the satellite map representation of the farm is shown in Figure 1.

Figure 1: The satellite view of the study area

The samples were dried at 100 ^{0}C using an oven until a constant weight was reached in order to remove moisture. The samples were crushed to powder with mortar and then sieved with a 2 mm mesh sieve to obtain homogenized sample. Thereafter, approximately 200 g of each of the samples was transferred to a cleaned, washed, uncontaminated cylindrical plastic containers of approximate uniform sizes.

The counting of radioactivity in this was carried out using a lead shield 76 mm by 76 mm NaI (Tl) detector crystal (model 802 series, Canberra Inc) coupled to a Canberra series 10plus multichannel analyzer (MCA) (model 1104) through a preamplifier.

2.2 Radioactivity Counting

The counting of each sample was carried out using 76 mm x 76 mm NaI (TI) detector coupled to a Canberra series 10 plus Multichannel Analyzer, the activity concentration was obtained using the expression:

$$A_{E_i} = \frac{N_{E_i}}{\varepsilon_{E_i} \times T \times \gamma_{E_i} \times M}$$

(1)

Where N_{Ei} is the net peak area at energy E of radionuclides, ε_{Ei} is the detection of efficiency, T is the counting time, γ_{E_i} is the number of gamma per nuclear transformation, and M is the mass in kg of the measured sample.

2.3 Evaluation of Radiological parameters
2.3.1 Annual Effective Dose

The annual effective dose rates were calculated using the expression [8]; [5] given in mSv. The purpose is to obtain the biological effect per unit of absorbed dose that vary with the type of radiation and the organ of the body. The recommended value for the public by ICRP is 1 mSv:

$$E(mSvy^{-1}) = D(nGy.h^{-1}) \times 8760(hy^{-1}) \times 0.2 \times 0.7(SvGy^{-1}) \times 10^{-6}$$

(2)

Where D is the absorbed dose rate in air, the factor 8760 is the number or hour in a year (365days), 0.2 is the outdoor occupancy factor and 0.7 $SvGy^{-1}$ is the conversion factor to convert the gamma ray absorbed dose to effective dose equivalent [5].

2.3.2 Absorbed Dose Rate in Air

This quantity is used to measure the exposure to human body in order to determine the amount of radiological hazards to humans. The absorbed dose rate at 1m above the ground (in $nGyh^{-1}$ by $Bq.kg^{-1}$) was calculated using the expression [9]; [5]:

$$D(nGy.h^{-1}) = 0.0417A_k + 0.462A_{Ra} + 0.604A_{Th} + 0.03A_{Cs}$$

(3)

Although, A_{Cs} is not considered in this research, therefore, it can be negligible.
The annual effective dose rate outdoors in units of μSvy^{-1} is calculated using the following formula:

$$Annual\ Effective\ Dose\ Rate = D \times T \times F$$

(4)

Where *D* is the calculated dose rate in ($nGy.h^{-1}$), *T* is the outdoor occupancy time (0.2 x 24h x 365.25days ≈ $1753hy^{-1}$) and *F* is the conversion factor (0.7×10^{-6} Sv Gy^{-1} [10] .

2.3.3 Radium Equivalent Activity

Radium equivalent activity is an index that has been introduced to represent the specific activity of ^{40}K, ^{232}Th and ^{226}Ra by a single quantity which takes into consideration the hazard of radiation associated with them. The equation is given in $Bq.kg^{-1}$, the Ra_{eq} expression is below:

$$Ra_{eq} = 0.077A_k + A_{Ra} + 1.43A_{Th}$$

(5)

From the above equation, it has been assumed that 4810 $Bqkg^{-1}$ of ^{40}K, 259 $Bqkg^{-1}$ of ^{232}Th and 370 $Bqkg^{-1}$ of ^{226}Ra (^{238}U) produce the same gamma dose.

2.3.4 Collective Dose Equivalent

The population size involved is important in any epidemiological study since it determines the actual number of people that are expected to suffer a given health effect. When effective dose E is multiplied by the population size N, collective effective dose S_E, is obtained [5]:

$$S_E = E \times N$$

(6)

2.3.5 Internal Radiation Hazard Index

The internal radiation hazard index formula is defined [10] as follows:

$$H_{int} = \frac{A_K}{4810} + \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} \leq 1$$

(7)

2.3.6 External radiation Hazard index

The external hazard index is obtained from Ra_{eq} expression through the supposition that its maximum allowed values corresponds to the maximum or upper limit of Ra_{eq} (370 $Bqkg^{-1}$) in order to limit the radiation dose 1.5 $mSv.y^{-1}$. This index value must be less than unity in order to keep the radiation hazard insignificant. The external hazard index is defined [10] as follows:

$$H_{ex} = \frac{A_K}{4810} + \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} \leq 1$$

(8)

2.3.7 Representative Level Index

This radiological hazard index could be calculated using:

$$I = \frac{A_K}{1500} + \frac{A_{Ra}}{150} + \frac{A_{Th}}{100}$$

(9)

2.3.8 Determination of Gamma dose rate levels in the farm

A calibrated analogue and digital survey meters were simultaneously used to determine the gamma dose rate levels at the farmland. The survey meters were placed 1m above the ground and the measurements were made. The average of the three measurements at a spot was taken as a representative gamma dose rate for that spot.

III. Results and Discussion

Determination of the radiological effects from soil samples collected at different locations on the farm were calculated using the net count.

3.1 Activity Concentration and Comparison with World range

The activity concentrations of ^{40}K, ^{226}Ra and ^{232}Th expressed in $Bqkg^{-1}$ for samples obtained from practical year agricultural farmland, University of Ibadan are presented in Table 1. The samples that were analyzed showed that ^{40}K has the highest activity value compared to the other radionuclides in the study area. The average activity concentration of the radionuclides in the soil samples was in this order $^{40}K > ^{232}Th > ^{226}Ra$. The values of ^{40}K ranged from 34.82$Bqkg^{-1}$ to 349.31 $Bqkg^{-1}$ with an average of 207.19 $Bqkg^{-1}$ while the values of ^{226}Ra ranged from BDL to 27.92 $Bqkg^{-1}$with an average of 12.46 $Bqkg^{-1}$ and the values of ^{232}Th ranged from BDL to 33.39 $Bqkg^{-1}$ with an average of 16.73 $Bqkg^{-1}$ for all the samples. Sample 12B has the highest concentration of ^{40}K as 349.32 $Bqkg^{-1}$ and ^{232}Th with the value 33.39 $Bqkg^{-1}$while sample 1A has the highest occurrence of ^{226}Ra with the value of 27.9 $Bqkg^{-1}$. Table 2 summarizes the mean values of the activity concentration of the radionuclides for each sample point. Sample 12 has the highest activity concentration of radionuclides when compared with other sample points as shown in Table 3. This could be as a result of the fact that the area of the land was kept undisturbed after it was being fertilized. Sample 15 has radionuclides with lowest activity concentrations; this could be attributed to the erosion that washes away some of the soil and radionuclides in that area of the farm.

Figure 2, 3 and 4 show the graphical representation of the activity concentration of all the samples. It can be seen in Figure 2, 3 and 4 that generally the values of the activity concentration of ^{40}K were higher in all the samples while the activity concentration of ^{226}Ra (^{238}U) and ^{232}Th were lower when compared with that of ^{40}K. This explains the fact that fertilizer application increases the concentration of ^{40}K in farm soil. If we compare the results of the activity concentration with the world average for soils, it can be observed that the average values of the activity concentrations of radionuclides in the soil samples collected are lower than the world average of 420, 33 and 45 $Bqkg^{-1}$ for ^{40}K, ^{226}Ra (^{238}U) and ^{232}Th respectively [5]. The results presented in Table 1 and Table 2 show that the activity concentration is low when compared with that of other researchers. Table 3 also gives the details of related research to which this present study was compared.

BDL- Below detection limit

3.2 Absorbed Dose

The absorbed dose in air due to the three radionuclides in the soil samples from the study area was calculated using equation 3. The absorbed dose has its highest value as 44.96$nGyh^{-1}$ which is lower than the global value of 55$nGyh^{-1}$ [5]. The average of the absorbed dose is given as 24.50$nGyh^{-1}$ which is lower than the world value. The ICRP-60(1990) recommends that any exposure above the natural background radiation should be kept as low as reasonably achievable (ALARA). Therefore, the results for the absorbed dose have no significant effect on the students working on the farm. The annual absorbed dose received due to the presence of radioactivity in the farm soil samples are presented in Tables 4,5 and 6.

Table 1: The locations and the distribution of the activity concentrations of Radionuclides in $Bqkg^{-1}$

LOCATION	Longitude	Latitude	Activity Concentration		
			^{40}K	^{226}Ra	^{232}Th
1A	3° 53' 33.92"	7° 27' 4.15"	128.26±9.31	27.92±2.24	3.26±1.27
1B	3° 53' 33.92"	7° 27' 4.15"	177.24±11.44	14.01±1.56	10.32±1.48
1C	3° 53' 33.92"	7° 27' 4.15"	163.34±10.82	22.54±1.98	12.20±1.55
2A	3° 53' 36.24"	7° 27' 02.81"	184.72±11.78	11.32±1.42	9.94±1.50
2B	3° 53' 36.24"	7° 27' 02.81"	191.01±12.06	12.61±1.48	17.41±1.76

2C	3° 53' 36.24"	7° 27' 02.81"	189.57±12.00	16.91±1.70	21.86±1.95
3A	3° 53' 38.48"	7° 27' 01.62"	149.05±10.20	18.30±1.77	7.82±1.40
3B	3° 53' 38.48"	7° 27' 01.62"	168.52±11.05	15.04±1.61	14.60±1.64
3C	3° 53' 38.48"	7° 27' 01.62"	173.11±11.26	20.84±1.90	15.08±1.66
4A	3° 53' 40.27"	7° 26' 58.99"	176.32±11.40	1.14±0.84	16.52±1.72
4B	3° 53' 40.27"	7° 26' 58.99"	169.77±11.11	4.08±1.02	24.70±2.09
4C	3° 53' 40.27"	7° 26' 58.99"	172.32±11.22	1.81±0.88	21.60±1.93
5A	3° 53' 43.32"	7° 26' 57.14"	172.39±11.22	1.60±0.87	15.27±1.67
5B	3° 53' 43.32"	7° 26' 57.14"	161.24±10.73	7.96±1.24	20.02±1.87
5C	3° 53' 43.32"	7° 26' 57.14"	212.32±13.04	10.39±1.37	23.87±2.04
6A	3° 53' 46.13"	7° 26' 55.80"	177.37±11.45	7.55±1.21	16.96±1.74
6B	3° 53' 46.13"	7° 26' 55.80"	175.87±11.38	7.08±1.19	18.47±1.80
6C	3° 53' 46.13"	7° 26' 55.80"	166.62±10.97	19.08±1.81	11.75±1.53
7A	3° 53' 48.74"	7° 26' 54.09"	234.82±14.08	13.55±1.53	22.55±1.98
7B	3° 53' 48.74"	7° 26' 54.09"	236.19±14.15	18.04±1.76	27.75±2.22
7C	3° 53' 48.74"	7° 26' 54.09"	274.74±15.96	22.23±1.97	28.01±2.23
8A	3° 53' 51.92"	7° 26' 52.34"	225.37±13.64	7.08±1.19	21.41±1.93
8B	3° 53' 51.92"	7° 26' 52.34"	229.24±13.82	23.01±2.00	23.50±2.02
8C	3° 53' 51.92"	7° 26' 52.34"	235.08±14.09	10.13±1.35	22.12±1.96
9A	3° 53' 33.98"	7° 27' 02.63"	300.65±17.20	7.24±1.19	30.93±2.37
9B	3° 53' 33.98"	7° 27' 02.63"	304.98±17.20	5.99±1.13	27.86±2.22
9C	3° 53' 33.98"	7° 27' 02.63"	331.14±18.67	16.23±1.67	25.10±2.10
10A	3° 53' 36.24"	7° 27' 01.30"	237.96±14.23	17.79±1.75	21.84±1.95
10B	3° 53' 36.24"	7° 27' 01.30"	287.60±16.58	15.77±1.65	33.33±2.49
10C	3° 53' 36.24"	7° 27' 01.30"	205.24±12.71	17.06±1.71	7.34±1.38
11A	3° 53' 38.85"	7° 26' 59.86"	332.32±18.72	22.64±1.99	32.79±2.46
11B	3° 53' 38.85"	7° 26' 59.86"	249.50±14.77	12.56±1.48	14.38±1.63
11C	3° 53' 38.85"	7° 26' 59.86"	207.60±12.81	14.11±1.56	2.29±1.25
12A	3° 53' 40.08"	7° 26' 57.29"	287.99±16.60	25.28±2.12	17.04±1.74
12B	3° 53' 40.08"	7° 26' 57.29"	349.31±19.55	22.13±1.96	33.39±2.49
12C	3° 53' 40.08"	7° 26' 57.29"	301.04±17.22	9.10±1.30	31.10±2.38
13A	3° 53' 43.04"	7° 26' 55.65"	180.72±11.60	7.03±1.18	2.38±1.25
13B	3° 53' 43.04"	7° 26' 55.65"	248.97±14.75	19.70±1.84	19.85±1.86
13C	3° 53' 43.04"	7° 26' 55.65"	162.95±10.80	6.51±1.16	2.79±1.26
14A	3° 53' 45.85"	7° 26' 53.60"	155.80±10.49	6.57±1.16	14.26±1.63
14B	3° 53' 45.85"	7° 26' 53.60"	170.16±11.12	6.82±1.17	2.57±1.25
14C	3° 53' 45.85"	7° 26' 53.60"	239.21±14.29	6.93±1.18	16.80±1.73
15A	3° 53' 48.32"	7° 26' 52.07"	34.82±6.00	4.65±1.05	3.48±1.27
15B	3° 53' 48.32"	7° 26' 52.07"	60.72±6.76	4.76±1.06	4.19±1.29
15C	3° 53' 48.32"	7° 26' 52.07"	36.52±6.04	4.70±1.05	1.43±1.22
16A	3° 53' 51.22"	7° 26' 50.38"	201.51±12.54	10.50±1.37	5.23±1.32
16B	3° 53' 51.22"	7° 26' 50.38"	275.41±15.99	9.57±1.32	15.42±1.68
16C	3° 53' 51.22"	7° 26' 50.38"	238.49±14.25	10.03±1.35	10.32±1.48
Mean±Std			207.19±68.28	12.46±6.82	16.73±9.20

Table 2 Mean of the activity concentration of the natural radionuclides in $Bqkg^{-1}$

Sample	^{40}K	^{226}Ra	^{232}Th
1	156.28±10.52	21.49±1.93	8.60±1.43
2	188.43±11.95	13.61±153	16.40±1.74
3	163.56±10.84	18.06±1.76	12.50±1.57
4	172.81±11.24	2.34±0.91	20.94±1.91
5	181.99±11.66	6.65±1.16	19.72±1.86
6	173.29±11.27	11.24±1.40	15.72±1.69
7	248.59±14.73	17.94±1.75	26.11±2.14
8	229.9±13.85	13.41±1.51	22.35±1.97
9	312.26±17.69	9.82±1.33	27.96±2.23
10	243.60±14.51	16.87±1.70	20.84±1.94
11	263.14±15.43	16.44±1.68	16.49±1.78
12	312.78±17.79	18.84±1.79	27.18±2.20
13	197.55±12.38	11.08±1.39	8.34±1.46
14	188.39±11.97	6.77±1.17	11.21±1.54
15	44.02±6.27	4.71±1.05	3.03±1.26
16	238.47±14.26	10.03±1.35	10.32±1.49
Mean±Std	207.19±68.28	12.46±6.82	16.73±9.20

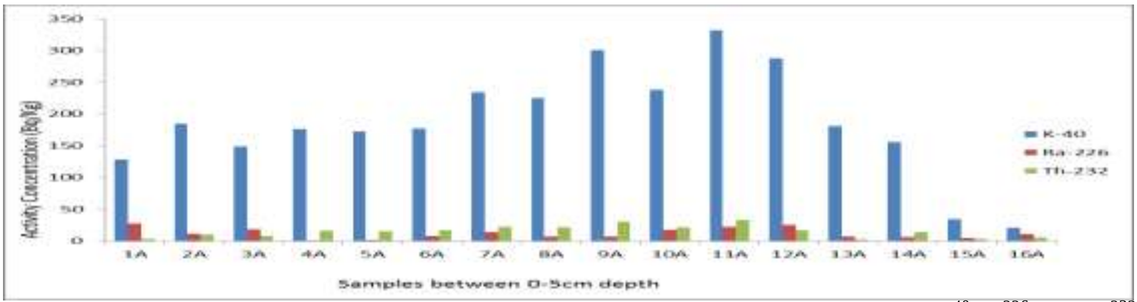

Figure 2 Graphical representation of the spatial distribution of the activity concentration of ^{40}K, ^{226}Ra and ^{232}Th between 0-5cm depths

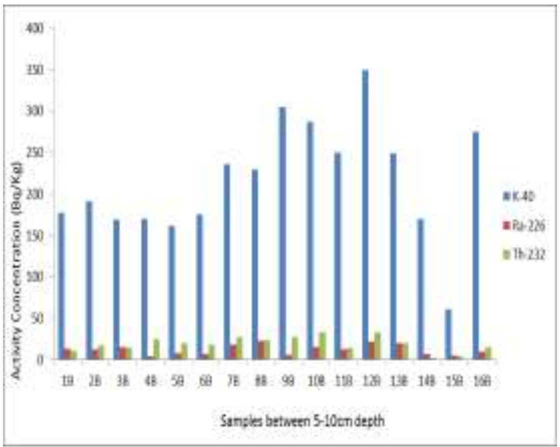

Figure 3 Graphical representation of the spatial distribution of the activity concentration of ^{40}K, ^{226}Ra and ^{232}Th between 5-10cm depths.

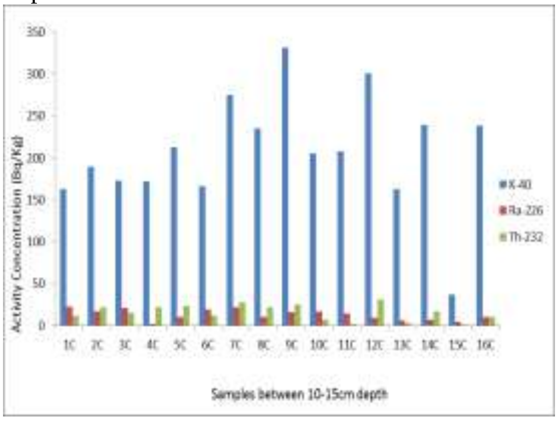

Figure 4 Graphical representation of the spatial distribution of the activity concentration of ^{40}K, ^{226}Ra and ^{232}Th between 10-15cm depths.

Table 3: The Comparison of natural radioactivity levels in soil samples under investigation with those in other countries

Region of Study	^{232}Th	^{226}Ra	^{40}K	Reference
Spain	6.9-205	14-174	63-1648	[11]
Spain	13-85	20-748	317-730	[12]
United States	~37	~39	-	[13]
Cyprus	<4-40	13-41	317-602	[14]
Italy	74-86	59-74	602-792	[15]
Denmark	17	19	460	[5]
Syrian	20	20	270	[5]
U.I	16.73	12.46	207.19	This Study
World Average	45	33	420	[5]

Table 4: Radiological hazard indices of soil samples from faculty of Agriculture's farm between 0-5cm

Samples	Absorbed Dose(nGyh^{-1})	Annual Effective dose(mSv)	Ra_{eq}(Bq/kg)	H_{ex}	H_{int}	I
1A	20.22	0.025	42.46	0.11	0.19	0.30
2A	18.93	0.023	39.75	0.11	0.14	0.30
3A	19.39	0.024	40.96	0.11	0.16	0.30
4A	17.86	0.022	38.34	0.10	0.11	0.29
5A	17.15	0.021	36.71	0.01	0.10	0.28
6A	21.13	0.026	45.45	0.12	0.14	0.34
7A	29.67	0.036	63.87	0.17	0.21	0.47
8A	25.61	0.031	55.08	0.15	0.17	0.41
9A	34.56	0.042	74.62	0.20	0.22	0.56
10A	31.33	0.038	67.33	0.18	0.23	0.50
11A	44.12	0.054	95.12	0.26	0.32	0.70
12A	33.98	0.042	71.83	0.19	0.26	0.53
13A	12.22	0.015	24.34	0.07	0.08	0.19
14A	18.14	0.022	38.95	0.11	0.12	0.29
15A	5.70	0.007	12.31	0.03	0.05	0.09
16A	16.41	0.020	33.49	0.09	0.12	0.26
Mean±Std deviation	23.33±9.86	0.029±0.012	49.81±21.40	0.13±0.07	0.17±0.07	0.37±0.15

Table 5: Radiological hazard indices of soil samples from faculty of Agriculture's farm between 5-10cm

Samples	Absorbed Dose(nGyh^{-1})	Annual Effective dose(mSv)	Ra_{eq}(Bq/kg)	H_{ex}	H_{int}	I
1B	20.10	0.025	42.42	0.11	0.15	0.31
2B	24.31	0.030	52.23	0.14	0.17	0.39
3B	22.80	0.028	48.90	0.13	0.17	0.36
4B	23.89	0.029	52.49	0.14	0.15	0.39
5B	22.50	0.028	49.01	0.13	0.15	0.36
6B	21.76	0.027	47.03	0.13	0.15	0.35
7B	34.95	0.043	75.92	0.21	0.25	0.56
8B	34.38	0.042	74.26	0.20	0.26	0.54
9B	32.32	0.040	69.32	0.19	0.20	0.52
10B	39.41	0.048	85.57	0.23	0.27	0.63
11B	24.90	0.031	52.35	0.14	0.18	0.40
12B	44.96	0.055	96.77	0.26	0.32	0.71
13B	31.47	0.039	67.25	0.18	0.23	0.50
14B	11.80	0.015	23.60	0.06	0.08	0.18
15B	7.26	0.009	15.42	0.04	0.05	0.11
16B	25.22	0.031	52.82	0.14	0.17	0.40
Mean±Std deviation	26.38±9.64	0.032±0.012	56.59±21.10	0.15±0.06	0.18±0.07	0.42±0.15

Table 6: Radiological hazard indices of soil samples from faculty of Agriculture's farm between 10-15cm

Samples	Absorbed Dose(nGyh^{-1})	Annual Effective dose(mSv)	Ra_{eq}(Bq/kg)	H_{ex}	H_{int}	I
1C	24.60	0.030	52.57	0.14	0.20	0.38
2C	28.92	0.035	62.76	0.17	0.21	0.46
3C	25.95	0.032	55.72	0.15	0.21	0.41
4C	21.07	0.026	45.97	0.12	0.13	0.34
5C	28.07	0.034	60.87	0.16	0.19	0.45
6C	22.86	0.028	48.71	0.13	0.18	0.36
7C	38.65	0.047	83.45	0.23	0.29	0.61
8C	27.84	0.034	59.86	0.16	0.19	0.45
9C	36.47	0.045	77.62	0.20	0.25	0.58
10C	20.88	0.026	43.37	0.12	0.16	0.32
11C	16.56	0.020	33.37	0.09	0.13	0.26
12C	35.54	0.044	76.76	0.21	0.23	0.57
13C	11.49	0.014	23.05	0.06	0.08	0.18
14C	23.33	0.029	49.38	0.13	0.15	0.37
15C	4.56	0.006	9.56	0.03	0.04	0.07
16C	20.81	0.026	43.16	0.12	0.14	0.33
Mean±Std deviation	24.22±8.88	0.03±0.01	51.63±19.52	0.14±0.05	0.17±0.06	0.38±0.14

3.3 Gamma dose rate Levels in the Farm

The environmental survey of the farm using both the digital and the analogue survey meter placed at 1m above the ground show that the gamma dose rate level in the environment is low, having its highest value as 0.18±0.01 µSv/h and its lowest value as 0.06±0.01 µSv/h for the analogue survey meter. This compared well with digital which is 0.14±0.01 and 0.04±0.01 representing the highest and the lowest value for the digital survey meter respectively. These signify no radiological hazard to the farmers and personnel working on the farm (study area). The table for this result is as presented in Table 7.

3.4 Annual Effective Dose

The annual effective dose received due to the presence of radioactivity in soil samples collected were calculated using equation 4. The maximum value of radioactivity in the soil samples is 0.055mSvy^{-1} while the minimum is 0.006mSvy^{-1}. The average mean for all the samples is 0.030mSvy^{-1}. The mean value is lower than the recommended value of 1mSv by ICRP for the general public.

3.5 Radium Equivalent Activity

Radium equivalent activity was calculated using equation 5. The radium equivalent concentration for the soil samples ranged between 9.56 to 96.77Bqkg^{-1} with a mean value 52.34 Bqkg^{-1}. The result was presented in Table 4, 5 and 6. It can be observed that the result obtained from these calculations were lower than the recommended maximum value of 370Bqkg^{-1} [5].

Table 7: Survey Meter measurement

Selected points	Analogue measurement	Digital measurement
	Radiation level (µSv/h)	Radiation level (µSv/h)
1	0.13±0.01	0.09±0.01
2	0.08±0.01	0.07±0.01

3	0.10±0.01	0.07±0.01
4	0.13±0.01	0.11±0.01
5	0.10±0.01	0.13±0.01
6	0.10±0.01	0.14±0.01
7	0.18±0.01	0.11±0.01
8	0.08±0.01	0.1±0.01
9	0.06±0.01	0.14±0.01
10	0.08±0.01	0.1±0.01
11	0.10±0.01	0.09±0.01
12	0.13±0.01	0.08±0.01
13	0.13±0.01	0.07±0.01
14	0.15±0.01	0.13±0.01
15	0.08±0.01	0.08±0.01
16	0.16±0.01	0.1±0.01
17	0.13±0.01	0.08±0.01
18	0.15±0.01	0.08±0.01
19	0.13±0.01	0.04±0.01
20	0.12±0.01	0.12±0.01
21	0.14±0.01	0.1±0.01
22	0.11±0.01	0.06±0.01
23	0.11±0.01	0.07±0.01
24	0.1±0.01	0.11±0.01
25	0.1±0.01	0.11±0.01
26	0.13±0.01	0.07±0.01
27	0.08±0.01	0.07±0.01
28	0.12±0.01	0.08±0.01
29	0.1±0.01	0.09±0.01
30	0.15±0.01	0.1±0.01
Average	0.12±0.01	0.10±0.01

3.6 External Hazard Index and Internal Hazard Index

The external hazard index and the internal hazard index were both calculated from the activity concentrations of the soil samples. The result presented in Table 4, 5 and 6 show that the minimum value and maximum value for the external hazard are 0.03 and 0.26 respectively. The result for the internal hazard has its minimum at 0.04 and its maximum value at 0.32. The mean averages for both internal and external hazard dose are 0.17 and 0.14 respectively. These results showed that there is insignificant radiation effect on farmers or students working on the farm and that the farm soil is appropriate for any further use of the soil on the farm since the values obtained are less than unity.

IV. Conclusion

4. Conclusion

The activities of the radionuclides of the student practical year farm give rise to an effective dose equivalent value lower than the world's soil average value. The health burden due to natural background radiation from the soils on the farmers (students) is low and hence carries insignificant health hazards.

The values of external hazard index (H_{ex}) and internal hazard index (H_{in}) were equally lower than acceptable limit of unity therefore the radiation risk from these soils are seen to be insignificant.

References

[1]. H Florou, and P. Kritidis, Gamma Radiation Measurements and Dose rate in The Coastal Areas of Island, Aegean sea, Greece. *Journal of Radiation protection Dosimetry, 45,* 1992, 227-279.

[2]. A. T Ramli , Environmental Terrestrial Gamma Radiation Dose and Its Relationship with Soil type and Radiation Isotope and Underlying Geological Formation in Pontain District, Malaysia, *Journal of Applied Radiation and Isotopes, 48,* 1997, 407-412.

[3]. M Tzortzis, H. Tsertos, S. Christofides, and G. Christodoulides, Gamma ray Measurements of Naturally occurring Radioactive Samples from Cyprus Characteristic Geological Rocks, *Radiation Measurements, 37,* 2003, 221-229

[4]. E Larsen, and D. Gottfried , Uranium and Thorium in Elected site of Igneous Rock, *American Journal of science, 258,* 1960, 151-169.

[5]. UNSCEAR United Nation Scientific Committee on the Effect of Atomic Radiation, Sources, Effects and Risks of Ionizing Radiation. *UNSCEAR publication: Report to the General Assembly, New York (1),* 2000.

[6]. H.M Taskin, P. Karavus, A. Ay, S. Touzogh , Hindiroglu, and G. Karaham, Radionuclide Concentration in Soil and Lifetime Cancer Risk Due to the Gamma Radioactivity in Kirklareli, Turkey, *Journal of environmental radioactivity, 100,* 2009, 49-53.

[7]. C Jordan, J.G. Cruickshank , A.J. Higgins, and K.P. Hamil, The soil Geochemical Atlas of Northern Ireland. *Department of Agriculture for Northern Ireland. Belfast.UK* 1997.

[8]. ICRP International Commission on Radiological Protection, Recommendations of the International Commission on Radiological Protection. *ICRP publication 60, Annuals of the ICRP* 21 (1-30). Pergamon press, Oxford, 1990.

[9]. H.L Beck, L. Decompo, and C. Gogolack,. In-situ Ge(Li) and Na(Tl) Gamma ray Spectrometry. USA HASL-758, 1972.

[10]. A El-Taher, M.A.M. Uosif, and A. Orabi, Natural Radioactivity Levels and Radiation Hazard indices in Granite from Aswan to Wadi El- Allaqi South Eastern Desert – Egypt. *Radiatio. Protection Dosimetry 124 (2),* 2007, 148-154.

[11]. A Baeza, M. Del-Rio, and C. Miro, Natural Radioactivity in Soils of the Province of Caceres (spain), *Radiation Protection Dosimetry, 45(1/4),* 1994, 261-263.

[12]. A Martinez- Aguirre, and M. Garcia- Leon , Radioactivity Impact of Phosphate ore Processing in a Wet Marshland in Southwestern Spain. *Journal of Environmental Radioactivity, 34,* 1997, 45-47.
[13]. T.E Myrick, B.A. Berven , and F.F. Haywood, Determination of Concentration of Selected Radionuclides in Surface Soil in the U.S. *Health Physics 45930,* 1983, 631-642.
[14]. M Tzortzis, and H. Tsertos, Determination of Thorium, Uranium and Potassium Elemental Concentrations in Surface Soils in Cyprus. *Department of Physics, University of Cyrus, P.O. Box 20537, 1678 Nicosia, Cyprus,*2004a.
[15]. S Bellia, M. Brai, S. Hauser, P. Puccio, S. Rizzo, Natural Radioactivity in a Volcanic Island Ustca , Southhern Italy. *Appl. Radt. Isot. 48,* 1997, 287-293.