

MEASUREMENT OF THE ACTIVITY CONCENTRATION IN FLUTED PUMPKIN (*Telfairia occidentalis*) SAMPLES FROM SELECTED LOCAL GOVERNMENT AREAS IN AKWA IBOM STATE, NIGERIA.

Osadebamwen Isaac EHIWE¹, Mfon U. BASSEY², Aniesua Akpan ESSIET³,
Imaobong ESSEN⁴

¹Department of Physics, Ritman University, Ikot Ekpene, Akwa Ibom State

²Department of Chemistry, Ritman University, Ikot Ekpene, Akwa Ibom State

³Department of Physics, University of Uyo, Akwa Ibom State

⁴Department of Science Technology, Akwa Ibom State Polytechnic, Akwa Ibom State.

Corresponding Author's Emails: osadebamwen.ghiwe@ritmanuniversity.edu.ng
bassey.mfon@ritmanuniversity.edu.ng

ABSTRACT

The main aim of this study is to measure the activity concentration in fluted pumpkin samples in selected Local Government Area in Akwa Ibom State. A total of 18 pumpkin leaf samples were collected, samples, at each sampling location, the soil surface was cleared of stones, pebbles, vegetation and roots. The samples were then ground to powdery form, sieved and then weighed. The prepared samples were taken to National Institute of Radiation Protection and Research in University of Ibadan for analysis. The activity concentration of naturally occurring radionuclides in edible plants and their corresponding soil samples were measured using a High Purity Germanium (HPGe) Detector. Activity concentration of potassium (^{40}K) ranged from 805.28 ± 42.89 to $1582.93 \pm 83.72\text{Bq/Kg}$. The range of AC for ^{238}U was between BDL to $86.96 \pm 5.63\text{Bq/Kg}$, while AC of ^{232}Th ranged from 4.81 ± 0.84 and $65.32 \pm 3.59\text{Bq/Kg}$. Activity concentration of ^{226}Ra ranged between 6.90 ± 0.81 and $28.23 \pm 2.03\text{Bq/Kg}$. Mean activity concentration (AC) values were $26.34 \pm 2.36\text{Bq/Kg}$, $13.80 \pm 1.22\text{Bq/Kg}$, $26.44 \pm 1.77\text{Bq/Kg}$ and $1349.58 \pm 71.35\text{Bq/Kg}$ for ^{238}U , ^{226}Ra , ^{232}Th and ^{40}K respectively. Activity concentration of ^{238}U and ^{232}Th in fluted pumpkin in this study is slightly above the world reference limit of 20Bq/kg for ^{238}U and 15Bq/kg for ^{232}Th for leafy vegetables, while that of ^{226}Ra is lower than the world mean value. For the distribution of mean AC of radionuclides in fluted pumpkin leaves from each LGA of the study area, ^{40}K is found to be the predominant radionuclide with the highest mean concentration found in Ikono LGA, while Essien Udim had the lowest mean activity concentration.

Keywords: Fluted Pumpkin leaf, Radionuclides, Health Risk, Radiation, Nigeria

1. Introduction

Human activities can lead to the introduction of natural radioactive elements. These elements are present in very low concentrations in the earth's crust and are brought to the surface through human activities such as oil and gas exploration or mining through natural processes like leakage of radon gas into the atmosphere or through dissolution in groundwater. The addition of inorganic phosphate fertilizers to soils and crops to increase crop yield is a common practice in agriculture worldwide. Phosphate rocks are starting material for the production of phosphate fertilizers. Fertilizers are considered as products of technological enhancement of natural radiation, which increase the uranium and partially thorium concentrations in the environment (Gosh *et al*, 2008). The fresh juice from-fluted pumpkin leaves have been used as a medicinal drink to help correct anemia and other ailments due to its richness in iron and vitamins (Samson and Isaac, 2019). Hematology and comparative study of fluted pumpkin leaves and seed by Samson and Isaac, 2019 also confirmed that some components such as white and red blood corpuscle were high above limits in white wister albino rats when fed with fluted pumpkin leaves combinations hence acts as blood booster that could help fight infections in human body. Fluted pumpkin (*Telfairia occidentalis*) is one of the most consumed plants in the study area. It is a tropical vine grown in West Africa. It belongs to the species "Occidentalis" and a member of the Cucurbitaceae family. The fluted pumpkin is also called fluted gourd and is known in the local language of the area as ikong-ubong. It is also popularly called uguwu in other parts of the country. Due to these benefits fluted pumpkin is highly recommended and widely consumed generally in Nigeria and more so in the study area. There is therefore need to assess the radioactive contents and possible health hazards due to its consumption. This research work involves the measurement of activity concentration in plant samples in selected Local Government Area in Akwa Ibom State,

2. Methodology

2.1 Samples Collection and Preparation

Sample sites were selected from cultivated farmlands in the study area. Some factors considered in selection of sample sites include: farmlands where highly-consumed crops were cultivated; and farmlands cultivated for both subsistence and small-scale commercial purposes. The type of pesticide used if any were noted, fertilizers used were also noted, whether organic or inorganic fertilizers. A total of 18 pumpkin leaf samples were collected, samples, at each sampling location, the soil surface was cleared of stones, pebbles, vegetation and roots. The pumpkin leaf samples collected were thoroughly washed with tap water to remove surface sand and debris (Jwanbot *et al*, 2013). The samples were then cut into small pieces and exposed to ambient air in a dust-free environment before being dried to a constant weight for 48 hours in a monitored oven maintained at 150°C in the laboratory. The samples were then ground to powdery form, sieved and then weighed. The weight of the plant samples varied between 220g and 300g.

2.2 Method for Sample Analysis

The prepared samples were taken to National Institute of Radiation Protection and Research in University of Ibadan for analysis. The activity concentration of naturally occurring radionuclides in edible plants and their corresponding soil samples were measured using a High Purity Germanium (HPGe) Detector. The HPGe used was manufactured by Canberra, model GC 8023 with serial number 9744. It is coupled to a pre amplifier, model 2002CSL with serial number 13000742. The standard source used for calibration was Multi-Gamma Ray Standard (MGS6M315). The detector has a resolution (FWHM) of 2.3Kev, ⁶⁰Co at

1.33Mev with relative efficiency of 80%. The software used for analysis was Genie 2K. For each sample, 200g was measured and poured into a 500ml Marinelli beaker. The beaker was covered with the beaker lid and sealed properly to ensure that there was no space for escape of any radioactive gas. It was left for 28 days to attain secular equilibrium before being moved to the gamma analysis room for counting. Each sample was counted for 18,000seconds. Peak analysis was then done with Genie 2000 software. Activity concentration was determined by the earlier efficiency calibration done. The radionuclides considered were ^{238}U , ^{232}Th , ^{226}Ra and ^{40}K .

2.3 Calculation of Activity Concentration

The activity concentration (AC) in unit of Bq kg^{-1} , for radionuclides with detected photo peak at energy E, was calculated from Equation 1 given by (IAEA, 1989).

$$C = \frac{N_t}{TP_r \epsilon M} \quad \text{Equation 1}$$

Where C is the activity concentration of radionuclides in Bq kg^{-1} , N_t is the net count under corresponding photo peak, T is the counting time in seconds, P_r gamma intensity of specific gamma-ray, ϵ absolute efficiency, and M mass of sample in (kg), respectively. World reference values for AC in leafy vegetables are 20 Bq/kg for ^{238}U and 15 Bq/kg for ^{232}Th (UNSCEAR, 2000).

3. Results

Table 1: Activity concentration of ^{40}K , ^{226}Ra , ^{238}U and ^{232}Th in Bq/Kg for fluted pumpkin (*Telfairia occidentalis*) samples from the study areas

LGA	Sample codes	²³⁸ U	²²⁶ Ra	²³² Th	⁹⁰ K
Abak	F1	43.16±3.75	6.91±1.63	11.43±0.94	1152.35±60.95
	F2	BDL	10.42±0.89	14.50±1.04	1694.24±89.01
	F3	16.50±1.99	8.85±0.61	9.02±0.61	1127.59±59.64
	F4	18.54±2.85	14.72±1.94	22.15±1.70	1409.71±74.57
	Mean	19.55±2.14	10.22±1.27	14.27±1.07	1345.97±71.04
Essien Udim	F5	50.47±4.08	28.23±2.03	24.10±4.08	1293.38±68.41
	F6	73.13±5.54	25.94±1.48	65.32±3.59	1499.98±79.33
	F7	50.47±4.23	21.67±1.24	49.27±2.71	1227.26±64.91
	F8	BDL	15.43±0.98	36.16±2.02	805.28±42.89
	Mean	43.52±3.46	22.82±1.43	43.71±3.10	1206.47±63.88
Etim Ekpo	F9	19.57±2.32	8.47±1.09	23.76±1.74	1605.07±84.89
	F10	9.08±1.51	6.90±0.81	28.04±1.56	1393.45±73.70
	F11	15.11±1.91	13.08±0.95	42.81±2.38	1363.62±72.12
	Mean	14.59±1.91	9.48±0.95	31.54±1.89	1454.05±76.90
	Ikot Ekpene	F12	BDL	9.48±1.36	4.81±0.84
F13		25.27±2.23	7.17±0.83	27.94±1.59	1286.69±68.05
Mean		12.64±1.12	8.33±1.09	16.37±1.21	1434.81±75.88
Ikono	F14	BDL	14.46±1.36	25.97±1.52	1538.42±81.37
Oruk Anam	F15	47.69±4.18	13.60±1.36	18.02±1.17	1260.88±66.69
	F16	18.17±2.21	13.15±1.03	17.10±1.17	1444.44±76.40
	F17	86.96±5.63	21.28±1.38	44.30±2.46	1361.34±72.00
	Mean	50.94±4.01	16.01±1.26	26.47±1.60	1355.55±71.70
Uyo	F18	BDL	8.67±1.08	11.35±0.74	1245.91±65.70
Overall Mean		26.34±2.36	13.80±1.22	26.44±1.77	1349.58±71.35

BDL= Below Detection Limit

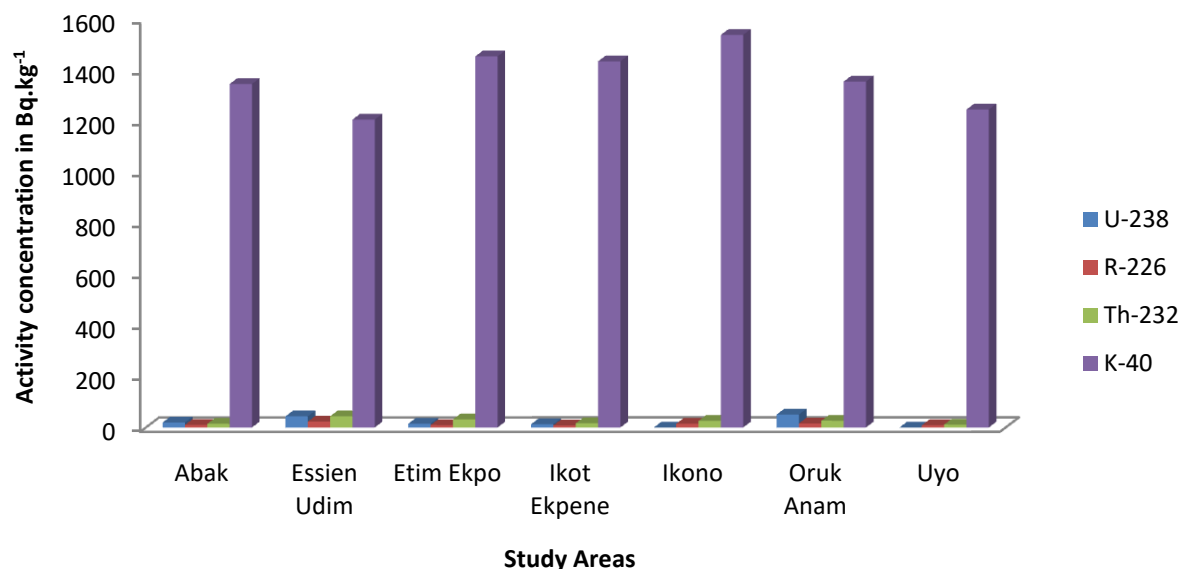


Figure 1: Distribution of the mean activity concentration in Bq/Kg of the fluted pumpkin samples from the study areas

3.1 Contour Maps

Contour maps were produced using coordinates from field data and activity concentrations from Table 1 and surfer (a contouring and 3D surface mapping software program that runs under Microsoft windows which generated contour lines). The contour maps of activity distribution of ^{238}U , ^{226}Ra , ^{232}Th and ^{40}K in fluted pumpkin in the study locations are shown in Figures 2-5.

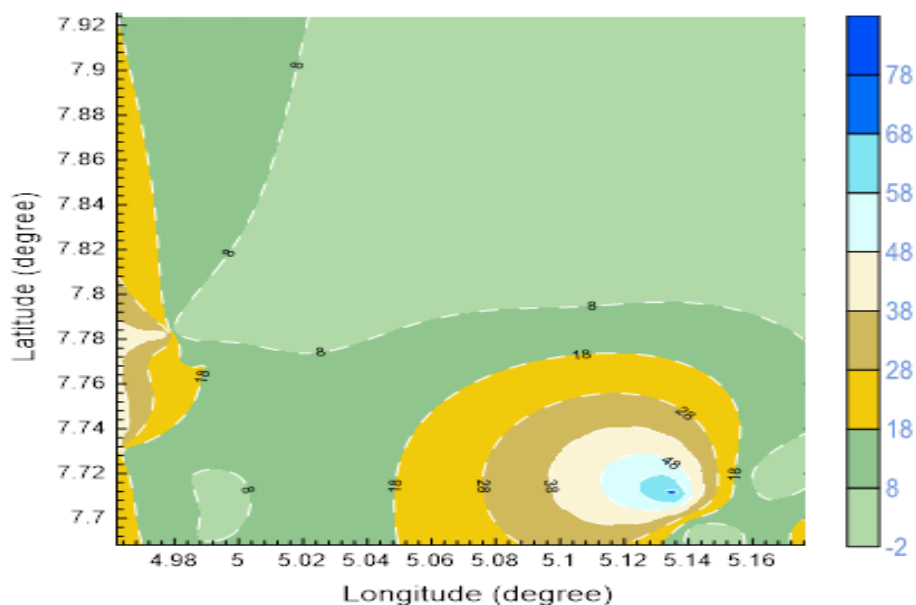


Figure 2: Contour diagram for activity concentration (Bq/kg) of ^{238}U in fluted pumpkin leaves

Source: Researcher, 2026

The contour map of the distribution of activity concentration of ^{226}Ra in fluted pumpkin in the study area is presented in Figure 3. It shows high activity concentration between longitude 5.12⁰ and 5.14⁰ for ^{226}Ra .

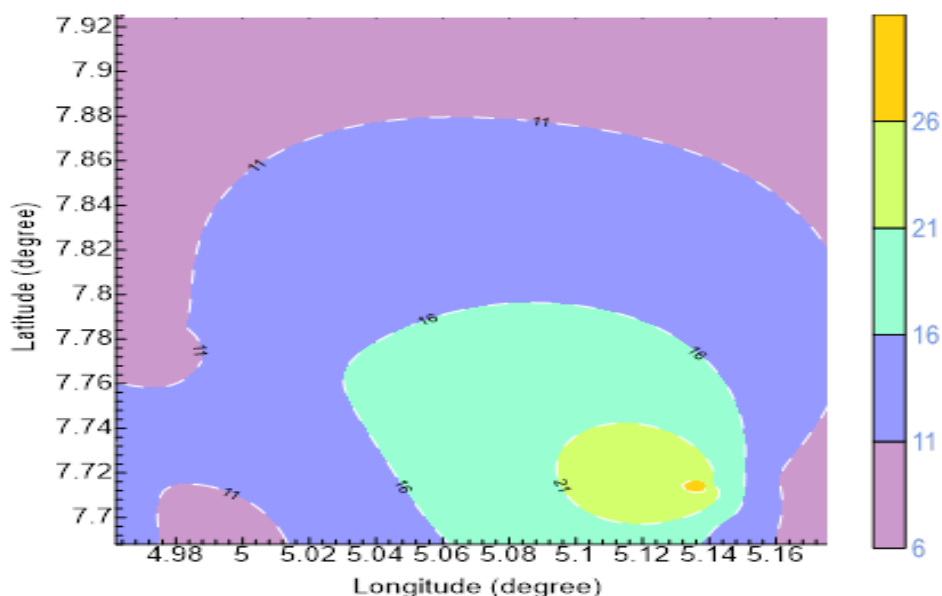


Figure 3: Contour diagram for activity concentration (Bq/kg) of ^{226}Ra in fluted pumpkin

Source: Researcher, 2026

The contour map of the distribution of activity concentration of ^{232}Th in fluted pumpkin in the study area is presented in Figure 4.

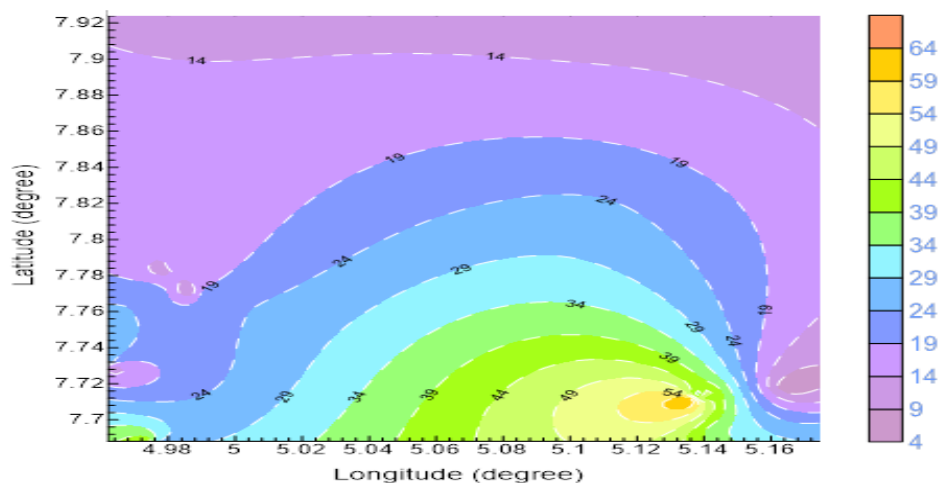


Figure 4: Contour diagram for activity concentration (Bq/kg) of ^{232}Th in fluted pumpkin leaves

Source: Researcher, 2026

The contour map of the distribution of activity concentration of ^{40}K in fluted pumpkin in the study area is presented in Figure 5. Activity concentration values of 1400 – 1550 Bq/kg occupy the greater portion of the map as indicated by a light blue colour while the deep blue colour with range between 1550 – 1700 Bq/kg indicate areas with highest activity concentrations ^{40}K .

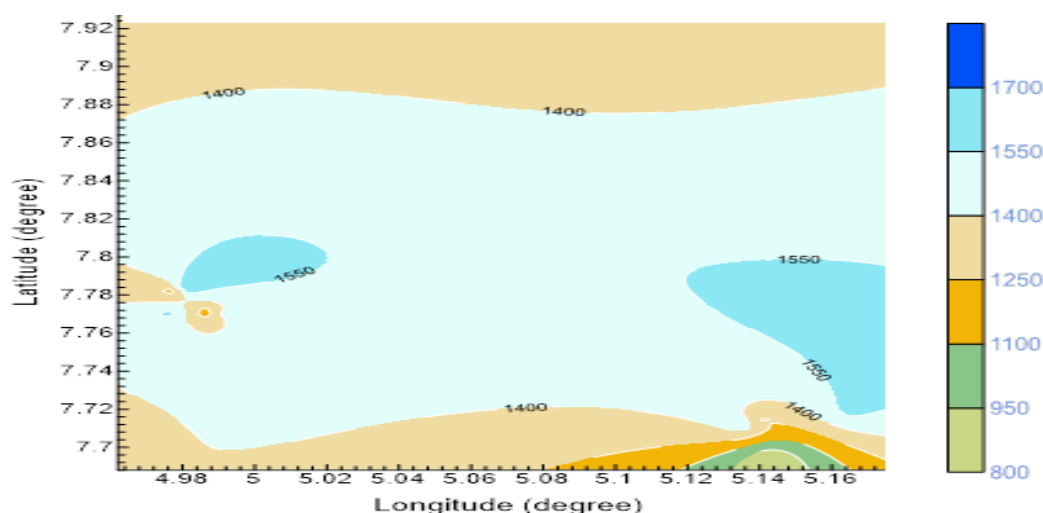


Figure 5: Contour diagram for activity concentration (Bq/kg) of ^{40}K in fluted pumpkin leaves

Source: Researcher 2026

4. Discussion

Results for activity concentration of radionuclides in fluted pumpkin leaves are presented in Table 1 according to locations sampled in each LGA. Activity concentration of potassium (^{40}K) ranged from 805.28 ± 42.89 to $1582.93 \pm 83.72 \text{ Bq/Kg}$. The range of AC for ^{238}U was between BDL to $86.96 \pm 5.63 \text{ Bq/Kg}$, while AC of ^{232}Th ranged from 4.81 ± 0.84 and $65.32 \pm 3.59 \text{ Bq/Kg}$. Activity concentration of ^{226}Ra ranged between 6.90 ± 0.81 and $28.23 \pm 2.03 \text{ Bq/Kg}$. Mean AC values were $26.34 \pm 2.36 \text{ Bq/Kg}$, $13.80 \pm 1.22 \text{ Bq/Kg}$, $26.44 \pm 1.77 \text{ Bq/Kg}$ and $1349.58 \pm 71.35 \text{ Bq/Kg}$ for ^{238}U , ^{226}Ra , ^{232}Th and ^{40}K respectively. These results show a relatively higher rate of deposition of potassium in fluted pumpkin leaves compared with absorption of other radionuclides. The deposition was high even where the activity concentrations of the radionuclides in corresponding soil samples were lower. This suggests that the quantity of transferred radionuclide to plant is not directly proportional to the quantity of the radionuclide present in the soil. There could be transfer of radionuclides from the atmosphere to aerial parts of the plants. The use of wood ash which is known to contain high levels of potassium on the leaves to check insects and other pests, which is a common practice among farmers in the study area could also be a contributory factor. Occasional use of pesticides to control pests by farmers, as was admitted to by farmers in some of the sample locations could also add to the radionuclide levels in the pumpkin leaves. It is an established fact however, that potassium is an essential elemental requirement for plant growth that is abundantly available in the environment (Golmakani *et al.*, 2008; Adesiji and Ademola, 2019).

Additionally, most of the farmers admitted to use of both organic and inorganic fertilizers to improve yield of all the types of crops sampled. Sampled farms with very high values of AC of ^{40}K in fluted pumpkin leaves were located in Abak, Etim Ekpo, Ikot Ekpene and Ikono LGAs. High level of potassium in plants does not pose any significant health concerns in the food chain since the body has a reliable way of regulating the level of potassium in the body to maintain a metabolic balance (Golmakani *et al.*, 2008). Farms with highest AC of ^{238}U , ^{226}Ra , and ^{232}Th in fluted pumpkin leaves were located in Essien Udim LGA followed by

farms in Oruk Anam and Etim Ekpo LGAs. Mean AC obtained for ^{238}U in fluted pumpkin in this study is less than that obtained by Agwu *et al.*, (2016) in southeast Nigeria. The activity concentration of ^{232}Th obtained here is however higher than that obtained by the last two researchers in their cited works. The mean values of AC obtained for ^{238}U , ^{226}Ra , ^{232}Th and ^{40}K in this work is similar to what was reported by Yeasmin *et al.*, (2014) for vegetable samples in Bangladesh, and also similar to that of Nyanda and Nkuba, (2017) in a study of radionuclides in vegetables in Tanzania. The mean AC of ^{238}U in fluted pumpkin leaves in this study is similar to that obtained in Delta State, Nigeria by Agwu *et al.*, (2016), while AC of ^{232}Th and ^{40}K are comparatively higher in this study. Compared with report of work done by Adedokun *et al.*, (2019) in Lagos State on AC of radionuclides in leafy vegetables, values of mean AC of ^{226}Ra and ^{232}Th in spinach were similar to mean AC of the same radionuclides in fluted pumpkin in this study.

Mean AC of ^{40}K in fluted pumpkin leaves in this study was however higher than that obtained for spinach in that study. Activity concentration of ^{238}U and ^{232}Th in fluted pumpkin in this study is slightly above the world reference limit of 20Bq/kg for ^{238}U and 15Bq/kg for ^{232}Th for leafy vegetables (UNSCEAR, 2000), While that of ^{226}Ra is lower than the world mean value. The distribution of mean AC of radionuclides in fluted pumpkin leaves from each LGA of the study area is presented in Figure 1. It shows ^{40}K to be the predominant radionuclide with the highest mean concentration found in Ikono LGA, while Essien Udim had the lowest mean activity concentration.

The numbers on the contour lines in the radionuclides contour diagrams, represent the activity concentrations of the radionuclides involved. The intervening spaces are marked with colours to further highlight the contributions of radionuclides. The higher the number on the contour line, the higher the concentration of the radionuclide involved. This could be used in the prediction of activity concentration in areas outside the sampling points. In Figure 2, the areas with light green colours show area with low activity concentration of ^{238}U , while blue with different shades show areas of high activity concentration. The yellow colour indicates portion of activity concentration between 0.18Bq/kg to 0.3813Bq/kg. It also shows high activity concentration between longitude 5.12° and 5.14° for ^{238}U .

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