RESEARCH AND INVESTIGATION TO ESTABLISH THE DATABASE OF ENVIRONMENT RADIATION BACKGROUND FOR VIETNAM (PHASE 2009 -2011)

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Project information:

- **Code: NV.BVMT.04/09/NLNT**
- **Managerial Level: Government**
- **Allocated Fund: 3,800,000,000 VND**
- **Implementation time: 24 months (12/2009-12/2011)**
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- **Paper published in related to the project:**

+ T. V. Giap, B. D. Dung, T. Kovacs and N. H. Quyet, *"Natural Radioactive in the Area where the first Nuclear Power Plants of Vienam will be built",* Terrestrial Radioisotopes in Environment, pp 61-65, Veszprem, Hungary, 2012.
+ B.D. Dung, T.V. Giap, T. Kovacs, L.D. Cuong, and N.H. Quyet, *"Indoor Radon concentration measurements at the locations of the first Nuclear Power Plants of Vietnam",* Romanian Journal of Physics, Vol. 58, Suplement, 2013.

ABSTRACT: Setting up data base of natural radiation background serves for planning socio-economics development in a province as well as the whole country and estimating annual effective dose of population. Beside external irradiation dose caused by the natural radioisotopes in the series ^{238}U, ^{232}Th and ^{40}K in soil, population has been received internal dose caused by the above radioisotopes taken in the body from several ways. In order to complete the database of national radiation background and go to estimate annual effective radiation dose of population in the whole country, this project focus to carry out the works as following: (i) *Setting up database of radiation background in the whole country:* 150 soil samples that collected in the districts of 46 provinces have been analyzed. The average activity concentration of ^{238}U, ^{232}Th and ^{40}K are 37.86 Bq/kg, 58.88 Bq/kg and 462.78 Bq/kg, respectively. The outdoor, indoor and total annual effective doses are calculated: 0.087±0.036 mSv; 0.488±0.202 mSv and 0.576± 0.240 mSv, respectively. (ii) *Setting up database of radiation background of province Ninh Thuan and Quang nam:* The detailed database of radiation background of all villages in Ninh Thuan and Quang Nam has been established. 84 soil samples in Ninh Thuan and 311 in Quang Nam were collected for analyze. The indoor and outdoor radon concentration at sampling positions has been measured. The average activities of ^{238}U, ^{232}Th, ^{40}K, and ^{222}Rn isotopes in Ninh Thuan are reported: 33.50 Bq/kg, 55.43 Bq/kg, 701.12 Bq/kg and 12.1 Bq/m^3, 9.5Bq/m^3, respectively. The outdoor, indoor and total annual effective doses in Ninh Thuan are calculated: 0.095±0.029 mSv; 0.529±0.162 mSv and 0.624± 0.382 mSv, respectively. The average activities of ^{238}U, ^{232}Th, ^{40}K, and ^{222}Rn isotopes in Quang Nam are reported: 44.47 Bq/kg, 52.68 Bq/kg, 459.33 Bq/kg, 18.0 Bq/m^3. The outdoor, indoor and total annual effective doses are calculated: 0.086±0.039 mSv; 0.482±0.216 mSv and 0.568± 0.254 mSv, respectively. The digital maps of radiation background on scale of whole country as well as the detailed for Ninh Thuan and Quang Nam provinces are established using Mapinfor software. The data of activity of ^{238}U, ^{232}Th, ^{40}K, ^{137}Cs and ^{222}Rn as well as the data of soil parameter at sampling position is founded in the map.

I. INTRODUCTION

Radiation background has two main sources: natural and artificial. Natural radiation sources (from radioactive ore, some minerals, rocks, materials, etc.) hold a very high rate. (According to the International Atomic Energy Agency (IAEA) report, the rate is up to 88.3%). Natural radiation background mainly caused by the radioactive elements in the natural radioactive series U, Th and K, while the rate of total artificial radioactivity caused by activities related to nuclear power plant, to radioisotopes producing, to using artificial sources in the medical, industrial, gas, agricultural fields is only 11.7%. Therefore, for any country that has or not nuclear power plant, natural radiation background assessment is always necessary.

For the purposes of planning and ensuring socio-economic and sustainable tourism development and health of the community, the majority of countries around the world have built the natural radioactive background map as a basis for assessment of public radiation dose. Especially in developed countries, the map of radiation background on the whole territory as well as in the area of natural radioactive abnormalities has been developed and widely used to ensure radiation safety for the community.

Currently, about 3/5 of the regions where people are living in the world have a database of natural radiation dose to the public such as India (1986), the former Soviet Union (1987), U.S. (1988), the European Community (2005), Japan (2005) that has established a map of natural radiation background in the national scope.

In the reports of IAEA regarding radiation safety, there are many studies on the measurement method, introduction of measuring the equivalent dose rate, the radiation dose from air, soil, outdoor and indoor radiation doses, the amount of radioactive materials in the soil, water, air, food samples, etc., from which assessment methods of dose that impacts to the public.

In our country, the study of the natural radiation background was made quite early, from the 50s, with the geological survey flights on many areas in the North of Vietnam. Over the next years, in collaboration with geology sector, laboratories in the atomic energy sector, with new equipment and depth knowledge, through programs such as 50B, KC-09, and different projects have collected a lot of data on the distribution of natural and artificial radioactivity in various regions of the country, especially in areas with radiation background higher than the average, as mountains of the North, Quang Nam province, mineral sand areas along the coast of Binh Dinh, Ha Tinh and areas rich in mineral water…

From 1994 to 2007, a number of projects and tasks in this field are conducted by bodies under the Ministry of Natural Resources and Environment in some mountain areas of the North and the Centre, typically such as "Geological survey of urban environment", "Survey of the radioactive environment status, capabilities of influence and countermeasures on some radioactive mines in Lai Chau, Cao Bang and Quang Nam"," Survey of the status of radioactive environment on the Dong Pao, Then Sin - Tam Duong mines of Lai Chau provinces, Muong Hum mine of Lao Cai province, Yen Phu of Yen Bai province, Thanh Son of Phu Tho province, An Diem, Ngoc Kinh, Suon Giua of Quang Nam province". And some results of the evaluation of mineral sand ore resources from Thanh Hoa to Ba Ria-Vung Tau. There are also a lot of other projects and tasks done by bodies of Vinatom, Geological Association and some Universities.

However, previous studies that primarily served different purposes and applications are also discrete, not complementary together to form the data set following the same standard. Therefore, a comprehensive database on natural environmental radiation background in the Central region has not yet been completed and the natural radiation background map for each province has not yet been formed.

In the first phase of this task, with the active participation of relevant bodies, specialized laboratories of the Vietnam Atomic Energy Institute, geological agencies and some universities have collected, assessed and analyzed all the data collected during the past half last century. The results of the reports showed that in 10 provinces of central coast, the digital map of the natural radiation background is lack of information class that may to be used for public dose assessment in the region, such as: activity of the radio nuclides in the series U, Th, K in soil, water, food, Rn content in houses, etc. Moreover, measurement points very little (rate 1/1.000.000). Therefore, in this stage, the authors focus on:

- Construction of the natural radiation background map for two specific provinces (Quang Nam province where much natural radioactive anomalies concentrate in and Ninh Thuan province where radiation background is normal and first NPP of VN will be).
- Supplementation of the data set on the content of radio nuclides in series U, Th, K in soil environment of the project studying Cs-137 in order to evaluate public dose.

II. EQUIPMENT AND STUDYING METHOD

II.1. Studying method of the tasks

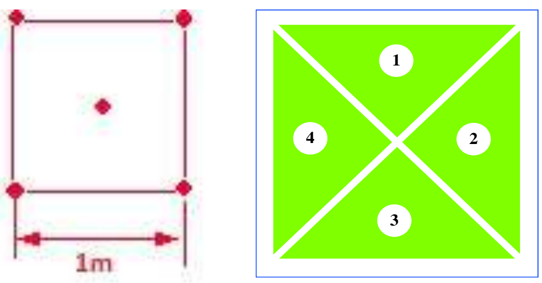
Development of radiation background database in some area in terms of limited cost, as well as discontinuous implementation time, must always inherited the available data in the previous studies, simultaneously supplement the missing data in accordance with the objectives. However, in previous studies, for different purposes, the measurement methods for data collection are often not standardized, at different levels of reliability, the available data set is not used directly for the long-term aim that is to assess population dose in the studying area. Therefore, in this study, the data obtained from previous studies need to be standardized and verified by the new measurement. Simultaneously, this study collect additional data in areas lacking of gamma dose rate, as well as collect environmental samples to analyze the content of radioactive elements for the purpose of assessing public dose. To verify measurement results and measure additional data, the following measurements were made:

- *a/ Method of measurement of environmental gamma dose rate and measuring the Radon concentration:* Use the measuring device instantaneous dose rate to assess the environmental radiation background and the potential ability of irradiation to the public:
- Establish satellite addressing to measure equivalent dose, such as measuring points position pick, use the GPS to determine measuring points coordinate;
- Measurement at the selected point. Use the survey meters to measure, taking the averaging values;
- Use measuring equipment radon concentrations RAD7 detector and some charcoal detectors and LR-115.

b/ Method of sampling: Environmental samples (soils) according to the following sampling process:

- In selected areas, the sampling was carried out at the top and center of the square next to 1m (Figure 1 a);
- Use stainless steel corer, Ø 50mm collected 05 soil cores at the point marked with the dots as shown on Figure 1 a;
- Sampling Depth: 20 cm;
- The amount of land from the 05 cores of each position is accumulated, mixed, shortened to get the necessary amounts (about 1.5-2 kg), the package brought to the laboratory.

a) Arranged the average soil sampling at a location representative sampling. area



b) Rule shortened form: Share 4 half, 1 and 3 get 2 and 4 left.

Figure 1: Demonstration of soil sampling.

- Fewer *samples:* method split (Figure 1 b). After mixing the sample by the method of annular and conical finished, the sample is sprayed into a square or flat plate of equal thickness, size 1cm. Sample divided by two diagonal or diameter perpendicular to each other. Two peaks dismiss, while the other 2 parts for top mixed together and then repeat the above process until the remaining sample volume of about 1.5-2 kg, packed in polyethylene bags 2 layers to transferred to the laboratory. Put the sample scorecards and tied the mouth of the bag. Sample scorecards must clearly state: Sampling Location, location, depth of sampling, fresh weight, date of sampling, weather, sampling. More detailed information to be filled in sampling protocol sheet for each position.

c/ Method of determination of the radioisotopes: Sample containers to be used with 2 different configurations: cylindrical small box with a diameter of 6.7 cm high 4 cm; box to the cylinder with a diameter of 10.3 cm high by 6.7 cm. Depending on the concentration of radioactive elements in the sample in the study area that could use one of two types of sample containers.

Land is considered to form the size (<1 cm), remove the roots, yeast spread evenly on a tray or aluminum, air dried or dried at a temperature of 50 ^{0}C to remove all water and can crusher small. Using porcelain pestle or ball mill for grinding the sample, then use the hole diameter 1 mm sieve to sieve samples, samples will be stored in the meter box to analyze radioactive elements based on the spectral gamma. The food samples were weighed, dried, crushed and put into the measurement box.

II.2. Equipments

a/ Gamma spectrometer: Using analysis-Gamma spectrometer HP-Ge ultra-pure with the following parameters: Hp-Ge detector GMX diameter 59.5 mm in length 72.6 mm resolution power strip and performance record relative for spectral peak at an energy of 1332 keV 2.0 keV and 35% respectively. Low-background lead cylindrical chamber inside and outside diameter corresponding to 28 cm and 50.4 cm is made of an outer steel layer has a thickness of 1 cm, a graphite layer has a thickness of 10 cm and a lining the same thickness of 0.2 cm (Figure 2).

The DART spectrum amplifier EG & G ORTEC compatible with the pre-amplifier gain adjustable from 3 to 1000 steps of regulation 1/4000. Pulse time constant can choose 1 or 6 μs. The spectrum data collection MCA DART EG & G ORTEC 8000 channel can contain 2 billion counts per channel. Using the software Gamma Vision version 5.3 is installed inside the computer for permission to collect and process data automatically. Using the spectral gamma characteristic of the radioactive isotope in the sample to determine their contents by comparison with standard samples. Total alpha and beta activity in water samples were measured on the total alpha + beta-shirts low after the sample has been chemically treated. Measuring time per sample was selected to ensure the statistical error.

Figure 2: Detector Hp-Ge system.

Figure 3: The standard soil sampling.

b/ Soil sampling kit: Consists of 4 instruments as present in Figure 3

+ 01 sampling spoon: length 38 cm, stainless steel material.

+ 01 spoons sample: length 28 cm, stainless steel material.

+ 01 core samples, denoted AMS # 417.03: diameter 5 cm (2 inch), the maximum depth of 30 cm, handle length 46 cm (18 inch), stainless steel material.

+ 01 mixing bowl: diameter 33cm, stainless steel material.

c/ Survey meters: as shown in Figure 4.

- The TCS-171 survey meter: Using NaI detector, the measuring range upto 30 μSv/h. The meter is made by ALOKA, Japan.

- The Radiagem meter: Using Geiger Mueller detector, made by CANBERRA USA. The measuring range is 0.01 μSv/h upto 100 mSv/h.

- Rad 7 Radon measuring meter: Measuring boths Radon and Thoron.

TCS 171 Survey meter *Radiagem Survey meter* *Radon Rad-7*

Figure 4: The survey meters.

II.3. The process and measurement models

In the experiment, soil samples were dried naturally in the air, then dried overnight at a temperature of 1058 ^oC. The soil samples were crushed and sifted to remove the roots or stones in the sample, 500 g of soil samples taken in the measurement box and locked thoroughly to achieve radioactive equilibrium between ^{226}Ra and its progeny in the range uranium in the sample. Gamma radioactivity in the samples was measured by low background gamma spectroscopy using detector ultra-pure germanium (HPGe). Radioactivity of ^{226}Ra is computed Germany on the radioactivity of the descendants of the ^{214}Pb (spectral lines of 295.2 and 351.9 keV) and ^{214}Bi (spectral lines of 609.3 keV); longer zoom radiation of thorium were calculated on the basis of the radioactivity of ^{212}Pb (spectral lines of 238.6 keV), ^{208}Tl (spectral lines of 583.2 keV) and ^{228}Ac (spectral lines of 338.3 and 911.1 keV). radioactivity of ^{40}K is computed directly from the spectral lines of 1461 keV. All soil samples were analyzed at four laboratories (at Hanoi, Da Lat and Ho Chi Minh City).

To measure the amount of radon in the air, passive measurements (passive) nuclear use detector stain LR-115 stripping has been used. Measuring 3x3cm box type configuration was used, after a 3-month period in the field, the nuclear detector collected brought to the laboratory and treated chemically (chemical laced) in 10% NaOH at a temperature of 60 °C, soaked time is 110 minutes. Then traces of alpha particles on the labeling detector traces were counted automatically by the counter wound automatically by the electric spark method, environmental levels of radon in the air is calculated by the following formula:

$$C_{Rn} = \frac{D_{DET}}{k.H} \qquad (1)$$

where - C_{Rn}, Rn concentration (Bq.m^{-3});

- D_{DET}, density (counts.cm^{-2})

- H, expose time in air (h) and k, is 6.75.10^{-4} (counts.cm^{-2})/(Bq.m^{-3}).h

III. Results

III.1. Building a database on levels of radiation on a national wide

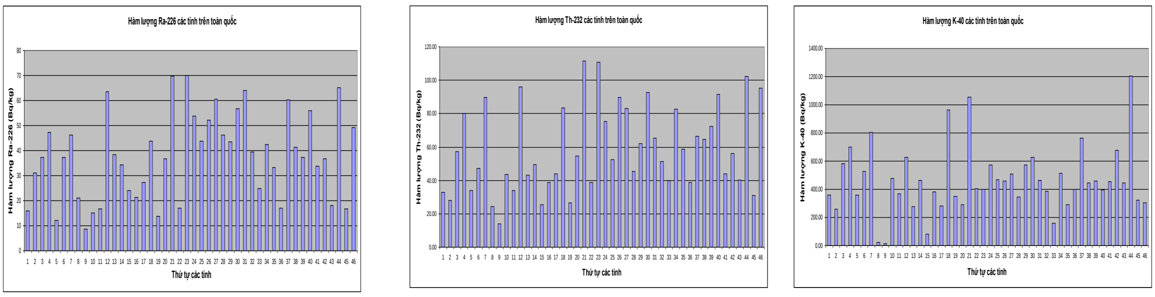
The Radioactivity (SAS) of the isotope ^{226}Ra, ^{232}Th and ^{40}K of the 150 samples in 46 provinces and cities have been analyzed and calculated. From the radioactivity of the sample, the following parameters were calculated:

+ Gamma dose rate at 1 m high (OADRs)
+ Out door Annual Effective Dose (OAED)
+ In door Annual Effective Dose (IAED)
+ Total Annual Effective Dose (TAED)

Table 1: Works average radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K.

	^{226}Ra Concentration (Bq/kg)	**^{232}Th Concentration (Bq/kg)**	**^{40}K Concentration (Bq/kg)**	**Absorbed dose rate at height of 1 m (nGy/h)**	**OAED (mSv/year)**	**IAED (mSv/year)**	**TAED (mSv/year)**
Average	37.86	58.88	462.78	71.13	0.087	0.488	0.576
STD	17.10	25.55	235.26	29.69	0.036	0.202	0.240
Max	70.10	111.57	1203.80	141.15	0.173	0.969	1.143
Min	8.63	13.85	14.60	12.68	0.016	0.087	0.103

Summary values are given in Table 1. The average radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K of the province is represented in Figure 5. When compared to the average value of radioactivity of the isotope ^{226}Ra, ^{232}Th, ^{40}K with the average value of the activity of the isotope in the world reported in 2000 was 35, 30 and 400 Bq/kg, and the weighted average value is 33, 45 and 420 Bq/kg , so the average value of the activity of the isotope ^{226}Ra, ^{232}Th and ^{40}K, as well as by weights of the isotopes in Vietnam larger than the corresponding value in the world.



(a) $^{226}Ra_{Av}$ = 37.86 Bq/kg *(b) $^{232}Th_{Av}$ = 58.88 Bq/kg* *(c) $^{40}K_{Av}$ = 462.78 Bq/kg*

Figure 5: Concentration of the radioactive isotope provinces nationwide.

High dose rate at 1 meter: (OADR-nGy.h$^{-1)}$ was calculated from the radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K of the soil surface by the following formula:

$$OADR = SA_{Ra} \times F_{Ra} + SA_{Th} \times F_{Th} + SA_K \times F_K \quad (2)$$

where SA_{Ra}’ SA_{Th}’ SA_K is the specific radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K. The F_{Ra}, $F_{Th,}$ F and F_K is the conversion factor of the isotope ^{226}Ra, ^{232}Th and ^{40}K, respectively, are given by theoretical calculations and experiments. In the previous publication, these values are respectively: 0.4368 nGy.h^{-1}/Bq.kg^{-1}, 0.5993 nGy.h^{-1}/Bq.kg^{-1} and 0.0417 nGy.h^{-1}/Bq.kg^{-1} corresponding to the isotopes. In this report also uses the above values.

On the basis of the radioactivity of the isotopes in soil samples collected, OADR value of the provinces has been calculated. The OADR average value is 71.13 ± 29.69 nGy.h^{-1}. Annual effective dose of the population were calculated on the basis of absorbed dose is calculated from the radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K in soil samples, the ratio of inside and outside the home, conversion coefficient from absorbed dose, outdoor living coefficient and coefficient of residence. Annual effective dose for indoor and outdoor use in Vietnam is calculated as follows:

$$\text{Outdoor: } OAED\ (mSv) = OADR \times 8760h \times CF \times OF \quad (3)$$

where: OADR absorbed dose rate (nGy.h$^{-1)}$

CF is the conversion coefficient from absorbed dose by 0.7 Sv.Gy^{-1} .OF is outdoor residence coefficient equal to 0.2

$$\text{Indoor: } IAED\ (mSv) = OADR \times F_{io} \times 8760h \times CF \times IF \quad (4)$$

where: F_{io} coefficients inside and outside the home by 1.4

IF is the number of occupants in the house by 0.8

And the total effective dose for a total of: TAED = OAED + IAED

Calculation results OAED, IAED and TAED of the province was calculated. The average values are: OAED = 0.087 ± 0.036 mSv; IAED = 0.488 ± 0.202 mSv and TAED = 0.576 ± 0.240 mSv (the value of the world is 0.07; 0.41 and 0.48mSv).

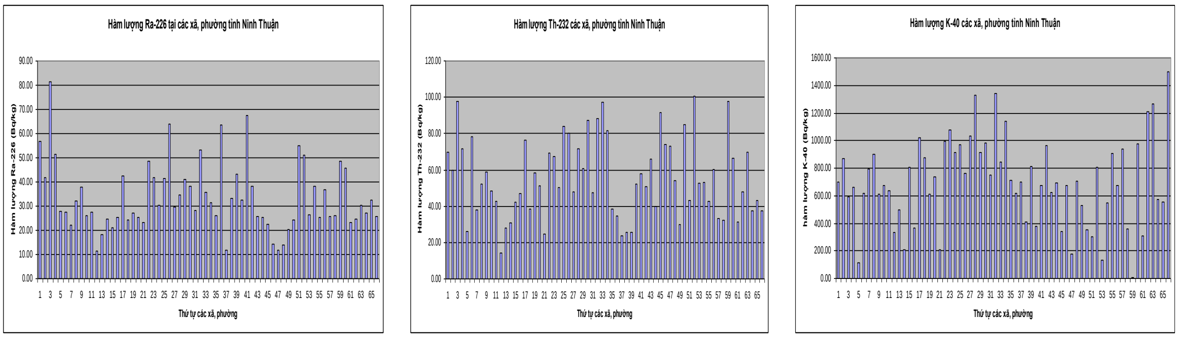
III.2. Building database content of radio nuclides in Ninh Thuan province

Private radioactivity (SAS) of the isotope ^{226}Ra, ^{232}Th and ^{40}K of 84 samples were analyzed and calculated. From the radioactivity of the sample, the same above parameters OADRs, OAED, IAED and TAED were calculated.

Table 2: Works average radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K.

	^{226}Ra Concentration (Bq/kg)	**^{232}Th Concentration (Bq/kg)**	**^{40}K Concentration (Bq/kg)**	**Absorbed dose rate at height of 1 m (nGy/h)**	**OAED (mSv/year)**	**IAED (mSv/year)**	**TAED (mSv/year)**
Average	33.50	55.43	701.12	77.09	0.095	0.529	0.624
STD	14.07	21.58	316.6	23.59	0.029	0.162	0.382
Max	81.37	100.37	1499.15	132.08	0.162	0.907	1.069
Min	11.44	14.23	9.10	27.55	0.034	0.189	0.223

Summary of the average concentration of the isotopes and the average values of OADR, OAED, IAED and TAED are given in Table 2. The average radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K of the province is represented in Figure 6. That value of the corresponding isotopes is 33.50 Bq/kg (with the range of values from 11.44 to 81.37 Bq/kg) for ^{226}Ra; 55.43 Bq/kg (with the range of values from 14.23 – 100.37 Bq/kg) for ^{232}Th and 701.12 Bq/kg (with the range of values from 9.10 – 1499.15 Bq/kg) for ^{40}K, respectively.



(a) ^{226} Ra$_{Av}$ = 33.50 Bq/kg (b) ^{232} Th $_{TB}$ = 55.43 Bq/kg (c) ^{40} K $_{TB}$ = 701.12 Bq/kg

Figure 6: Concentration of the radioactive isotope in Ninh Thuan.

Database of Radon in Ninh Thuan: The average values of Radon concentration in the areas of Ninh Thuan are given in Table 3. The indoor Radon Concentrations are in the range from 5 Bq/m^3 to 28 Bq/m^3. The average value for whole province is 12 Bq/m^3. The annual effective dose is 0.365 mSv.

Table 3: The Radon concentration in Ninh Thuan.

	Indoor Rn Concentration	Outdoor Rn Concentration	IAED (mSv)	OAED (mSv)	TAED (mSv)
Average	12.1	9.5	0.305	0.060	0.365
STD	6.6	5.5	0.138	0.032	0.158
Max	28.5	26	0.718	0.165	0.820
Min	5.0	2.8	0.126	0.017 0017	0.158

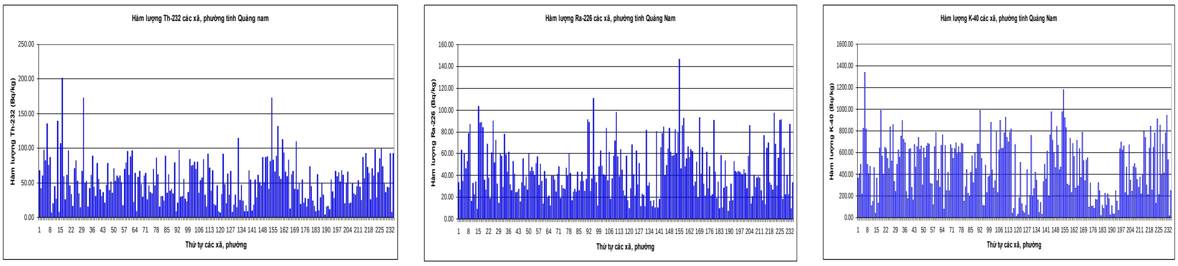
III.3. Building database content of radio nuclides in Quang Nam province

Radioactivity concentration (SAS) of the isotope ^{226}Ra, ^{232}Th and ^{40}K of 311 samples were analyzed and calculated. From the radioactivity of the sample, the same above parameters OADRs, OAED, IAED and TAED were calculated.

Table 4: Works average radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K.

	^{226}Ra Concentration (Bq/kg)	^{232}Th Concentration (Bq/kg)	^{40}K Concentration (Bq/kg)	Absorbed dose rate at height of 1 m (nGy/h)	OAED (mSv/year)	IAED (mSv/year)	TAED (mSv/year)
Average	44.47	52.68	459.33	70.15	0.086	0.482	0.568
STD	23.83	31.35	267.51	31.41	0.039	0.216	0.254
Max	146.60	201.30	1336.95	187.09	0.229	1.285	1.514
Min	7.19	4.19 4:19	14.00	6.61	0.008	0.045	0.054

Summary of the average concentration of the isotopes and the average values of OADR, OAED, IAED and TAED are given in Table 4. The average radioactivity of the isotope ^{226}Ra, ^{232}Th and ^{40}K of the province is represented in Figure 7. That value of the corresponding isotopes is 44.47 Bq/kg (with the range of values from 7.19 to 146.60 Bq/kg) for ^{226}Ra; 52.68 Bq/kg (with the range of values from 4.19 to 201.30 Bq/kg) for ^{232}Th and 459.33 Bq/kg (with the range of values from 14.0 to 1336.95 Bq/kg) for ^{40}K, respectively.



(a) $^{226}Ra_{Av}$ = 44.47 Bq/kg (b) $^{232}Th_{Av}$ = 52.68 Bq/kg (c) $^{40}K_{Av}$ = 459.33 Bq/kg

Figure 7: Concentrations of ^{226}Ra, ^{232}Th and ^{40}K in the areas of Quang Nam.

Database of Radon in Quang Nam: The average values of Radon concentration in the areas of Quang Nam are given in Table 5. The indoor Radon Concentrations are in the range from 4 Bq/m^3 to 38 Bq/m^3. The average value for whole province is 18.3 Bq/m^3. The annual effective dose is 0.505 mSv.

Table 5: The Radon concentration in Quang Nam.

	Indoor Rn Concentration	**Outdoor Rn Concentration**	**IAED (mSv)**	**OAED (mSv)**	**TAED (mSv)**
Average	18.3	7.7	0.461	0.044	0.505
STD	8	2	0.220	0.015	0.223
Max	38.6	12	0.983	0.076	1.049
Min	4	2	0.101	0.013	0.136

IV. CONCLUSION

In the national wide, we have taken 150 samples, analyzed and estimated the dose from the concentration of the isotopes ^{238}U, ^{232}Th and ^{40}K. The annual outdoor effective dose, annual indoor effective dose and total annual effective dose are 0.087±0.036 mSv; 0,488±0.202 mSv and 0.576 ± 0.240 mSv, respectively. Study and monitoring radioactive background in detail for the 2 provinces Quang Nam and Ninh Thuan will wake base to deploy for other provinces in the country.

In Ninh Thuan province, the average concentrations of ^{238}U, ^{232}Th and ^{40}K are 33.50 Bq/kg, 55.43 Bq/kg and 701.12 Bq/kg, respectively. From the result of concentration of ^{238}U, ^{232}Th and ^{40}K the values of annual dose were estimated. The annual outdoor effective dose, annual indoor effective dose and total annual effective dose are 0.095±0.029 mSv; 0.529±0.162 mSv and 0.624± 0.382 mSv, respectively. The average Indoor and Outdoor Radon concentrations are 12.1 Bq/m^3 and 9.5 Bq/m^3.

In Quang Nam province, the average concentrations of ^{238}U, ^{232}Th and ^{40}K are 44.47 Bq/kg, 52.68 Bq/kg and 459.33 Bq/kg, respectively. From the result of concentration of ^{238}U, ^{232}Th and ^{40}K the values of annual dose were estimated. The annual outdoor effective dose, annual indoor effective dose and total annual effective dose are 0.086±0.039 mSv; 0.482±0,216 mSv and 0.568± 0.254 mSv, respectively. The average Indoor and Outdoor Radon concentrations are 18 Bq/m^3 and 7 Bq/m^3.

All the above databases are usefully for estimate the public dose in future works. The database is also to be submitted to the UNSCEAR to update about the public dose from environment. It also would be useful database for the purpose of comparison of the environment background before and after the Nuclear Power Plants are to be operated in the future.

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