DETERMINATION OF SURFACE RADIATION DOSE AND CONCENTRATIONS OF URANIUM AND THORIUM IN SOIL AT UITM PERHILITAN RESEARCH STATION KUALA KENIAM, TAMAN NEGARA, PAHANG

Ahmad Saat[1], Nurulhuda Kassim[2], Zaini Hamzah[2], Ahmad Farisz[2]

[1]International Education Center, Universiti Teknologi MARA, Shah Alam

[2]Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam

Corresponding Author E-mail: ***hooda_86@hotmail.com***

ABSTRACT

Taman Negara is a famous tourism destination for nature lover in Malaysia. The area is well kept from human activities and disturbances. Since there is no data for human exposure to natural radiation, there is a need to do this study. It will give a baseline data for surface dose and radionuclide concentrations and one can estimate the external hazards index for the visitor to this unexplored area, i.e. UiTM-Perhilitan research station, Kuala Keniam, Taman Negara, Malaysia. The surface dose rate measurements were done in-situ using portable radiation survey meter at the surface and 1 m above the surface. The top soil samples were taken using hand auger up to 15 cm depth at nine locations around research station. Samples were brought back to the UiTM laboratory in Shah Alam, dried, ground to powder form, and sieved using 250 µm sieve. Then the uranium and thorium concentrations were analyzed using Energy Dispersive X-Ray Fluorescence (EDXRF).The mean value for surface dose rates on surface were 0.164 µSv/hr while the mean value for surface dose rates on 1m above the surface were 0.161 µSv/hr. The mean concentration of thorium was 2.62µg/g while the mean concentration of uranium was 0.61µg/g.

ABSTRAK

Taman Negara adalah destinasi percutian yang sangat popular bagi pencinta alam di Malaysia. Kawasannya adalah terpelihara daripada aktiviti dan gangguan manusia. Disebabkan ketiadaan data mengenai kadar pendedahan sinaran tabii kepada manusia, kajian ini sangat diperlukan. Kajian ini akan memberikan data asas untuk dos permukaan dan kepekatan radionuklid, dan indeks 'hazard' luaran untuk pelancong yang datang ke tempat yang belum diterokai ini iaitu Stesen Penyelidikan UiTM- Perhilitan,Kuala Keniam,Taman Negara,Malaysia. Pengukuran dos permukaan dijalankan di tempat kajian menggunakan pengukur radiasi mudah alih di permukaan tanah dan 1 meter di atas permukaan tanah. Lapisan atas tanah diambil menggunakan 'auger' sedalam 15 sm di sembilan lokasi dalam kawasan kajian. Sampel dibawa pulang ke makmal di UiTM Shah Alam, dikeringkan, ditumbuk sehingga dalam bentuk serbuk, dan diayak menggunakan pengayak bersaiz 250 µm. Selepas itu kepekatan uranium dan torium dianalisis menggunakan Pendaflur Sinar X Serakan Tenaga. Nilai purata untuk dos permukaan ialah 0.164 µSv/j manakala nilai purata untuk dos permukaan pada 1 meter di atas permukaan ialah 0.161 µSv/j. Nilai purata untuk kepekatan torium ialah 2.62µg/g manakala nilai purata untuk kepekatan uranium ialah 0.61µg/g.

Keywords: soil, surface radiation dose, uranium, thorium, EDXRF

INTRODUCTION

Radiation cannot be sensed but human is exposed to background radiation both from natural and man made sources. Natural background radiation, which is equivalent to 2.4 mSv per person, makes up around 80% of the total radiation dose a person exposed within a year (IAEA, 1996). One of the main factors of the natural background radiation is the radionuclide activity concentration in soil (Taskin *et. al*., 2009). The natural radioactivity in soil comes from the uranium-238, thorium-232 decay series and natural potassium-40 (UNSCEAR, 2000). The level of natural radioactivity in the soil and in the surrounding environment plus the gamma radiation intensity in a region depends mainly on the geological and geographical condition (Degerlier *et. al.*, 2008). Exposure to radiation can give effect to health implication which it can harm living cells, causing death in some of them, and modifying others, and in fact lower doses of radiation can increase the likelihood of lifetime cancer risk (Asha Rani *et. al.,* 2005).

Taman Negara is the biggest and the oldest protected region in Malaysia. Taman Negara is in fact one of the oldest rainforests in the whole world, estimated to be 130 million years old. The central coordinates are 04°30' north latitude and 102°59' east longitude. The altitude range from 60 m to 2187 m at the top of Gunung Tahan and it covers 4,343 square km of area. This huge area are actually shared among three states which is Pahang 2,477 square km (57%), Kelantan 1,043 square km (24%) and Terengganu 853 square km (19%). To preserve the land's indigenous nature in perpetuity, it was gazette separately by each state's Enactments in 1938-1939. After the nation gain independence, the park was renamed as Taman Negara instead of King George V National Park. (*http://www.tourism.gov.my*)

In Taman Negara Pahang, the geological foundation is sedimentary rock**s**, mainly sandstone and shale, with some scattered limestone outcrops and caves. Higher radiation levels are associated with igneous rocks, such as granite and lower level with sedimentary rocks (Asha Rani *et. al*., 2005). No commercial exploitations are permitted in the area, except for subsistence hunting by the aboriginals or Malaysian addressed them as 'Orang Asli'. The rainforest landscape has been geologically stable through out. Thus, without any major geophysical upheaval, the forest has evolved relatively uninterrupted since primordial times. (*http://www.tourism.gov.my*)

The area was chosen to provide baseline data of the undisturbed area in Malaysia. The aim of this study was to measure the concentration of uranium and thorium in soil at study area using Energy Dispersive X-Ray Fluorescence (EDXRF). At the same time, the surface dose were measured using portable Geiger Muller Survey meter, to access to surface radiation dose level in the area.

EXPERIMENTAL PROCEDURE

Soil samples were collected from nine points in Taman Negara Kuala Keniam area, Pahang. The study area is around UiTM-Perhilitan Research Station. Sample from each point were collected by digging using hand auger. Five representative's samples were collected at equivalent distance along the 1m circumference around the point at each location. This method

will improve the representative homogeneity of sample from every sampling point (Zaini *et. al*., 2007). The distance between each point is about 50 meters.

The coordinates and the elevation of each sampling points were determined by Global Positioning System (GPS).Undisturbed geographical locations which was the trail for rainwater were selected as sampling points. The surface dose rate was–done in situ using portable radiation survey meter Ludlum Model 2241. Radiation dose were measured at the surface and at about one meter height from the surface.

After collection, the sample was dried under the sun to remove the moisture content. A portion of sample was kept aside for pH measurement. All the contaminants (roots, leaves, stems, stick) will be removed manually before grinding. After that, the sample was crushed into fine powder by using grinder. Then the fine quality of samples will be obtained using a 250 µm mesh sieve. Then, the sample was pressed to get the palette by using a compressor. Afterward, the palette was dry in oven at the temperature of 60°C. After the palette dry, it was then put in desiccator's for 30 minutes to get the constant weight. Then the sample was weighed.

The MiniPal4 XRF instrument was used in this study. The resolution for the instrument use is 145 keV with energy resolution at 5.9 keV. The analysis was done using Standard Reference Material (Soil 7 IAEA). The detector use in this study is High-resolution Si Drift Detector. Generally, this technique may improve the low atomic elements intensities such as Na, Mg and Al. The MiniPal4 consist 2048 multi-channel analyzer which use to determine the present of elements in the sample. The MiniPal4 XRF instrument will be used in this study which used High-resolution Si Drift Detector. XRF is used generally to determine the concentration of the different elements in a sample with advantages of good sensitivity, non-destructiveness and because of the simple relation to the fundamental physics of atom radiation interaction. This relation is normally expressed in terms of a so called fundamental parameter model used for quantifying the XRF results (Pantenburg *et. al*., 1992).

RESULTS AND DISCUSSION

Table 1 shows the longitude, latitude and surface radiation dose rate measurements (at the surface and 1 meter height) in the study area. The GPS lies on 04°31' north latitude and 102°28' east longitude. From Table 1, the mean value for surface dose rates are 0.164 µSv/hr at the surface and 0.161 µSv/hr at 1 m from the ground. This indicates the normal range which is below global range of 0.5-1.3 µSv/hr set by UNSCEAR.

Table 1: Illustrates the GPS for both North and East, Surface dose of the surface and 1m from the ground for the soil in Taman Negara, Kuala Keniam, Pahang.

LOCATION	LATITUDE	LONGITUDE	SURFACE DOSE RATE (µSv/hr)	SURFACE DOSE RATE 1M(µSv/hr)
TNOS3	04°31.080′	102°28.538′	0.179	0.167
TNJS6	04°31.051′	102°28.561′	0.277	0.187
TNJS7	04°31.024′	102°28.568′	0.147	0.186
TNJS8	04°31.125′	102°28.541′	0.175	0.165
TNJS9	04°31.998′	102°28.571′	0.158	0.172
TNJS10	04°30.998′	102°28.555′	0.125	0.127
TNJS11	04°30.977′	102°28.546′	0.125	0.178
TNGS	04°31.131′	102°28.568′	0.140	0.138
TNJS	04°31.168′	102°28.604′	0.153	0.127
			Mean=0.164	Mean=0.161

The concentration of uranium and thorium in the study area are listed in Table 2. It shows that the uranium concentration in the study area ranges from 0.46 µg/g to 0.75 µg/g. The concentration for uranium in study area is low compared to the average concentration of uranium in soil which is 1.8 µg/g (Cooper *et. al*., 2003) and compared to the world average which is 2.1 µg/g (Surinder e*t. al.,* 2005). The thorium concentration for soil in the study area ranges from 2.02 µg/g to 3.19 µg/g. The concentration for thorium in study area is low compared to the average concentration of thorium in soil which is 6.2 µg/g (Cooper *et. al*., 2003). Table 2 also show the ratio of thorium and uranium are about 4, which is slightly higher than other places as normal ratio for Malaysian soil is 3 (Zaini *et. al*., 2007). Perhaps this could due to undisturbed area or it has slightly higher thorium contents.

Table 2: Illustrates the concentration of U and Th in soil samples (µg/g) for the soil in Taman Negara, Kuala Keniam, Pahang.

	U(µg/g)		Th(µg/g)		Ratio
			Mean	Std.	(Th/U)
LOCATION	**Mean**	**Std. Dev**		**Dev**	
TNOS3	0.63	0.001	2.67	0.04	4.2
TNJS6	0.75	0.01	3.19	0.07	4.3
TNJS7	0.69	0.03	2.95	0.07	4.3
TNJS8	0.66	0.02	2.78	0.03	4.2
TNJS9	0.60	0.01	2.68	0.08	4.5
TNJS10	0.63	0.01	2.83	0.02	4.5
TNJS11	0.57	0.01	2.40	0.07	4.2
TNGS	0.46	0.01	2.02	0.08	4.4
TNJS	0.49	0.01	2.06	0.05	4.2

Table 3: Illustrates the elemental concentration of U and Th in soil samples (µg/g) in the soil samples from work conducted worldwide

LOCATION	**U(µg/g)**	**Th(µg/g)**	**Ratio(Th/U)**	**References**
Jengka 15, Pahang, Malaysia	2.28±0.18	6.76±0.12	3.0	Zaini et al.(2007)
Palong, Johor, Malaysia	20.19±0.86	153.98±12.44	7.16	A.T.Ramli et al.(2005)
Amman, Jordan	7.1	4.6		Ahmad et al.(1997)
Alps-Apennines, Italy	0.3-16.7	0.3-5.6		Chiozzi et al.(2002)
Worldwide average	7.4	2.8		UNSCEAR report (2000)

These results also were analyzed for their correlation. Table 4 shows the correlation between uranium, thorium, with surface dose at surface and 1m from the ground. There are strong correlations between uranium and thorium which is 0.973.While for the surface dose, the correlation with the uranium and thorium is low.

Table 4: Pearson correlation coefficient, r, U and Th with surface dose (μSv/hr).

	U	Th	Surface dose	Surface dose(1m)
Uranium	1	0.973	0.372	0.455
Thorium		1	0.317	0.385
Surface Dose			1	0.22
Surface Dose (1m)				1

Results show that the TNJS7 location gives the highest concentration of Uranium and Thorium which is 0.75 ppm and 3.19 ppm compare to the other locations. The same goes to the lowest concentration of Uranium and Thorium was at TNGS location which is 0.46 ppm and 2.02 ppm. These shows that the concentration of uranium and thorium was link to one another, as confirmed as the correlation coefficient, r in the Table 4 above.

CONCLUSION

The surface dose rate from the study area is 0.125-0.277 μSv/hr indicate the normal range which is below global range of 0.5-1.3 μSv/hr set by UNSCEAR . The concentration of uranium in the study area is 0.46 μg/g to 0.75 μg/g is low comparing to the world average value which is1.8 μg/g (Cooper *et. al*., 2003). The concentration of thorium in the study area is also low which is 2.02 μg/g to 3.19 μg/g comparing to the world average value 6.2 μg/g (Cooper *et. al*., 2003). To conclude the data can be used as a baseline data for Malaysia.

ACKNOWLEDGEMENT

The authors would like to thanks the Ministry of Higher Education (MOHE) for the FRGS grant.

REFERENCES

Ahmad, N., Matiullah, L., Khataibeh, A.H., (1997) Indoor radon levels and natural radioactivity in Jordanian soil. *Radiat. Protect. Dosim.* 71 (3): 231–233.

A.Termizi ramli,A.Wahab M.A Hussein,A.Khalik Wood., (2005) Environmental U-238 and Th-232 concentration measurements in an area of high level natural background radiation at Palong, Johor, Malaysia. *Journal of Environmental radioactivity* 80: 287-304

Asha Rani, Surinder Singh (2005) Natural radioactivity levels in soil samples from some area of Himachal Pradesh, India using gamma ray spectrometry. *Atmospheric Environment* 36: 6306-6314

Cooper J.R, Keith Randle,Ranjeet S.Sokhi (2003) *Radioactive releases in the environment: impact and Assesment,*England John Wiley & Sons,Ltd.

Chiozzi, P., Pasquale, V., Verdoya, M., (2002) Naturally occurring radioactivity at the Alps-Apenninestransition. *Radiat. Measur*. 35: 147–154

Degerlier.M, G Karahan,G Ozger (2008) Radioactivity Concentration and Dose Assessment for Soil Samples around Adana Turkey, *Journal of Environmental Radioactivity* 99(7):1018-1025

IAEA, 1996.International Atomic Energy Agency. Radiation Safety. IAEA Division of Public Information ,96-00725 IAEA/PI/A47E

Pantenburg, F.J., T.Beier, F.Hennrich ,H.Mommsen (1992).The Fundamental Parameter Method Applied to X-ray Fluorescence Analysis with Synchrotron Radiation, *Nucl Instrum Methods Phys.Res*. B68: 125-132

Taskin.H, M. Karavus, P.Ay, A. Topuzoglu, S.Hiridoglu,G.Karahan (2009),Radionuclide concentrations in soil and lifetime cancer risk due to gamma radioactivity in Kirklareli,Turkey, *Journal of Environmental Radioactivity*.100**:** 49-53

UNSCEAR, (2000) United Nations Scientific Committee on the effects of Atomic radiation, sources and Biological effects of ionizing Radiation United Nations, New York.

Surinder Singh,Asha Rani,Rakesh Kumar Mahajan (2005), ^{226}Ra,^{232}Th and ^{40}K Analysis in Soil Samples from some areas of Punjab and Himachal Pradesh, India using Gamma ray spectrometry, *Radiation measurement*.39: 431-439

Zaini Hamzah, Masitah Alias, Ahmad Saat, Abdul Khalik Wood, Zakaria Tajuddin (2007) Surface Radiation Dose Measurement and Mapping of Jengka 15 Oil Palm Land, *The Malaysian Journal of Analytical Science.* 11: 237-245