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Environmental radiology of Kelantan state, Malaysia

Nuraddeen Nasiru Garba¹, Ahmad Termizi Ramli² and Muneer Aziz Saleh^{3,4}¹Ahmadu Bello University, Nigeria²Universiti Teknologi Malaysia, Malaysia

Natural environmental radioactivity arises mainly from primordial radionuclides such as ^{40}K and also from ^{238}U and ^{232}Th decay series and has always been present in a variety of concentrations in every part of the earth's mantle and in the tissue of every living being. Natural radioactivity can be found almost everywhere; in soil, public water supplies, oil and atmosphere. The present study was aimed at providing the base line data of Terrestrial Gamma Radiation Dose rates (TGRD), natural radioactivity concentrations and the corresponding radiological health hazards in the environments of Kelantan state, Malaysia. TGRD were measured using a micro roentgen survey meter model 19 manufactured by Ludlum, from 150 and 145 locations. A total of thirty six (36) soil and five (5) water samples from major rivers were collected. The soil samples were analyzed using a high purity germanium detector (HPGe) and Genie2000 software, while the water samples were analyzed at Malaysian Nuclear Agency using atomic absorption spectrometry (AAS) for ^{40}K and inductively coupled plasma mass spectrometer (ICP-MS) for U and Th activity concentrations. The measured TGRD mean values of 209 nGyh^{-1} which is about three times the world and two times Malaysian averages of 59 nGyh^{-1} and 92 nGyh^{-1} , respectively. The mean activity concentrations of ^{226}Ra , ^{232}Th and ^{40}K in the soil samples was found to be 82 Bqkg^{-1} , 123 Bqkg^{-1} and 643 Bqkg^{-1} , respectively. ^{226}Ra and ^{232}Th are three times the world average values of 32 Bqkg^{-1} and 45 Bqkg^{-1} , while ^{40}K is slightly higher than the world average value of 420 Bqkg^{-1} . For water samples, the mean activity concentrations of U and Th and activity concentration of ^{40}K was found to be 13 mBqL^{-1} , 4 mBqL^{-1} and 1119 mBqL^{-1} . The health hazard impact of radium equivalent (Raeq), annual effective dose (AED), and external radiation hazard index (Hex) which are indicators of radiological health hazards were computed as 307 Bqkg^{-1} , 1.28 mSvy^{-1} and 0.83 which are on the average higher than both the world average and Malaysian average but were still within the recommended values of 370 Bqkg^{-1} , 0.48 mSvy^{-1} and unity, thus should not pose any significant danger to the populations. Statistical relationships between TGRD with underlying geological formations and soil types were obtained. Isodose contour maps which shows the distribution pattern of TGRD for the state was produced.

nurangetso@yahoo.com

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