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Radiological risk assessment due to Naturally Occurring Radioactive Material (NORM) in the proposed radioactive waste storage area of Pilikwe, Botswana, using Radiometrical techniques.

Abstract

Determination of NORM concentrations followed by the radiological risk assessment were conducted and then characterised based on the activities of the identified nuclides for the different stages of the radioactive waste storage facility to be constructed at Pilikwe village of central district in Botswana. Sixty soil and two borehole water samples were collected representing the area of construction site and its surrounding. The radioactivity measurement was performed by means of high-resolution gamma-ray spectrometry in a low background configuration at the Centre for applied radiation science and technology laboratories, North west university. The high-resolution gamma-ray spectrometry attained activity concentration results for the soil samples show that max value for Ra-226 is 36.308 Bq/kg, min value is 6.658 Bq/kg and average value is 15.853 Bq/kg; max value of U-238 is 53.471Bq/kg, min value is 7.754Bq/kg and average value is 25.550Bq/kg; max value of Th-234 is 46.782Bq/kg, min value is 11.580Bq/kg and average value is 24.976Bq/kg and the max value for K-40 is 468.600Bq/kg, min value is 59.150Bq/kg and average value is 201.304Bq/kg for the Pilikwe area before any construction work of the radioactive waste storage facility is conducted.

The average estimated absorbed dose rate (D) for soil samples was 35.289 ± 2.261 nGy/h, which was lower than the worldwide absorbed dose rate of 57 nGy/h for soil. The average estimated annual effective dose equivalent (AEDE) from soil samples was 43.2782 ± 2.773 μ Sv/y, which was lower than the recommended worldwide value of 70 μ Sv/y for soils. The radium equivalent activity (Raeq) for soil was 76.775 ± 5.0509 Bq/kg. The external hazard index (H_ext) for soil was 0.207362 ± 0.014 . The mean Raeq values for soil, bottom ash, coal and fly ash were all below the worldwide accepted value of 370 Bq/kg. The average H_ext value for soil, was found to be below the worldwide recommended value of one. All the hazard indices show that the samples from Pilikwe village area and surrounding have acceptable indices with no hazard. Thus, a radioactive storage facility can be built in the identified location provided there is proper management and safeguarding the leaching of the stored radiative into waste into the soil, as well as having measures in place for monitoring and inspecting the NORM radioactivity concentrations of the area on specified time frames for assuring that there are no nonconformities

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