

- Original Article
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# Environmental Risks Assessment of Kaolin Mines and Their Brick Products Using Monte Carlo Simulations

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## Abstract

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This study aimed to assess the radiological health implications to humans due to the use of kaolin from kaolin mines in Nigeria. A calibrated RS-125 spectrometer was used in-situ to monitor the activity concentrations of  $^{40}\text{K}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and dose-rate of kaolin minefields in Ilorin-south and Ilorin-west, Nigeria. The in-situ monitoring and measurements were done in 90 locations selected at random in the study areas. The *in-situ* measurements were consolidated via laboratory analysis of 48 samples of Kaolin bricks using lead-shielded NaI(Tl) detector. The estimated average values for all radiological hazard parameters for the in-situ measurements of Ilorin-west are higher than that of Ilorin-south minefield. However, the opposite was the case with the laboratory analysis of the bricks. This apparent conundrum was due to the higher values of  $^{238}\text{U}$  observed in the samples of bricks from Ilorin-south. In addition, the measured activity concentration of the primordial radionuclides in the Kaolin bricks from both mines are lower than the on-site measurements. This was attributed to the contribution from other terrestrial materials on-site. The 5th, 50th, and 95th percentiles of the cumulative

probabilities for the excess lifetime cancer risk using the Monte Carlo simulation are  $167.00 \times 10^{-6}$ ,  $281.00 \times 10^{-6}$ ,  $414.00 \times 10^{-6}$  for Ilorin-west (in-situ),  $104.00 \times 10^{-6}$ ,  $232.00 \times 10^{-6}$ ,  $392.00 \times 10^{-6}$  for Ilorin-south (in-situ),  $706.00 \times 10^{-6}$ ,  $1,250.00 \times 10^{-6}$ ,  $1,900.00 \times 10^{-6}$  for Ilorin-west (lab), and  $742.00 \times 10^{-6}$ ,  $1,480.00 \times 10^{-6}$ ,  $2,460.00 \times 10^{-6}$  for Ilorin-south (lab), respectively. Therefore, the cancer risks are within the acceptable limits for both mining sites. This study is useful in developing radiation risk assessment models for decision makers in different fields of environmental sciences.

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## Data Availability

The data supporting the findings of this study are available on request from the corresponding author.

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#### Contributions

MMO conceived and designed the research work, performed the Monte Carlo Simulations, and wrote the paper. MMO, TBA and CAO collect the data, performed the risks analysis and compilation of the work. MT and MV contributed to the writing and final editing of the manuscript. MRU and KJO supervised the work and final editing of the manuscript.

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