Title: Natural radioactivity in soil and concomitant hazards in the BSCIC Industrial Area, Jhenaidah, Bangladesh: a pioneering study

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Abstract: Soil serves as both a repository and a pathway for natural radioactivity, influencing human exposure through the transfer of radionuclides into the food-chain and atmosphere. Industrial activities can further disrupt this distribution by introducing contaminants, potentially leading to environmental accumulation. This pioneering study investigates the activity concentrations of naturally occurring radioactive materials (NORMs) and assesses radiological hazards in soil from the Bangladesh Small and Cottage Industries Corporation (BSCIC) Industrial Area in Jhenaidah, Bangladesh. Thirty soil samples were systematically collected at radial distances of 100, 400 and 800 m from the industrial center. The range of activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K were found to be 20 ± 2 to 35 ± 3, 23 ± 2 to 55 ± 4, and 420 ± 32 to 610 ± 51 Bq kg^{-1}, respectively, while the activity concentrations of certain ^{226}Ra, most ^{232}Th, and all ^{40}K exceed the global average values of 30, 35, and 400 Bq kg^{-1}, respectively. Notably, ^{40}K levels remain relatively consistent across the study area, whereas ^{226}Ra and ^{232}Th concentrations tend to decrease with increasing distance from the industrial site. The elevated radionuclide levels may be attributed to local geological formations rich in heavy minerals, industrial processes that redistribute these elements, and anthropogenic activities such as waste disposal and construction. Additionally, Sample 16 (23.5422849°N, 89.1951063°E) exhibited trace amount of ^{137}Cs (1.84 ± 0.26 Bq kg^{-1}), indicating possible contamination from past nuclear fallout events such as Chernobyl or Fukushima. While radium equivalent activity and hazard indices remain within safety limits, certain outdoor absorbed dose rates, external effective doses, gamma representative level indices, and excess lifetime cancer risks exceed recommended thresholds, raising concerns about potential long-term health risks. These findings underscore the need for cautious land use planning, particularly for agricultural and construction purposes. Furthermore, this study provides essential baseline data to monitor radioactivity in industrial zones before the commissioning of the Rooppur Nuclear Power Plant.

Keywords: Soil, natural radioactivity, radionuclide distribution,radiological hazards industrial contamination, BSCIC Industrial Area

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