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An Integrated Baseline Environmental Radioactivity Assessment Across Various Exposure Pathways

Monitoring natural radionuclides in the environment is important for establishing baseline radioactivity levels that support the evaluation of public exposure. The study presents baseline environmental radioactivity levels measured in collected soil, external gamma, water and indoor radon samples to assess resultant public doses through external, inhalation and ingestion exposure pathways.

The soil media comprised six (6) beach sand samples, seven (7) sediments, and twenty-two (22) surface soils. Water samples included twelve (12) surface water, five (5) seawater, and sixteen (16) groundwater samples, which were analysed for natural radionuclides originating from the Uranium-238, Uranium-235 and Thorium-232 decay series. External gamma radiation measurements were conducted at fifty-three (53) locations, and indoor radon concentrations were measured in fifteen (15) dwellings. The water and soil samples were analysed using calibrated gamma spectrometry and alpha spectrometry. External gamma radiation was measured in situ using a calibrated portable gamma survey meter (RS-230) to determine ambient dose rates. Passive solid-state nuclear track detectors were deployed in dwellings for a period of three (3) months to measure indoor radon (Radon-222) concentrations.

The radioactivity levels measured in soil samples were found to be significantly lower than the reported worldwide average values of 420 Bq/kg for Potassium-40, 32 Bq/kg for Radium-226, and 45 Bq/kg for Thorium-232. The calculated radiological hazard indices, including radium equivalent activity and external hazard index, were also below internationally recommended safety limits. Similarly, radioactivity levels in water samples were below the World Health Organisation's (WHO) recommended drinking water reference levels, corresponding to an annual committed effective dose of less than 0.1 mSv/year. The measured external gamma dose in the study area due to natural background radiation was below the reference level of 1 mSv/year, which is the public dose limit for planned exposure situations. Indoor radon concentrations were generally below the 100 Bq/m^3 reference level recommended by the World Health Organisation, except for one measurement (117 Bq/m^3), which was nonetheless below the 300 Bq/m^3 action level recommended by the International Atomic Energy Agency (IAEA). Further investigations indicated that the elevated level was unlikely to be attributed to underlying geology but may instead be attributed to factors such as building characteristics or ventilation.

The results of this study provide integrated baseline data of environmental radioactivity levels, which are relevant for environmental monitoring and assessment of public exposure. These findings support radiation protection and safety initiatives.

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