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Terrestrial background radiation study in Norochcholei in the north western coast of Sri Lanka

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Abstract

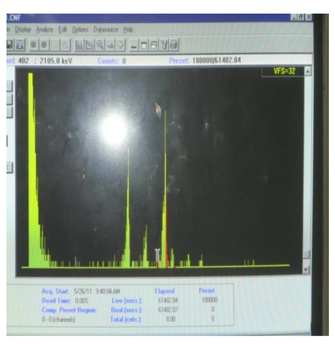
Radiation from natural sources can be broadly classified in to two, namely, terrestrial radiation and extra-terrestrial radiation. Terrestrial radiation originates from natural radio-nuclides present in rocks, soils, atmosphere, and the hydrosphere. Extra terrestrial radiation or cosmic radiation having very high energy originates from the sun. In most of the cases, radiation exposure from natural sources is not harmful to humans. But health protection measures need to be considered. This study assesses radiation levels in soil, water and air in Norochcholei area which is situated in the North Western coast of Sri Lanka. Background radiation levels at 1m height was recorded using a survey meter (automess dose rate meter 6150AD). Superficial soil samples from 23 locations and water samples from 15 locations were analysed by Gamma spectrometry. The activity concentration of natural radionuclides in the soil and water samples were measured by using a HPGe detector having a relative efficiency of 32.6% at ISO 17025 accredited Gamma spectrometry laboratory of the Sri Lanka Atomic Energy Board. The radioactivity concentrations of ^{232}Th,^{40}K,^{226}Raand ^{210}Pb radionuclides in the soil and water samples were measured. The median radioactivity concentration(range) of ^{232}Th,^{40}K,^{226}Ra and ^{210}Pb were 56.0Bqkg^{-1}(16-256), 96Bqkg^{-1}(62.5-294)24Bqkg^{-1} (0.7-83Bqkg^{-1}) and 27Bqkg^{-1} (13-81Bqkg^{-1}), respectively. The mean background radiation level was 0.1µSv h^{-1}. The gamma ray absorbed dose rates due to ^{32}Th, ^{40}K and ^{226}Ra ^{2} in soil samples varied between 13.9 nGyh^{-1} and 202.8 nGyh^{-1} with an average of 61.0 nGy h^{-1} which is higher than the global average of 57 nGyh^{-1}. The mean effective dose was 74.9 μSv.y^{-1}. Radium equivalent activity ranged from 30.3-458.4 Bqkg^{-1} with a mean of 136.5 Bqkg^{-1}. Only one sample recorded an radium equivalent activity above 370 BqKg-1 which is the limit set by the NEA group of experts as safe to be used in building materials, thus the soil from this area is suitable for construction of buildings. The absorbed dose rate did not correlate with the background radiation levels detected (p= 0.727). The annual effective dose due to the terrestrial radiation (0.074 mSv.y^{-1}) was less than the worldwide average of annual effective dose from natural background radiation due to terrestrial gamma radiation (0.46 mSv.y^{-1}). Radioactivity was not detected in any of the water samples. The gamma ray absorbed dose rate in soil samples is higher than the global average. The annual effective dose due to radioactivity in soil samples is lower than the world average of 0.48mSvy^{-}. Radium equivalent activity is lower than the worlds average. Thus the soil from this study area is safe for human health.

Introduction

Most nuclear power plants release gaseous radioactive material into the air and chemically mobile radionuclides into the sea in the case of a radiation accident. Norochcholai, in the Puttalam district was chosen for the study as this population is the closest to the Kundankulam nuclear power plant in India (about 200 km away from Kundankulam). This study assessed background radiation in relation to soil, water and air. The concentrations of thorium, potassium, and radium in the earth is commonly measured by Gamma ray spectrometry. The exposure to radiation by the residents can be calculated using values obtained by Gamma spectrometry.

Method

The soil and water samples were collected from residences of selected persons in the north western coast of Sri Lanka such that the entire area is represented. Superficial soil samples from 23 locations and water samples from 15 locations were analysed by Gamma spectrometry.



1 kg of soil samples were taken from homesteads 10 feet and 6” deep in front of the front door of the house of selected participants. The samples were immediately brought to the laboratory for analysis in sealed dark plastic bags. soil samples were prepared for Gamma spectroscopic analysis. Samples were hermetically sealed and stored to achieve secular equilibrium for three weeks before analysis. Background radiation levels in homes of all participants were monitored by using a calibrated (automess dose rate meter 6150AD) survey meter.

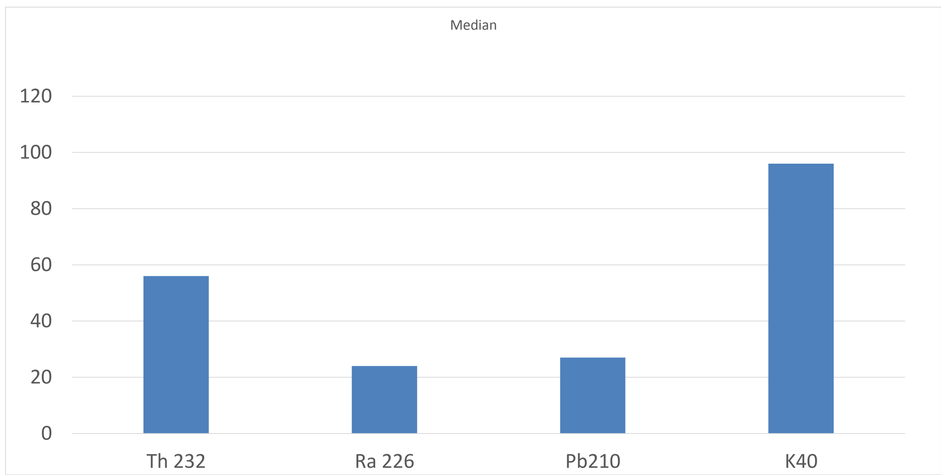
The specific activities of the radionuclides ^{40}K, ^{226}Ra , ^{232}Th, ^{210}Pb in the collected samples were measured in the hyper- pure germanium detector (HPGe)(model: Gx3020) with a relative efficiency of 32.6% and an energy resolution of 1.84 keV at 1.3 MeV gamma line of ^{60}Co. Relevant spectra were analyzed using the GENIE 2000 data acquisition Canberra software .

Results & Discussion

Table 1. Median activity concentration and range for ^{40}K, ^{226}Ra, ^{210}Pb and ^{232}Th in soil samples (Bqkg^{-1})

	Th ^{232}	Ra ^{226}	Pb^{210}	K^{40}	Dose rate (µSv h-1)
Median	56	24	27	96	0.1
Minimum	16	0.7	13	62.5	0.05
Maximum	256	83	81	294	0.13
25th percentile	32	14	23	82	0.09
75th percentile	89	40	43	108	0.11

Figure1. Median activity concentration and range for ^{40}K, ^{226}Ra, ^{210}Pb and ^{232}Th in soil samples (Bqkg^{-1})



The average gamma ray absorbed dose rate (61.0nGyh^{-1}) in soil samples is higher than the global average (57nGyh^{-1}). The annual effective dose due to radioactivity in soil samples (0.074 mSv.y^{-1}) is lower than the world’s average (0.48mSvy-^{1}). Kundankulum has reported a higher mean ^{232}Th activity concentration than the present study.

Figure 2. Correlation between ^{232}Th and ^{226}Ra (Bqkg^{-1})

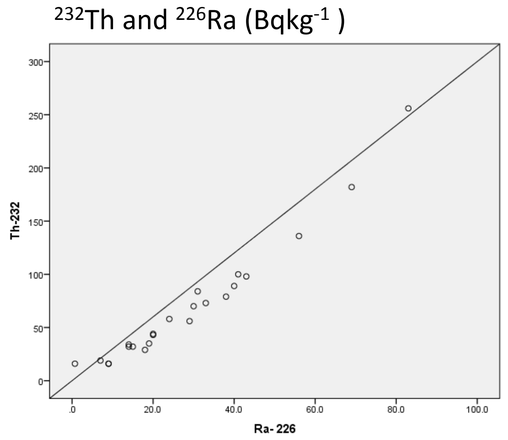
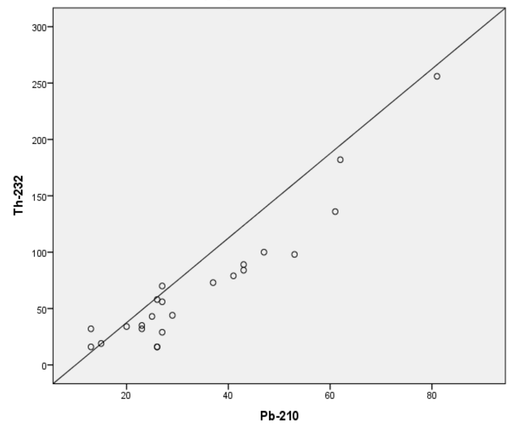


Figure 3. Correlation between ^{232}Th and ^{210}Pb (Bqkg^{-1})



There was a significant positive correlation between radioactivity concentrations of ^{226}Ra and ^{232}Th and ^{232}Th and ^{210}Pb (figures 2 & 3).

According to the International Atomic Energy Agency, emergency planning category states “all countries within 300 km are notified for a General Emergency at a large reactor site (transnational emergency)”. Norochchalai in Sri Lanka is about 200 kms from Kundankulam nuclear power plant located in southern India. Therefore emergency preparedness of this area is important.

Conclusion

The annual effective dose due to radioactivity in soil samples is lower than the world average. Radium equivalent activity is also lower than the world average. Thus the soil from this area is safe for human health.

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