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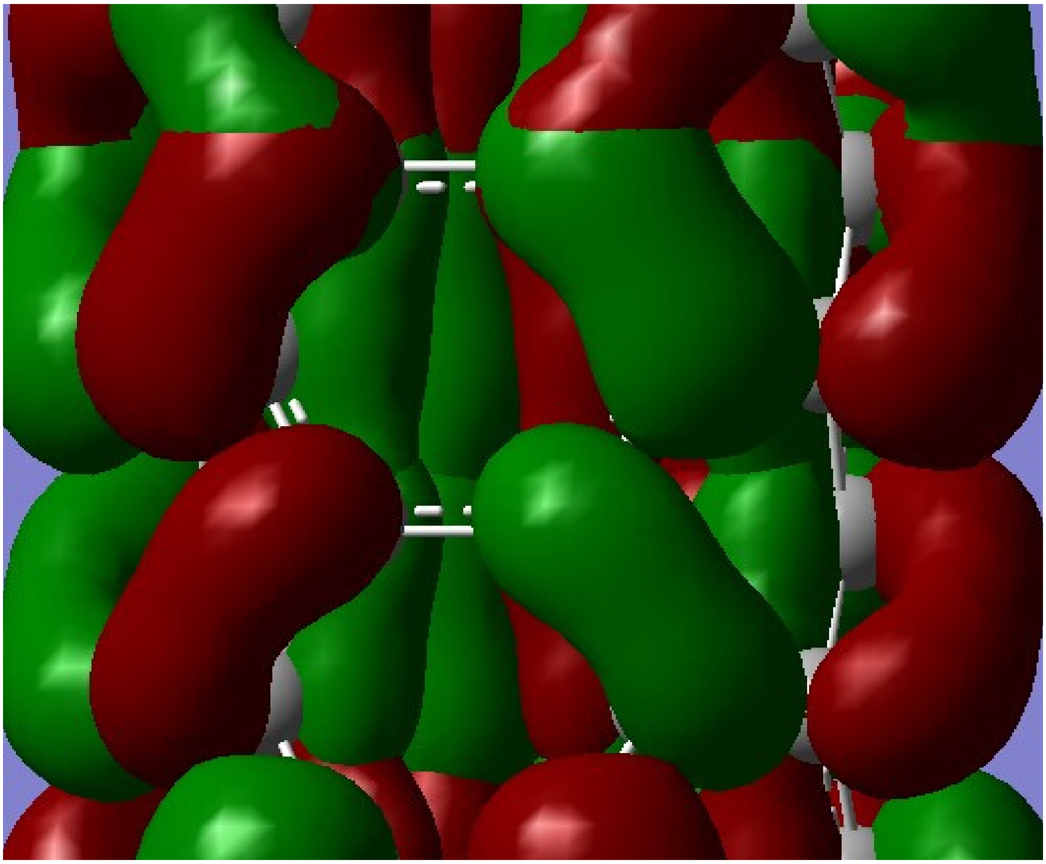

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Outdoor effective dose and associated health risk in the premises of Tribhuvan University in-situ gamma ray spectrometry

Research Article

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Abstract: The gamma radiation present in the environment contributes to radiation dose intake which is hazardous for the people.The outdoor terrestrial radiation dose in the premises of Tribhuvan University, Kirtipur, Nepal is estimated by measuring absorbed dose rate in air by in-situ gamma ray spectrometry using NaI(T1) scintillation detector, PGIS-2 (0.3 litre).The natural radionuclides present in the surface of the earth crust and the building materials (^{238}U, ^{232}Th, ^{40}K) are the major source of gamma radiation. The absorbed dose rate in air was found in the range of 76.896 nGy/h to 205.100 nGy/h. The outdoor Annual Effective Dose (AED), calculated from the average absorbed dose was found 0.142 mSv/y which is higher than the world average value; however, the Excess Lifetime Cancer Risk (ELCR) is found to be 5.17×10^{-5} which suggests that there is no any associated risk due to the radiation.

Keywords: Absorbed dose rate • Gamma Ray Spectrometry • AED • ELCR

1. Introduction

The natural radiation is always present in our environment in the form background radiation, in everything around us, i.e. soil, rock, water, air and vegetation. We are thus always exposed to the ionizing radiation due to natural radionuclides present in the environment. Cosmic rays, cosmogenic radionuclides, terrestrial radionuclides in the earth crusts and building materials, radionuclides inside the human body are the source of natural exposure. Terrestrial gamma radiation is the important source of human exposure. The primordial radionuclide ^{238}U, ^{232}Th, ^{40}K present in earth crusts and building materials provide significant dose to human. The absorbed dose rate in air measured by direct method gives more detail evaluation of the exposure [1].

Many naturally occurring elements have radioactive isotopes, but only potassium, uranium and thorium decay series have radioisotopes that produce gamma rays of sufficient energy and intensity as they are relatively abundant in nature. The major source of background radiation in soil or rock is ^{238}U, ^{232}Th, ^{40}K and in the range 2-3 ppm, 8-12 ppm, and 2-2.5%, respectively [2]. Some areas have very high dose rate and are known as

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high background radiation area (HBRA). The Ramsar in Iran [3], Kerala in India [4], Yangjiang in China [5] and Guarapari in Brazil [6] have high background radiation. The high dose rate is also reported independently in various places of India [7] and in Malaysia [8, 9].

The aim of this work is to study the dose rate due to background radiation to estimate the associated health risk in the premises of Tribhuvan University and to prepare the radiological map of the study area, which contains old and new buildings, made of different materials (red bricks, clay, cement, stones, wood etc), thick vegetation and agricultural land. The rocks at this altitude, building materials and the fertilizers used for agriculture can enhance the background radiation. This area is of high importance due to the fact that a large number of radioactive sources are used in science departments, mainly in physics and chemistry. So, it is worth performing radiological survey of the Tribhuvan University Premises and to estimate the associated health risk for human. Gamma ray spectrometry is widely used for this purpose of measuring absorbed dose rate in air [1]. The spectrometer are generally semiconductor detector or scintillator detectors. Even though semiconductor detector has high resolution, scintillator detector is more efficient as it has higher detection efficiency [2].

Study Area

Tribhuvan University lies in Kirtipur municipality in the south-west of Kathmandu, the capital city of Nepal, It covers an area of 154.77 hectares with valley and hilly region (www.tribhuvan-uiversity.edu.np). The Tribhuvan University premises lies within the north latitude of 27.6760 to 27.6830 and east longitude of 85.2810 to 85.2950 and the altitude varies between 1283.5 m to 1350.2 m. The location map of the survey site is shown in Fig. 1

Figure 1. Location map of the survey site (Ref. Google Images)

2. Methodology

For the present study, a portable gamma ray spectrometer (PGIS-2) is used which consists of a 0.34 liter crystal of NaI(TI) [10]. The data with GPS location is recorded in data logger unit connected with detector via blue tooth. The detector is carried in a backpack and walked along the road and inside the departments of Tribhuvan University with speed less than 1 km/hr. The data along with GPS position get recorded in data logger unit which is analyzed later in laboratory using different softwares.

The outdoor Annual Effective Dose (AED), expressed in nSv, is calculated by using the following equation [1],

$$AED = D \times 8760 \times OF \times CF$$

where D is the average absorbed dose rate in nGy/h, CF is the conversion factor (= 0.7 Sv/Gy; to convert absorbed dose rate in air to effective dose equivalent for humans), OF is the outdoor occupancy factor (=20%) and 8760 is the total hours in one year.

The Excess Life Time Cancer Risk (ELCR) is calculated from AED using the equation [11],

$$ELCR = AED \times LE \times RF$$

where LE is Life Expectancy (66.2 year in Nepal) (http://en.worldstat.info/Asia/Nepal) and RF is the fatal risk per Sv (= 0.055, as recommended by ICRP for stochastic effect from low dose rate).

3. Results and Discussion

The absorbed dose rate in air is found in the range 76.896 nGy/h to 205.100 nGy/h with an average value of 115.845 ± 26.617 nGy/h. The value increases near the walls and is maximum close to the nuclear laboratories. The AED is found to be 0.142 mSv/y, which is higher than the world average AED for outdoor terrestrial radiation (= 0.07 nSv/h; [1]).

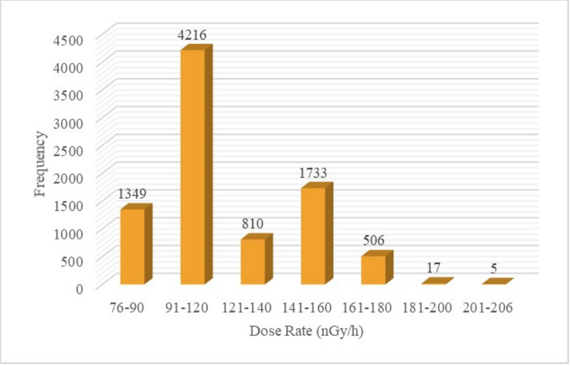

Figure 2. Frequency of dose rate

The frequency of dose rate distribution is shown in Fig. 2, which indicates the dose rate value of 91-120 nGy/h is the most repeated value. The smaller values are mostly inside thick vegetation, where there are no buildings and no coal tarred road. The highest value measured was near the nuclear laboratories, as expected.

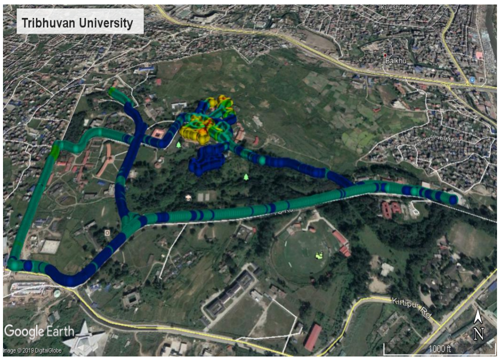

Figure 3. Radiological map of Tribhuvan University

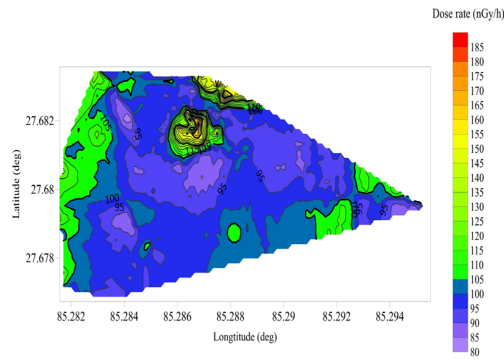

Figure 4. Contour map of Tribhuvan University

The radiological map showing dose rate and contour map of Tribhuvan University Premises is shown in Fig. 3 and 4 respectively. The domination of blue and green colour in the map means most of the region lies below 160 nGy/h dose rate.

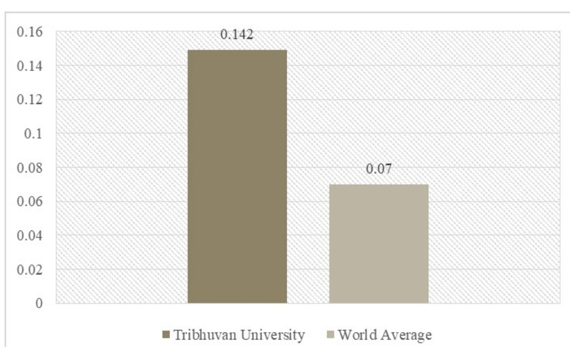

Figure 5. AED (mSv/y) at Tribhuvan University in comparison to world

The outdoor AED of Tribhuvan University Premises was found to be 0.142, which is more than twice the world average from terrestrial radiation (see comparative plot in Fig. 5). The resulting ELCR value is also higher than the world average value of 0.29×10^{-3} [12]. The risk of developing cancer due to ELCR value higher than the world average value was reported negligible [13].

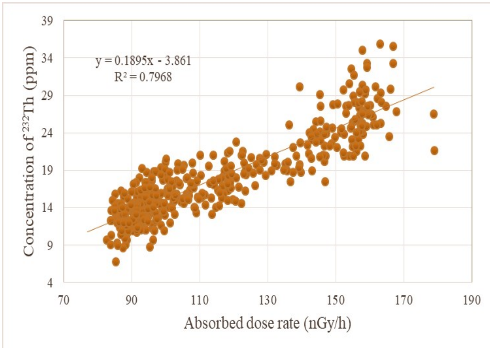

Figure 6. Correlation between absorbed dose rate and concentration of ^{40}K

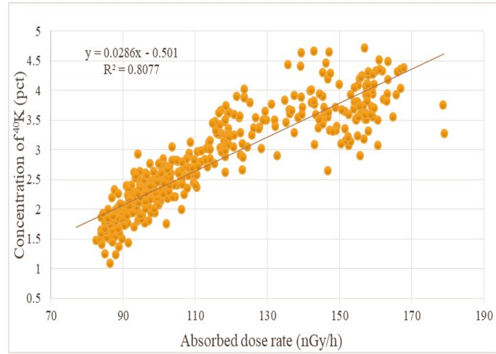

Figure 7. Correlation between absorbed dose rate and concentration of ^{232}Th

The absorbed dose rate in Tribhuvan Unversity Premises shows high correlation with the concentration of ^{40}K and ^{232}Th (Fig. 6 and 7). The natural radionuclides (^{238}Ur, ^{232}Th, ^{40}K) in earth crust and building materials are found to be the sources of background radiation. The increase in dose rate was found towards the wall of the buildings as the building materials is also contributors to the dose [14].

4. Conclusions

The outdoor background radiation of Tribhuvan University in Kirtipur, Nepal is studied using gamma ray spectrometry. The outdoor Annual Effective Dose (AED) is found to be higher than the world average but is still below the ICRP recommended value. The Excess Life Time Cancer Risk (ELCR) is also higher than the average value but no any associated health risk was found. The study confirmed that the background radiation is below the world average annual effective dose from exposure to natural sources of radiation, 2.4 mSv/y [1] and dose limit recommended for public, 1 mSv/y [11]. Hence, the people have no risk of radiological hazard in the study site.

5. Acknowledgements

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