

Assessment of Environmental Gamma Dose Rate in Ho Chi Minh City, Vietnam

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Assessment of environmental gamma dose rate in Ho Chi Minh city, Vietnam has been conducted to establish a baseline data of gamma dose rate. Soil samples were collected at 120 locations distributed widely in the city and the gamma dose rate at 2245 locations using a portable dosimeter installed on a motobike with GPS integrated and positioned 1 m above the ground surface. Cumulative gamma dose rates have also been measured using the TLD dosimeters located at 20 fixed locations around the city to evaluate the total component and the contribution of cosmic rays in the rainy and dry seasons. The gamma dose rates in the city were found in the range of 0.05–0.18 $\mu\text{Sv/h}$ with the average value of 0.10 $\mu\text{Sv/h}$. The cumulative gamma dose in the dry season is greater than that in the rainy season by about 15%.

Introduction

Ho Chi Minh city is located on the South of Vietnam. The area of the city is about 2095 km^2 , and the population is about 9.0 millions. The altitude of the city is within 1–32 m above the sea level. The city consisting of 24 districts is the biggest city of the country, contributing significantly in the transportation and economic development in the southern region of Vietnam and Southeast Asian countries. Therefore, further comprehensive assessment of natural radioactivity in the city for the purpose of baseline data establishment and environmental protection is considerably beneficial.

Two main sources of exposure of humans to environmental radiation are terrestrial gamma rays and cosmic rays. Terrestrial gamma rays are mainly from the primordial radioactive nuclides occurring naturally in soils, rocks existing in the earth's crust and building materials, such as ^{238}U , ^{232}Th series and ^{40}K .

The terrestrial gamma radiation level and associated external exposure due to the natural radioactivity, in particular outdoor gamma dose, depend on the geological structure and the activity concentration in the soil.

Instruments and Methods

Among several techniques for measuring gamma dose rate, portable survey meter, thermoluminescent dosimeter (TLD) and gamma spectrometer are widely used [1–8]. In this study, three methods have been applied in this study including the environmental radiation monitoring by surveymeter (model FH-40-Eberline) with GPS. The second one was an

indirect method combining the sampling and analysis of gamma radioactive isotopes in soil in order to determine the specific activity of natural and artificial radioactive isotopes in soil, thereby applying the dose conversion method and specialized software to calculate the external radiation dose [9,10]. For the last method, Thermoluminescent Dosimeter (TLD) was used.

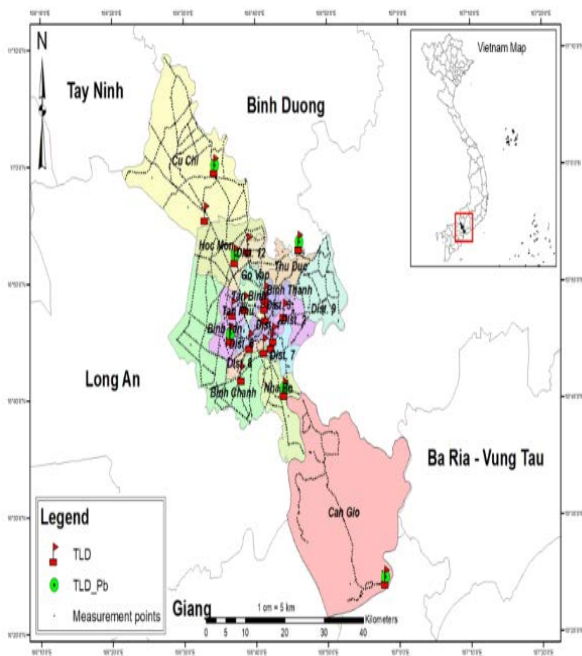


Fig.1. Map of Ho Chi Minh city and the locations of gamma dose measurement.

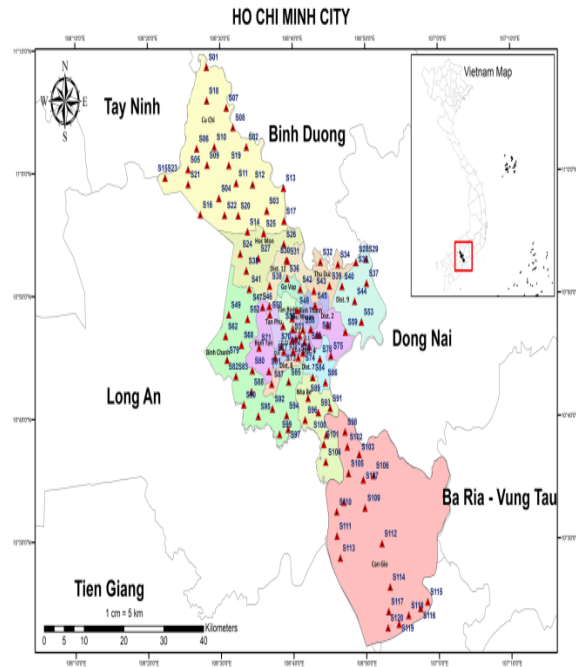


Fig.2. Map of Ho Chi Minh city and the locations of soil samples.

Collection of surface soils was carried out at 120 locations distributed evenly in 24 districts of Ho Chi Minh city as shown in Fig. 1. Measurements of activity concentrations in the soil samples were carried out using a low background gamma spectrometer with an HPGc detector (model GX3019). The relative detector efficiency is 30%, and the energy resolution is 1.90 keV FWHM at the 1332 keV peak of ^{60}Co . The measured gamma spectra were processed using MAESTRO-32 software.

The TLD dosimeters were installed at 20 positions distributed evenly in the city for measuring the cumulative gamma doses in air. One of the two TLD dosimeters was included with a lead shielding layer (TLD_Pb) to prevent the gamma rays coming from surface soils for measuring only the cumulative gamma dose from the cosmic rays. The other TLD dosimeter was used without the lead shielding layer for measuring the total cumulative gamma dose in air, i.e., including the components of gamma doses from cosmic rays and surface soils.

Measurement of the gamma dose rates in air at 2245 locations distributed evenly in the 24 districts of the city was performed using the portable dose survey FAG FH 40 dosimeter. This measurement was conducted by installing the FAG FH 40 dosimeter on a motobike and driving on the main roads of the city.

Results and Discussion

Figure 3 displays the distribution of the gamma dose rates in the city plotted from 2245 measured points. The average gamma dose rates in all districts are approximate, within the values from 0.10 to 0.11 $\mu\text{Sv/h}$. This means that the difference of the average gamma dose rates from district to district, as well as compared to the average value of the whole city, is within 10%.

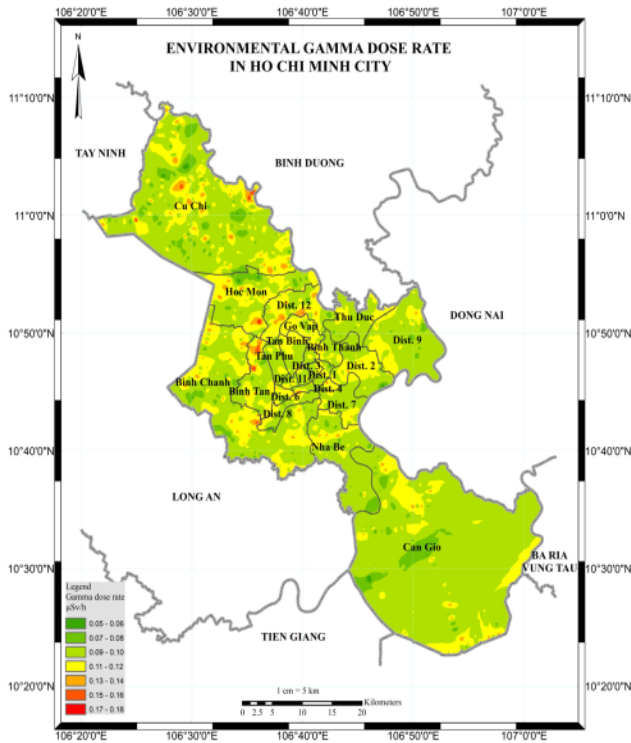


Fig.3. Distribution of environmental gamma dose rate in Ho Chi Minh city.

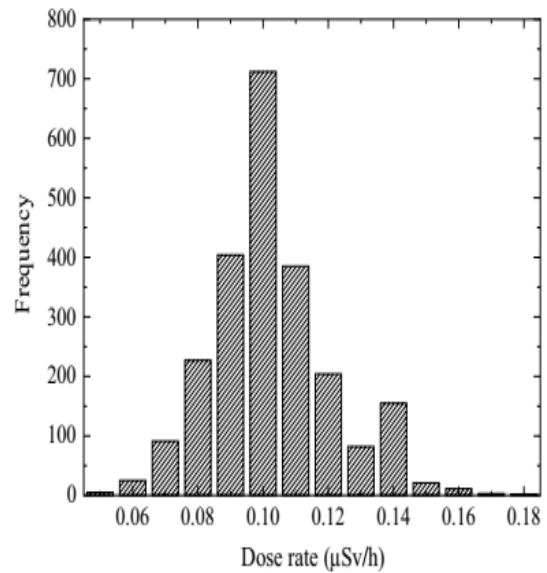


Fig.4. Frequency distribution of total gamma dose rates in air at 2245 locations in Ho Chi Minh city measured by the FAG FH 40 dosimeter.

For further statistical analysis, Fig. 4 displays the frequency distribution of the gamma dose rates measured at 2245 locations in the city. One can see that the gamma doses rates in air in Ho Chi Minh city follow the symmetrical distribution around the mean value.

Figure 5 displays the correlation of the gamma doses measured directly in air and that calculated from the radioactivity in surface soils. The correlation coefficient (r^2) between the measured and calculated values is 0.6336.

Figure 6 displays the cumulative dose rates in the rainy and dry seasons measured by the TLD dosimeters at 20 locations distributed evenly in the city. It can be seen that the cumulative doses measured in the dry season are greater than that in the rainy season by about 15%.

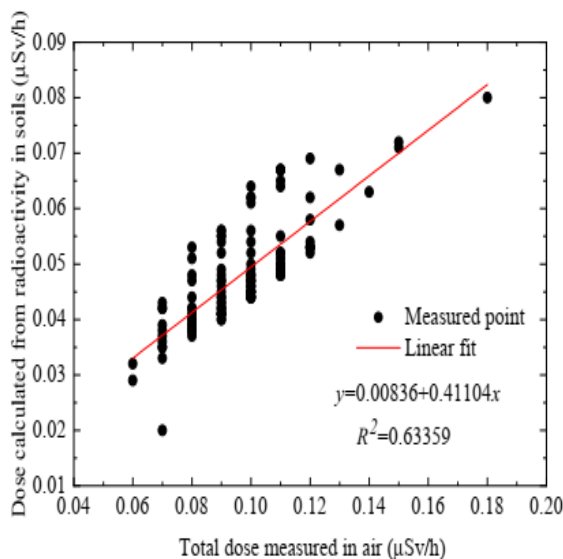


Fig.5. Correlation between the total gamma dose measured in air and that calculated from radioactivity in surface soils in Ho Chi Minh city.

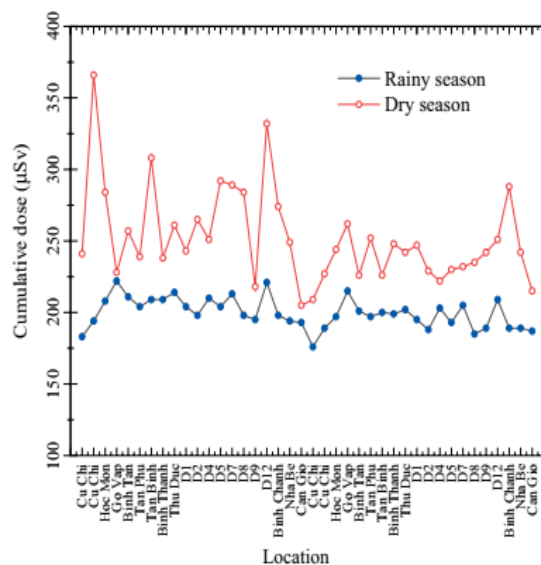


Fig.6. Cumulative gamma doses in the rainy and dry seasons measured by the TLD dosimeters at 20 locations in Ho Chi Minh city.

Conclusion

Assessment of gamma doses rates in Ho Chi Minh city, Vietnam has been conducted by three methods including using the FAG FH 40 dosimeter installed on a motobike driven around the city, it was found that the gamma dose rates measured in air in the city vary in the range of 0.05–0.18 $\mu\text{Sv/h}$ with the average value of about 0.10 $\mu\text{Sv/h}$. Measurement of the cumulative gamma dose rates in rainy and dry seasons and the contribution of cosmic rays has also been conducted using 20 TLD dosimeters at fixed locations, the results shows that the average dose rate in the dry season is greater than that in the rainy season by about 15%. Measurement of environmental radioactivity of primordial radioactive nuclides in surface soils in Ho Chi Minh city has been carried out using an HPGe detector for establishing a database of activity concentrations and associated radiological hazards. The results show that the radiological hazard indices are much lower than the safety limits. This implies no significant effect to human health.

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